ANNEXURE-7

DESIGN PHILOSOPHY - INSTRUMENTATION

PURGE GAS RECOVERY UNIT
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1.0 INSTRUMENTATION AND CONTROLS

2.0 SCOPE

2.1 This section outlines the general requirements and specifications for Instrumentation and Control System for the PROJECT. The Instrumentation and Control System shall consist of but not limited to the following:

a. Extension of existing Distributed Digital Control System (Yokogawa CS-3000) located in Main Control Room for Ammonia-II Plant. The existing DCS philosophy shall be maintained.

b. One Operator station along with Functional Key Board for control and monitoring.

c. All Field Instruments including control valves.

2.2 The Contractor’s scope of supply for Instrumentation and Control by seller shall comprise the design, engineering, manufacturing, testing, supply, erection and commissioning of complete Field Instrumentation and control system required for fail safe startup, operation, control and shutdown shall therefore be the responsibility of the contractor. Contractor scope of supply shall consist of the following as minimum.

a) Preparation of general specification for Instruments.

b) Sizing of flow instruments, control valves, pressure relief valves etc., and preparation of Technical data sheets for all Instruments.

c) Preparation of engineering and construction documents like functional schematics, I/O list for DCS System, configuration diagram, electrical load list, cable schedule, cable tray/trench layout, instrument air requirement, nameplate schedule, JB schedule, instrument location layout, electrical instrument signal interface, instrument index, layout drawings, loop diagrams, interlock diagram, primary and secondary sketches and bill of materials.

d) Preparation of all engineering documents for DCS like graphic schemes, instrument loop data base, log formats and any other documents necessary to carry out the system engineering of DCS. Co-ordination with DCS vendor for system engineering, implementation, software testing, supply and final commissioning and site acceptance tests.

e) Preparation of specification for erection materials like cables, cable trays, pipe & pipe fittings, air tubing, junction boxes, air distribution pots etc.

f) Site supervision of construction, erection, testing and commissioning activities of field instrumentation and control room instrumentation activities.

g) Supply of all instruments, cable, Junction box, cable glands, cable trays with covers shall be supplied by bidder. Also, cable laying, wiring, tubing, piping, installation of cabinets, cable termination etc. shall be in the scope of bidder.
In case of contradiction / conflict among documents, Bidder shall refer to Owner for clarification. However, most stringent specification shall be followed with Owner’s approval. Owner decision shall be considered as final.

3.0 CONTROL PHILOSOPHY

3.1 Design and installation of instrumentation shall comply with codes and recommendations listed in item 5.0.

3.2 New Controller, power supply module, communication module, I/O module, system bus, barriers/isolators, relays etc. for DCS shall be installed in the new cabinets and shall be in the scope of bidder. The colour of the system/marshalling cabinet shall be same as that of existing ones. This new FCS/Controller shall be interlinked with the existing DCS system.

3.2 One number of Operator station along with Functional Key Board and with configuration specified in Annexure-I shall be supplied, having key board and 22” colour TFT LCD and optical mouse and one number Printer (Laser Jet B&W). Specification for all stations/computers/HMI shall be as per Annexure-I.

All Operator station consoles shall be lockable and have proper cooling arrangement. The colour and size of these consoles shall be the same as existing so as to maintain the aesthetic look of the control room.

3.3 The control & monitoring shall be available in new operator station as well as existing operator stations so that the proposed purge gas recovery unit can be monitored and operated from the existing operator stations also. The operating philosophy of DCS shall be the same as existing.

3.4 100% fault tolerance and dual redundancy in DCS shall be for Controller cards, all communication cards and buses, all control buses, all type of common cards in the system, all power supply modules, all I/O modules for closed loops and interlock I/Os. The failure of any single I/O module for open loop shall not affect more than the channels being catered by that particular I/O card. Dual redundant power supply modules for each dual redundant controller shall be dedicated.

3.5 There shall be panel segregation for various I/Os meant for DCS system. Also there shall be panel segregation for diff. type of I/Os for DCS and other control system.

3.6 Controller loading shall not exceed more than 50% (hardware and software load of controller) in any case, after implementation of complete project and running at peak load. In case more controllers are required to meet 50% loading criteria, bidder to include additional controllers without any cost implication.

3.7 There shall be some signal exchange between the existing DCS with the new system for control and monitoring. The new and old DCS system shall sit on the same bus for ease of monitoring and control. Requirement of additional DI, DO card etc. And modification in the interlocks and graphics in the existing DCS shall be in the scope of
the bidder. All interlocks shall be configured in DCS and also their alarming sequence/SOE..

3.8 All marshalling panels shall be 1200 mm (wide) x 800 mm (depth) x 2100 mm (height) and System panels shall be 600 mm (wide) x 800 mm (depth) x 2100 mm (height), RITTAL make, with 100 mm black powder coated metal base frame and with colour shedding of RAL7032 (Siemens Grey) and removable gland plates at bottom only. This applies to all types of instrument panels to be used in the whole project like various PDB, Electrical / Instrument panels etc.

3.9 There shall be 25% installed spares minimum 1, installed and wired capacity for I/O cards of each category in DCS, including all peripheral termination modules, prefab cables, Relays, Safety barriers, etc. 25% extra I/O counts above normal shall be considered for this. The minimum spares as per Annexure shall be above this qty.

3.10 All marshalling and system panels shall have minimum 25 % wired spare capacity for future expansion (should be possible with the same wiring philosophy.)

3.12 DCS-ESD communication is to be used only for transferring Status and Alarm signals from ESD to DCS.

No tripping parameters shall be interfaced through serial communication and soft links.

Transfer of data through serial link MODBUS/TCP from DCS to ESD and vice versa shall be used only for monitoring purpose and not for control & trip.

3.13 OEM commissioning engineers shall be present for all the commissioning activities for specialized instrumentation systems like DCS etc.

4.0 BASIS OF DESIGN

General

Instrumentation for the Purge gas recovery unit is to provide a highly reliable and comprehensive control and monitoring system. To facilitate these well proven techniques shall be adopted for measurement and control.

The following philosophy is to be adopted.

1. Same valve cannot be used for both Control and ON-OFF actions. Separate Control valve and ON-OFF valve to be provided with the Control valve wired to DCS and the ON-OFF valve wired to ESD.

2. All control valves shall be provided with SMART valve positioner with valve position signal feedback connected to DCS system by 4 to 20 mA analog signal. It shall be HART compatible.
3. Universal HART Protocol with Latest Revision shall be used in all cases.

4. Wago/weidmuller/Phoniex /Klippon make screwless terminal shall be used with single tier only.

6. All limit switches shall be proximity sensor type.

7. Cable entry to control room shall be through MCT blocks.

8. No head mounted temperature transmitters are to be used.

9. Turbine flow meter shall not be used, wherever required Mass flowmeter shall be used in place of Turbine flowmeter.

10. All Contacts shall be Gold Plated 2 SPDT.

11. No Direct Process Switches (Pressure / Level/ Flow / Temp.) shall be used. However, if it’s not possible to install transmitter for particular application online pressure/level switches (float type) may be used if the need arise.

12. Execution type for all field transmitters in hazardous area shall be intrinsic safe. Flame / ex. proof enclosures shall be provided where intrinsic certifications are not available.

13. All field transmitters for pressure, d/p, level and flow shall be microprocessor based (dual compartment) SMART transmitters with “UNIVERSAL HART” protocol with latest revision. The transmitter selection shall be such that the operating maximum upper limit shall be around 70% of the total measurement range of the transmitter. One Universal HART calibrator shall be supplied with the Project for calibration of the Transmitters.

14. All equipment/materials supply shall include spares required for 2 years operation and consumable for commissioning.

15. Inputs from thermocouples shall be provided with cold junction compensation and downscale burns out feature for high temperature shut downs and vice versa for low. Passive alarms shall warn about the burn-out.

16. Hardwired signals from MCC / Switchgear to interposing relays shall be potential free contacts.

5.0 INSTRUMENTATION CODE AND PRACTICES

IEC 13  
Diagrams, Charts and Tables, Preparation of Logic Diagrams

IEC 534  
Industrial - Process Control Valves

IEC 584  
Thermocouples

IEC 605  
Equipment Reliability Testing elements

IEC 611-12  
Part 12Graphical Symbols for Diagrams. Binary Logic

IEC 654  
Measurement and Control equipment
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6.0 HAZARDOUS AREA CLASSIFICATION & ELECTRICAL EXECUTION

6.1 The execution of instrumentation shall be as per area Zone 2, group IIC, T3, EExib and Protection.

Electrical / Electronic instruments IP 67
Sensors; RTD, T/C, etc. IP 65
Local Gauges; PG, etc. IP 55
Pneumatic instruments IP 54
Solenoid valves IP 67
Local Panel / Skid Mounted Panels IP 55

EMC compatibility and electrical safety as per latest IEC standard.

6.2 Electrical instrument equipment shall be designed for and supplied as intrinsic safe certified.
Analysers, solenoid valves and other equipment that cannot be classified intrinsic safe shall be ex-proof in accordance with the above mentioned electrical specification.

Certification for installation in hazardous areas in accordance with IEC 60079 series is shown below:

Transmitters, positioners, I/P converters, etc.: Ex ib IIC T3
Switches: Ex de IIC T3
Analysers and Panels: Ex p IIC T3
Solenoid Valves: Ex d IIC T3 (Ex md not allowed)
Junction Boxes and Cable Glands: Ex d IIC T3

7.0 ELECTRICAL SUPPLY

The electrical supply will be as follows:

Distributed Control System, trip system, and Control Room Instruments: 115V AC
Solenoid Valves: 110V AC
Local Panels: 115V AC
Local Illumination, equipment for air conditioning, space heaters, ventilation of local panels and similar purposes: 240V AC
Field-mounted Transmitters and switches: 24V D.C. intrinsic safe
Safety Circuits: 115 V AC

The 115V AC supply will be an uninterrupted power supply (UPS) of 115V +/- 10%, 50Hz +/- 3%.

Where 24V DC is needed, it will be generated by local rectifier units, which are part of the instrumentation supply. The power supply to these units shall be taken from the UPS.

Where 24V DC are used for Safety Circuits, the rectifier units shall be duplicated and with high reliability.

8.0 INSTALLATION

8.1 INSTRUMENT CABLE

8.1.1 Overhead Runs
Existing main instrument main cable tray from field junction boxes to main control building or local control room can be used for cable laying. In case, existing main cable tray space is not sufficient, bidder to lay the new cable trays with tray covers.
Instrument branched cable runs from junction box or local panel to each instrument and from JB to main cable tray in the field shall also be routed aboveground and supported with trays along with tray covers, steel angles and channels.

Single pair cables from instrument to junction box and branch cable tray shall be through perforated aluminum cable trays with covers.

Cable trays with Trays cover, Elbows, junctions and brackets, channels, special pieces and secondary cable support shall be made of aluminium.

Cable tray segregation shall be based on the voltage level. Cable tray shall be supported at every 3M. 20% spare to be considered in the cable tray filling.

Instrumentation cables that form part of intrinsic safe (IS) circuits, if any, Shall be segregated from other instrument signal cables.

Instrument power supply (AC) cables shall not run in the same tray of instrument signal cables. Cable tray shall be dedicated for laying instrument power cables separately from the signal cable tray.

### 8.2 CABLES

All cables shall have PVC insulated primary insulation of 85°C PVC as per IS-583. Inner and outer jacket shall be made of extruded flame retardant 90 ac PVC to IS-5831

All cables shall be FRLS as per standard IEC 332-3 Part 3 Cat. A. Fire resistance cables whenever specified shall be as per me 331 Cat. A.

The insulation grade shall be 600 V/1000 V as a minimum arid shall meet insulation resistance, voltage and spark test requirements as per BS-5308 Part-2

All cables shall be armored. Amour over inner jacket shall be of galvanized steel wire/flat as per IS-1554 part I / IEC 502. All the cores of single pair or multi-pair shall be twisted and numbers of twist shall not be less than 10 per meter.

For signal and control cables, inner jacket colour shall be black. Outer jacket colour shall be light blue, for intrinsically safe application and black for others. For thermocouple extension cables the inner and outer jacket colour shall be as per IS-8784.

L/R ratio of adjacent cores shall not exceed 40 µH / 0 for cables with 1.5 mm² conductor and .25 pH / 0 for cables with 0.5 mm² conductor.
Contractor shall ensure a minimum of 20% of quantity of each type of cables supplied as spare including any special cable. In each multipair cables 20% pairs shall be kept as spare.

8.2.1 Instrument Signal Cable

a) Single pair shielded signal/alarm cables shall be used between field instruments switches and junction boxes/local control panels.

b) Multipair individually and overall shielded signal/alarm cables shall be used between junction boxes/local control panels and control room.

c) The single pair/triad cables shall be 1.5 mm² conductor size made of annealed electrolytic copper conductor of 7 strands with each strand of 0.53 mm diameter. Multipair cables with 0.5 mm² conductor size shall have 7 strands of annealed electrolytic grade copper conductor with each strand of 0.3 mm diameter. Multi triad cable or multi pair cable with 1.5 mm² conductor shall have 7 strand with each strand of 0.53 mm diameter. Colour of core insulation shall be black blue in pair and black, blue and brown in a triad.

d) Shield shall be aluminium backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/triad and 0.075 mm in case of multipair/triad cable.

e) Drain wire shall be provided for individual pair and overall shield which shall be 0.5mm² multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.

f) All multi pair cables shall have 6 pair/12 pairs only while multitriad cable shall have 6 triads/8 triads only.

8.2.2 Cables and Multicore Cables for Solenoids etc.

Cables and multicore cables for such items as solenoid valves and flame detectors shall normally have a conductor size of 1.5 mm²; however, conductor sizes for power cables shall be co-ordinated with the Electrical Group to avoid too many different cable types. Solenoid cable shall be single run cable from marshalling cabinet upto the solenoid.

Signals (4-20 mA or switch 'contact): 6/12 pair individually and over all shielded (screened) and armored, twisted, 0.5 mm² conductor.

8.2.3 Thermocouple Extension Wires

a) Single pair shielded thermocouple extension cables shall be used between Thermocouple head and junction boxes transmitters/ local control panel mounted instruments.
b) Multipair individually and overall shielded thermocouple extension cables shall be used between junction boxes and main control room mounted devices.

c) The type of thermocouple extension cables shall be compatible with thermocouple used. In addition the colour coding of the primary insulation shall be as per ANSI.

d) The cable shall have 16 AWG and 18 AWG solid conductors for single and multipairs respectively.

e) All thermocouple extension cable shall be matched and calibrated in accordance with MC-96.1.

f) Shield shall be aluminium backed by mylar/polyester tape bonded together helically applied with the metallic side down with either side having 25% overlap and 100% surface. Minimum shield thickness shall be 0.05 mm for single pair and 0.075 mm for multipair cable. Drain wire shall be 0.5-mm2 multi-strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with the aluminum side of the shield.

g) Inductance shall not exceed 4mH/Km.

h) All multi-pair cables shall have 6 pairs/12 pairs only.

8.2.4 Power supply Cables

All power supply cables shall be as per IS-1554 Part I and shall have copper conductors. Minimum conductor size shall be 2.5 mm2. The cables shall be PVC insulated and armoured. The higher size conductors shall be used incase of long distance power cable where voltage drops more than 3 volts than required supply.

Any other special cable required for instruments that should also be supplied as per Requirements. CONTRACTOR shall ensure that these cables are armoured type and shall meet all other requirements.

8.3 JUNCTION BOX

a) Junction box shall be of stainless steel. Junction boxes shall be certified for weather proof with IP 65 certification for IS signal. For non IS signals, Junction boxes shall be flame proof for IEC Zone 1 & Gas group IIC Ex. Proof. Junction box shall have screwed covers. All entries to junction box shall be side or bottom.

b) In general a junction box shall contain only signal of same class. The signal class is categorized as following type:
   i) Signal Level
      - Analog
      - Digital
      - T/C
      - Solenoid Valve
      - Instrument Power
ii) System
   - DCS
   - ESD

iii) Type of protection
   - Non IS, Ex d
   - IS

c) The multi-cable entry for 6/12-pair & 8 Triad JB shall be 1” & 11/2” NPT (F). Each junction box shall be provided with 2 multi-cable entries from the bottom of the junction box with one plugged with weather proof plugs. All Cable entry shall be at the bottom only, and not from side or top.

d) All spare cable cores shall be terminated in the Junction box, at the marshalling panel end and wired through spare barriers / isolators or relays (as the case may be) right upto the corresponding spare channel of I/O module.

e) All spares hole of JBs, T/C head etc to be plugged with metallic plugs. The metallic plugs, Junction box hinges, Handle, DIN rail, Allen screws shall be SS material of construction.

f) Cable glands shall be provided with Cables shrouds. 20% spare terminals shall be supplied in each junction box.

g) To the extent possible the Field Instrument Signal Distribution Junction-Box wise should be such that the signals terminated from individual Junction Box shall be terminated in the same DCS I/O module, i.e., signals from one junction box shall not be terminated in different I/O modules.

8.4 CABLE GLANDS

a) Contractor shall supply all cable glands required for glanding the above mentioned cables both at field instrument and local control panel side, junction boxes side and at control room side.

b) All cables glands shall be of SS and they shall be double compression type suitable for armoured cables. Glands shall be in line with Area classification.

c) Flame proof glands wherever required 'shall be supplied with EX'd' certification.

d) Vendor shall supply a minimum of 20% of cable glands as spare.

8.5 INSTRUMENT VALVES AND MANIFOLDS

a) Contractor shall supply instrument valves (miniature type) and valve manifolds wherever required.
b) Body rating shall be as per piping class or better. All valves and manifolds shall be forged type only.

c) Valve body and trim material shall be SS 316 unless otherwise specified. Superior trim material shall be selected as requirement by process conditions. Packing material in general shall be of PTFE.

d) For instrument air isolation valves, body material shall be nickel or cadmium paired carbon steel.

e) Vendor shall supply spares as per the Annexure.

8.6 INSTRUMENT IMPULSE LINES

a) In general 12mm OD annealed seamless SS tubing shall be used in preference to piping.

b) Tubing standard shall be used up to 600 # only where the same is required as per job specification. For rating above 600 # and hydrogen/lethal service, only piping standard shall be used. The tubing shall be 12mm OD tube with all fittings suitable for the same. Valves used shall be threaded. At the first isolation / root valve end suitable pipe tag to tubing conversion fittings shall be used. For remote installation suitable unions / couplings shall be used.

c) Piping standard shall be used for all installation where specified in job specification. For rating up to 600 #, the connection to the transmitters shall be with a male connector and tubing 12mm OD. For rating higher than 600 #, no tubing shall be used. The connection to the transmitters shall be with 1/2” piping with flanges in between piping standard, all pipes shall be 1/2” NB unless higher sizes required to meet the "requirements, with all fittings suitable for the piping. All the joints shall be welded or flanged as required. For instrument end connection i.e root valve of orifices and other items, level gauges vent and "drain connection, seal welding shall be provided. For non diaphragm seal instruments and instruments where provided with threaded connection, no welding is required at instrument end.

d) Steam, tracing of all instruments shall be considered on steam traced Process lines as per P&ID and other documents. For steam tracing of instruments copper tube & brass fittings shall be used, Tube fittings shall be double ferrule type. For each instruments steam trace bore shall be provided with steam trap duly connected to plant.

e) All instruments shall be provided with isolation, drain and/ or vent valves with vent/drain end duly capped. This isolation valve shall be in addition to the first isolation /root valve provided on the pipe or vessel at instrument take off.

f) For diaphragm seal type instruments, spacer ring with vent and drain connection along with vent / drain valve with end capped.

g) Contractor shall supply flareless compression type of tube fitting and of three piece construction with design similar to Swagelok/Parker Hannifen etc.
h) Socket-weld type forged pipe fittings of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 3000 #. Weld neck fittings shall be used where socket weld type are not allowed by piping class.

i) All pipe fittings shall be according to piping material specification as per piping class of the pipe on which instrument is connected. In case of vessel/equipment / reactor, PMS of equivalent piping class shall be considered.

### 8.7 INSTRUMENT AIR SUPPLY DISTRIBUTION

Instrument air headers, pipes and distributors shall be of S.S 304. Instrument air manifold shall be used for supplying instrument air to control valves and other instruments. These shall be with 10 nos. of tappings and be with ½” NPT (F), SS 304 valves. From the nearby air manifold, instrument air shall be supplied to the control valves. For the purpose, all tubing shall be used shall be of SS316, 6mm, 10mm,12mm OD, seamless tubes, laid in perforated aluminium trays. All intermediate fittings shall be double compression, SS316 MOC, Swaglok make only.

### 9.0 PNEUMATIC TRANSMISSION

#### 9.1 Output Signal

Output signal from all pneumatic transmitters shall be 0.2-1kg/cm2g.

#### 9.2 Pneumatic Receiver Instruments

Pneumatic receiver instruments shall have receiver elements design for 0.2-1kg/cm2g input signal.

#### 9.3 Instrument Air

Instrument air required is available at 6.5 kg/cm2g and max. 70 °C. Design pressure is 10 kg/cm2g. Dew point is ~40 °C at line pressure.

### 10.0 PROCESS CONNECTION

(Refer Annexure- 3)

#### 10.1 First tapping points for all pressure, d/p signals shall be 3/4” NPT. Mechanical piping scope shall be upto 1st isolation valve(s). Subsequent reduction to 1/2” size and impulse piping and connection shall be under the scope of instrumentation.

#### 10.2 Wherever diaphragm seals have been used, the vessel or piping nozzle shall be 3” flanged. Flange rating shall conform to piping index.

#### 10.3 All vessel or piping nozzles for temperature instruments shall be 1 1/2” flanged or 1” NPT (F) threaded.
ANNEXURE -1

SPECIFICATION FOR SERVER GRADE COMPUTER

Specification for Server grade computer DELL/IBM/HP make only.
These computers (latest configuration) should have as minimum, the following:
Redundant power supply
Dual Channel 10/100 Ethernet card.
One hot spare hard disk (SCSI)
DVD Rewriter Drive
In addition to above, following requirements are also to be taken care,
CPU : Latest configuration (Pentium –QUAD CORE @ 3 GHz Or better)
Memory (RAM) : 4 GB minimum
Cache : 2 MB (min)
HDD capacity : > 1 TB
Cooling Fans with dust filters : Yes
Mechanical & environmental specifications
Temperature : 0-50 Deg C, operating
Humidity : 60±5%, temp.27±3degC, noncondensing.
Vibration : 5 to 17 Hz, 0.1” double amplitude displacement; 17 to 500 Hz, 1.5G acceleration.
Shock (Operation) : 10G acceleration peak (11 msec duration)
Safety : UL approved
EMI : FCC/VDE class A
CE compliant : YES
Safety : UL/CSA/TUV approved
Monitor : Full color, Non Interlaced, TFT / LCD 22

No Client-Server configuration/architecture is to be used.
### INSTRUMENT ACCURACIES

The instrument reference accuracies shall be as per the table below. Any deviation shall have prior approval of the Owner.

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>DESCRIPTION</th>
<th>ACCURACY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gas Monitors all types</td>
<td>±5 %FS</td>
</tr>
<tr>
<td>2</td>
<td>Conductivity, pH meters</td>
<td>±0.5 % value</td>
</tr>
<tr>
<td>3</td>
<td>Belt weighers</td>
<td>±0.5 % range</td>
</tr>
<tr>
<td>4</td>
<td>Pressure, DP Transmitter</td>
<td>0.075 % of span (for 10:1 turndown)</td>
</tr>
<tr>
<td>5</td>
<td>Pressure, DP Transmitter rangeability</td>
<td>100:1</td>
</tr>
<tr>
<td>6</td>
<td>Pressure Gauges</td>
<td>1 % of span for Burdon type, 1.5 % of span for Diaphragm type.</td>
</tr>
<tr>
<td>7</td>
<td>Tank Gauging (Custody Transfer)</td>
<td>±1 mm with ±1 mm resolution</td>
</tr>
<tr>
<td>8</td>
<td>Other Tank Gauging</td>
<td>±5 mm</td>
</tr>
<tr>
<td>9</td>
<td>Displacer Transmitter</td>
<td>±10 mm</td>
</tr>
<tr>
<td>10</td>
<td>Temperature Gauge bimetallic</td>
<td>±1 %</td>
</tr>
<tr>
<td>11</td>
<td>TT for Thermocouple, RTD</td>
<td>±0.12°C</td>
</tr>
<tr>
<td>12</td>
<td>Orifice Plate: Normal Application</td>
<td>±2 % of flow rate</td>
</tr>
<tr>
<td>13</td>
<td>Orifice Plate: Special Application</td>
<td>±1.5 % of flow rate</td>
</tr>
<tr>
<td>14</td>
<td>Anriubar, lines&lt;10’</td>
<td>±1 % of flow rate</td>
</tr>
<tr>
<td>15</td>
<td>Rotameters</td>
<td>±2 % of flow rate</td>
</tr>
<tr>
<td>16</td>
<td>Vortex Meter</td>
<td>±0.7 % of flow rate</td>
</tr>
<tr>
<td>17</td>
<td>Magnetic Flow Meter</td>
<td>±0.5 % of flow rate</td>
</tr>
<tr>
<td>18</td>
<td>Positive Displacement Meter</td>
<td>±0.25 % of flow rate</td>
</tr>
<tr>
<td>19</td>
<td>Ultrasonic Flow Meter</td>
<td>±0.5 % of flow rate</td>
</tr>
<tr>
<td>20</td>
<td>Mass Flow Meter</td>
<td>±0.25 % of rate</td>
</tr>
<tr>
<td>21</td>
<td>All Utility flows for guarantee runs</td>
<td>±1 % or better</td>
</tr>
</tbody>
</table>
### ANNEXURE-3

**INSTRUMENT PROCESS CONNECTIONS**

<table>
<thead>
<tr>
<th>Instrument Devices</th>
<th>Vessel Or Tank</th>
<th>Piping Scrwl. Spec</th>
<th>Piping Fldg Or Sw</th>
<th>1st Block Valve</th>
<th>Instrument Connection</th>
<th>Vent And Drain Inst Connection</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Instrument</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow dP Cells</td>
<td>1/2 inch NPT</td>
<td>1/2 inch *</td>
<td>1/2 inch to Pipe Spec</td>
<td>1/2 inch NPT</td>
<td>1/2 inch NPT</td>
<td>* piping to provide ½&quot;NPT M when valve is SW</td>
<td></td>
</tr>
<tr>
<td>dP Cells with remote chemical seals</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>1/2&quot; to 3&quot; Flanged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable Area Meter</td>
<td>Line Size</td>
<td>Line Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Averaging Pilot</td>
<td>1 1/2 inch</td>
<td>1 1/2 inch</td>
<td>see Remarks</td>
<td></td>
<td></td>
<td>When hot tap is used use full sized ball valve</td>
<td></td>
</tr>
<tr>
<td>Flow Glasses</td>
<td>Line Size</td>
<td>Line Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level Instrument</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand Pipes</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>3/4 inch NPT</td>
<td></td>
<td>Stand pipe size 2&quot; or 3&quot;</td>
<td></td>
</tr>
<tr>
<td>External Displaces / Guided Wave Radar</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>3/4 inch NPT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Displacers</td>
<td>4 inch Flanged</td>
<td>4 inch Flanged</td>
<td>4 inch Flanged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Ball Floats</td>
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<td>4 inch Flanged</td>
<td>4 inch Flanged</td>
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<tr>
<td>Gauge Glasses</td>
<td>2 inch Flanged</td>
<td>1 inch 2 inch*</td>
<td>1 inch 2 inch*</td>
<td>1/2 inch NPT</td>
<td></td>
<td>* For Magnetic type</td>
<td></td>
</tr>
<tr>
<td>Level Instrument with Remote Chemical seals</td>
<td>2 inch or 3 inch Flanged</td>
<td>2 inch or 3 inch Flanged</td>
<td>2 inch or 3 inch Flanged</td>
<td>2 inch or 3 inch Flanged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Instruments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>2 inch Flanged</td>
<td>3/4 inch NPT</td>
<td>3/4 inch</td>
<td>3/4 inch</td>
<td>1/2 inch NPT</td>
<td>½ inch NPT</td>
<td>Except where 1&quot; to Pipe Specification</td>
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<tr>
<td>Transmitters</td>
<td>2 inch Flanged</td>
<td>3/4 inch NPT</td>
<td>3/4 inch</td>
<td>3/4 inch to Pipe Spec</td>
<td>1/2 inch NPT</td>
<td>1/2 inch NPT</td>
<td>Except where 1&quot; to Pipe Specification</td>
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<tr>
<td>Instrument Devices</td>
<td>Vessel or Tank</td>
<td>Piping Scr. Spec</td>
<td>Piping Fig or SW</td>
<td>1st Block Valve</td>
<td>Instrument Connection</td>
<td>Vent and Drain Inst Connection</td>
<td>Remarks</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------</td>
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<td>-----------------</td>
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<td>----------------------</td>
<td>-------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>dP Cells</td>
<td>2 inch Flanged</td>
<td>3/4 inch NPT</td>
<td>3/4 inch</td>
<td>3/4 inch to pipe Spec</td>
<td>1/2 inch NPT</td>
<td>1/2 inch NPT</td>
<td>Except where 1” to Pipe Specification</td>
</tr>
<tr>
<td>Pressure Instrument with Remote Chemical seals</td>
<td>2 inch or 3 inch flanged</td>
<td>2 inch or 3 inch Flanged</td>
<td>2 inch or 3 inch Flanged</td>
<td>2 inch or 3 inch Flanged</td>
<td>1/2 inch NPT</td>
<td>1/2 inch NPT</td>
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</tr>
<tr>
<td>Thermowell</td>
<td>2 inch Flanged</td>
<td>1 1/2 inch Flanged</td>
<td>1 1/2 inch Flanged</td>
<td>1 1/2 inch Flanged</td>
<td>1/2 inch NPT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyzers</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>2 inch Flanged</td>
<td>Seller’s std</td>
<td>Seller’s std</td>
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STANDARD SPECIFICATION FOR

FIELD INSTRUMENTS
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<th>DESCRIPTION</th>
<th>SHEET NUMBER</th>
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<td>04</td>
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<tr>
<td></td>
<td>1.1 Conductivity Analyser</td>
<td>05</td>
</tr>
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<td>1.2 pH Analyser</td>
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<td>2.0</td>
<td>FLOW INSTRUMENTS</td>
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<td>2.1 Rotameter</td>
<td>08</td>
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<td>3.0</td>
<td>PRIMARY DIFFERENTIAL PRODUCERS</td>
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</tr>
<tr>
<td></td>
<td>3.2 Nozzles</td>
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</tr>
<tr>
<td></td>
<td>3.3 Venturi Tubes</td>
<td>09</td>
</tr>
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<td>3.4 Pitot Elements</td>
<td>09</td>
</tr>
<tr>
<td></td>
<td>3.5 Local Flow Indicator</td>
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</tr>
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<td>4.0</td>
<td>OTHER FLOW METERS</td>
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<td>4.1 Mass Flowmeter</td>
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</tr>
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<td></td>
<td>4.2 Vortex Meter</td>
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<td></td>
<td>4.3 Ultrasonic Flowmeter</td>
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<td></td>
<td>4.4 Electro-Magnetic Flowmeter</td>
<td>10</td>
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<td>4.5 Guided Wave Radar</td>
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<td>LEVEL INSTRUMENTS</td>
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<td>5.1 External Displacement</td>
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</tr>
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<td>5.2 Level Gauge Glass</td>
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<td></td>
<td>5.3 Capacitance Level Transmitter</td>
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<td></td>
<td>6.1 Pressure Transmitters</td>
<td>12</td>
</tr>
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<td>6.2 Pressure Gauges</td>
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<td>6.3 Pressure Switch</td>
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<td>6.4 Diaphragm seal</td>
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<td>7.0</td>
<td>TEMPERATURE INSTRUMENTS</td>
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<td></td>
<td>7.1 Thermocouples</td>
<td>14</td>
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<td></td>
<td>7.2 Resistance Temperature Probes</td>
<td>14</td>
</tr>
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<td></td>
<td>7.3 Thermometers</td>
<td>14</td>
</tr>
<tr>
<td>7.4</td>
<td>Thermowells</td>
<td>15</td>
</tr>
<tr>
<td>-----</td>
<td>-------------</td>
<td>----</td>
</tr>
<tr>
<td>8.0</td>
<td><strong>SWITCHES AND SOLENOID VALVES</strong></td>
<td>15</td>
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<td>8.1</td>
<td>Level Switches</td>
<td>15</td>
</tr>
<tr>
<td>8.2</td>
<td>Pressure Switches</td>
<td>15</td>
</tr>
<tr>
<td>8.3</td>
<td>Temperature Switches</td>
<td>15</td>
</tr>
<tr>
<td>8.4</td>
<td>Flow Switches</td>
<td>15</td>
</tr>
</tbody>
</table>
1.0 **Analyser**

All gas analysers shall be housed in pressurised shelter(s) conforming to Namur recommendations. Purge type analysers for all flammable gases shall be specifically certified for execution class of hazardous area besides the purge unit. Purging medium shall be nitrogen. LEL gas detectors shall be provided to detect leakage of gases in the purge line in each shelter. The shelters shall be pressurised through cooled air in summer and steam coil shall be provided in the duct to have warm air during winter through HVAC unit. All electrical apparatus related to the analyser shelter shall be flame proof conforming to the area classification. The gas sample conditioning unit shall be installed outside the shelter.

All liquid analysers shall be of intrinsic safe design suitable for execution class specified for the area. Liquid Analyser, sampling conditioning unit and other accessories shall be mounted on a rack suitable for field mounting. pH, conductivity shall be installed preferably in a bypass line to facilitate maintenance of the analyser.

Analyser’s performance quality shall be in line with the following as a minimum:

Service, Accuracy, repeatability, Span & Zero drift speed of response Analyser’s performance quality shall be in line with the following as a minimum:

<table>
<thead>
<tr>
<th>Service</th>
<th>Accuracy</th>
<th>repeatability</th>
<th>Span &amp; Zero drift</th>
<th>speed of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4</td>
<td>+/- 2% F.S</td>
<td>+/- 1% F.S.</td>
<td>+/- 0.5% F.S.</td>
<td>+/-&lt;than 5 S for infrared 63% of reading</td>
</tr>
<tr>
<td>NH3</td>
<td>+/- 2% F.S</td>
<td>+/- 1% F.S.</td>
<td>+/- 0.5% F.S.</td>
<td>+/-&lt;than 5 S for infrared 63% of reading</td>
</tr>
<tr>
<td>CO2</td>
<td>+/- 2% F.S</td>
<td>+/- 1% F.S.</td>
<td>+/- 0.5% F.S.</td>
<td>+/-&lt;than 5 S for infrared 63% of reading</td>
</tr>
<tr>
<td>O2</td>
<td>+/- 2% F.S</td>
<td>+/- 1% F.S.</td>
<td>+/- 0.5% F.S.</td>
<td>+/-&lt;than 10 S for zirconia 63% of reading</td>
</tr>
<tr>
<td>O2</td>
<td>+/- 2% F.S</td>
<td>+/- 2% F.S.</td>
<td>+/- 1% F.S.</td>
<td>+/-&lt;than 20 S for paramagnetic 63% of reading</td>
</tr>
<tr>
<td>H2</td>
<td>+/- 2% F.S</td>
<td>+/- 2% F.S.</td>
<td>+/- 1% F.S.</td>
<td>+/-&lt;than 20 S for thermal conductivity 63% of reading</td>
</tr>
<tr>
<td>SO2</td>
<td>+/- 2% F.S</td>
<td>+/- 2% F.S.</td>
<td>+/- 2% F.S.</td>
<td>+/-&lt;than 20 S for ultraviolet 63% of reading</td>
</tr>
<tr>
<td>Nox</td>
<td>+/- 2% F.S</td>
<td>+/- 2% F.S.</td>
<td>+/- 1% F.S.</td>
<td>+/-&lt;than 20 S for chemiluminecent 63% of reading</td>
</tr>
<tr>
<td>S.G</td>
<td>+/- 2% F.S</td>
<td>+/- 1% F.S.</td>
<td>+/- 0.5% F.S.</td>
<td>+/-&lt;than 5 S for 90% of</td>
</tr>
</tbody>
</table>
1.1 Conductivity Analyser

a) The Conductivity Analyser shall be 2 electrode or multi-electrode depending upon the applications. multi-electrode system shall be used in services where errors from polarisation and contamination of the electrodes is minimised to achieve high accuracy, if not otherwise specified in the specification sheet. The system shall comprise a sampling system, electrodes with electrode holder, flow cell, temperature compensator, interconnecting cables and Conductivity transmitter.

b) In cases where pH electrode are utilising the sample line with conductivity sensor, the pH electrodes shall be located downstream of the conductivity sensor.

c) For automatic temperature compensation, thermistors in good contact with the electrolyte shall be built into the sensor. For measurement in ultra pure water e.g. conductivity below 0.05 micro s/cm, a system with double temperature compensation or a programmable system with single temperature compensator and calculations features to compensate for the combined effect of temperature, one for the water conductivity and the other for the impurity conductivity shall be provided. The reference temperature shall be 25°C.

d) The electrode holder shall be mounted directly in the flow chamber with a packing system which will ensure complete tightness of the system. However, the electrodes shall be easy to remove for maintenance and inspection. The electrode can be supplied either integral with the transmitter or apart from it and in the latter case interconnecting cables shall be supplied. Complete sealing of the cable entry is required.

1.1.1 Transmitter

The conductivity transmitter shall be 24V loop powered with 4-20 mA DC output, if not otherwise specified in the individual specification sheets. The transmitter shall be either conventional or smart type with HART protocol with latest revision as specified in the individual instrument specification sheets.

The transmitter shall be factory calibrated to the range stated in the Instrument specification sheet. Assembly for easy adjustment of range and zero shall be provided. It shall have diagnostic features including temperature Compensation for monitoring of electrode health.

1.1.2 General

a) Analysers in hazardous areas shall either be ex-proof or intrinsic safe conforming to area classification & execution specified against each tag in the individual specification sheets.

b) If Indian Standard for ex.proof certification conforming to IS - 2148 is specified then the same must be supplemented with the temperature classification certification confirming to IS - 8239.

c) Intrinsic safety certification shall in general conform to CENELEC standard EN 500014 and EN 50020, if not otherwise specified in the individual specification sheets.
d) All instruments shall be tropicalised and immune to “Radio Frequency Interference (RFI)”. The supplied electronic part shall have susceptibility of less than 0.5% of span for a frequency range of 20-500MHz in a field strength of 20 volt/meter.

e) Cable entries shall be plugged with metallic plug to avoid damage during transit.

1.1.3 Sampling System:

For conductivity measurement where the design temperature and/or pressure in the process pipe are higher than the maximum rating of the electrode arrangement, a continuous small sample of the liquid shall be drawn from the process pipe. The sample shall, if required flow through a cooling coil of adequate rating to cool it, and through a station to reduce the pressure. The sampling system shall be provided with on-line filters with bypass standby, flow regulator, pressure and temperature gauge. The sampling system shall be protected by a relief valve. All the components including tubes and fittings shall be included in the supply and all made of stainless steel, if not otherwise specified in the enclosed specification sheets or drawings. In order to improve the sample response it is important to keep the volume of the system at minimum. The process connection shall be 1/2" NPT(M). The complete sampling system alongwith the analyser, if not specified otherwise, shall be mounted on a steel frame suitable for installation near the tapping point in the field.

In addition to the above, sampling system of other ion selective electrodes which requires automatic chemical stabilisation to stabilise the electrodes, the additional accessories as listed in 2.01.02 shall be provided.

1.2 pH Analyser

The pH Analyser shall work on potentiometric pH Analyser measurement principle comprising of a sampling system, an electrode holder, a measuring electrode, a reference electrode, a temperature sensor, interconnecting cable and pH transmitter. A flow cell shall be provided for all flow through type of installations.

The pH measuring electrode shall be solid state or dual membrane type if not otherwise specified in the individual specification sheet. The electrode shall be shock-proof and screened with metal foil. The electrolyte and electrode pin shall have same properties as those of the reference electrode. Complete sealing of the electrode and cable entry is required.

The reference electrode shall be of the diffusion type (non-flowing) and the diffusion shall take place without the need for an external pressure. The electrode response shall be linear with respect to temperature changes.

For the purpose of automatic temperature compensation for the changes of the temperature coefficients of the electrodes, an electrode with a PT100 temperature resistor shall be included in the supply.

1.2.1 Flow cell

The pH electrodes shall be mounted in a specially designed flow cell, either in a bypass or in a sample line drawn from the process pipe. The flow system shall be with provision for mounting all electrodes, and shall allow quick and easy calibration,
cleaning and replacement. Direct pipe mounted electrodes (insertion type) or submersive type, if required, shall be specified in the individual specification sheets.

### 1.2.2 Transmitter

The pH transmitter shall be 24V loop powered with 4-20 mA DC output, if not otherwise specified in the individual specification sheets. The transmitter shall be either conventional or smart type with HART protocol with latest revision as specified in the individual instrument specification sheets.

The transmitter shall be factory calibrated to the range stated in the Instrument specification sheet. Assembly for easy adjustment of range and zero shall be provided. It shall have diagnostic features temperature Compensation for monitoring of electrode health.

### 1.2.3 Cables & Connectors

The interconnecting cables between the electrodes and the pH transmitter shall be screened with anti-noise sheaths and preferably be armoured type. Suitable plug in connectors at both ends matching the electrodes as well as the pH transmitter shall be included in the supply. The connectors shall be designed to prevent moisture from entering the cables. The cables and the connectors shall satisfy the high requirements of the insulating resistance and screening for high ohmic pH measurement for optimum measuring results.

### 1.2.4 Ion selective Trace Analyser

Ion selective analysers using solid state membrane electrodes, liquid ion exchange electrodes and Gas sensing electrodes for the measurement of wide range of ions of metals and salts shall have identical requirements of a pH analyser (ion sensitive glass electrode) but a sampling system for Automatic chemical standardisation to stabilise the electrodes shall be provided.

The sampling system shall include heat exchanger, pressure relief valve, solenoid valve, constant head unit, flow cell, temperature compensator, reagent container including peristaltic pump, wherever required.

### 2.0 FLOW INSTRUMENTS

D/P cells shall have measuring method on the floating capacitance technology. The signal transmitter shall normally be a 2-wire system and shall be capable of delivering rated current into external load of at least 600 ohms when powered with 24 V d.c. Protection against short circuit and reverse voltage shall be provided. Bodies shall normally be in stainless steel. Material of wetted parts shall be suitable for process fluid and condition in which the transmitter is installed. Integral 3- valve manifold shall be used for mounting transmitters on manifold for ease of maintenance. Material of manifold in general shall be SS316L but may vary
depending upon service. Digital output indication shall be preferable on the integral output meter with the transmitter. Integral output meter shall be configured for reading in direct engg units instead of %. All flow transmitters shall have sq.root extraction function.

Pressure elements in austenitic stainless steel is a requirement in hydrogen services. The transmitter shall be furnished with an output meter or gauge with a sqrt scale. Smart type transmitters will be used with Hart V protocol. Overall accuracy for SMART transmitters shall be +/- 0.075% or better. Process connection size shall be 1/2" NPT through oval flanges.

All field transmitters shall be 2 wire type, 24 Volt DC, SMART with HART protocol, and shall be equipped with Local LCD type digital indicator. Zero & Span shall be continuously adjustable externally but Non interacting type. 2" pipe mounting, SS304 MOC brackets, Accuracy 0.075% of Span, Rangeability 1:100, Local Display configurable, SS MOC, Double Compression SS cable glands, EExib IIC/T6, IP67, Wetted MOC SS316L, SS316L MOC Manifold, Housing Die-Cast Aluminium .Epoxy Painted, Universal Hart Protocol with Latest Revision is required.

### 2.1 Rotameter

Rotameters or variable area meters may be used in pipe sizes from 1 1/2" and smaller. The meter shall be selected for normal flow at 50 to 60% of the span. In applications with toxic or inflammable fluids, glass tubes must not be used except for low pressure analyser sample flows. They may be used for severe corrosive services and of fluid of high viscosity. The metal tube meters shall be of stainless steel, PTFE lined or any other suitable lining for the service. The Indicator assembly shall be magnetically coupled and mounted with rotameter body. Transmitters or Indicators on float extension are not recommended except for cryogenic services. The switch assembly shall be of proximity type. All Rotametres shall be metal tube type.

The rotameter transmitters shall have 4-20 mA output at 24V d.c. power on two wire system.

### 3.0 PRIMARY DIFFERENTIAL PRODUCERS

### 3.1 Orifice Plates

Orifice plates type selection shall be based on the process application.. Materials of orifice plate shall normally be AISI 316 unless special materials are required for the service. The maximum ratio of orifice to inside pipe diameter of 0.70 and minimum ratio of 0.25.

Orifice plates dimensions and calculations shall be in accordance with ISO 5167-1980.
3.2 Nozzles

ISA 1932 Nozzles may be used in high and medium pressure steam and BFW piping. Materials for nozzle element shall normally be AISI 316 steel unless special materials are required for the service. Dimensions and calculations shall be in accordance with ISO 5167-1980. Generally branch pipe is required with the nozzle the same shall be machined from higher schedule pipe than the one used for the service or forged branch pipe shall be used if higher schedule pipe is not available. The branch pipe bore shall be same as that of nozzle ID and shall have mirror finish.

3.3 Venturi Tubes

Venturi Tubes or nozzles as per ISO 5167-1980 or similar type elements may be used to measure the flow of low pressure gases or liquids where loss of pressure is an important consideration.

3.4 Pitot Elements

Pitot Elements of the averaging type may be used where high accuracy is not required or the pipe diameter is too large for acceptable orifice plate design. Use of annubars shall be limited to combustion air, flue gas raw water and fresh water services unless specifically indicated. The annubars shall be extraction type with ball valves and pipe fittings required for installation. The connection size shall be 1 1/2" NPT. For rating 1500# and above the process connection size shall be 2” flanged.

3.5 Local Flow Indicator

Motion balance (Barton cell type) type differential pressure indicator shall be used for local flow indication. Body and internals shall be of 316 SS. Process connection shall be 1/2" NPT(F). 3-valve manifold with 1/2" NPT connection shall be used with the meter.

4.0 OTHER FLOW METERS

4.1 Coriolis Mass Flowmeter

Coriolis type mass flow meter with local digital display of flow shall be used to measure the process flow where high accuracy is required. Normal accuracy for mass flowmeters shall be ±0.10%.

4.2 Vortex Meter

Vortex shedding meters may be used for wide range of flows for gases and liquids. The measured flow shall be temperature compensated.
Insertion type vortex meter may be used in utility services for line size more than 6” in place of Pitot /Annubar/Pitot venturi tubes.

4.3 Ultrasonic Flowmeter

Ultrasonic flow meters (non-insertion probes preferred) based on the “time-of-flight” method shall be used. Meters based on the “Doppler” principle are less accurate and shall not be used. Ultrasonic flow meters shall be considered for large turn downs and where pressure drop is not permitted. Upstream and downstream straight lengths shall be as per standard.

Mass/Ultrasonic/vortex shall be used in all instruments meant for energy calculations and where higher accuracy and reliability are desired

4.4 Electro-Magnetic Flowmeter

Electromagnetic flowmeter with ceramic lining shall be used for the measurement of flow with high accuracy for highly viscous and corrosive services like cooling water etc.

4.5 Guided Wave Radar

Displacer type level instrument shall be avoided and guided wave radar type shall be used in their place if suitable to process condition.

Ultrasonic / Radar type Instrument shall be used for large liquid storage tanks. Guided Wave Radar type level instruments, where used, shall be external type with side / side connections and rotatable transmitter head. Vent and drain valves shall be provided.

Guided Wave Radar Level transmitter shall be applicable for liquids or slurries, hydrocarbons too water-based media. In absence of dielectric constant for the process fluid, Bidder shall confirm the suitability of Guided Wave radar Level Transmitter for such applications and Bidder shall suggest the suitable model for the same.. Bidder shall suggest the suitable model for Interface applications like oil on water, Hydrocarbon on water, etc. Electronics shall be capable of measuring upper liquid and interface level simultaneously. Selection shall be available for analog output signal from level transmitter corresponding to upper liquid or Interface. Process connections shall normally be 2” flanged with side-side connections.
5.0 LEVEL INSTRUMENTS

5.1 External Displacement

Displacer type level instrument shall be avoided and guided wave radar type or remote diaphragm seal DP shall be used in their place if suitable to process condition.

If unavoidable External displacement type instruments shall generally be used for small spans only, in specific cases it may be used upto a range of 84". The cage material shall normally be forged material conforming to the service requirements. Where the vessels are of alloy steel construction, the body material shall be equivalent or of a better material. The displacer shall be in stainless steel and the torque tube in inconel. Process connections shall normally be 2" flanged with side-side connections. Heat jacketing of chamber shall be provided as per the requirement of process conditions.

For high temperature as well as low temperature and cryogenic services, torque tube heat insulation extension or torque tube extensions shall be applied. Radiation fins or extensions shall be used for temperature above 200 degree C or below zero degree Centigrade.

5.2 LEVEL GAUGE GLASS

5.2.1 Gauge Glasses

Glass gauges shall be avoided and magn1212etic type level gauges shall be used if suitable to process condition. If unavoidable Gauge Glasses shall normally be reflex type for all process services, except for boiler drums bicolour types shall be used, and in corrosive services. Where transparent gauges with glass protection and illuminators shall be used, Illuminators shall be explosion-proof in hazardous areas. Gauge glass columns will not exceed 1500 mm.

Transparent type gauge glasses (double glass) will be used for services in which a level may not be distinguishable, such as interface services, between different liquids, where mica shields are required and fluids of high viscosity or high solid content.

Level gauges shall be supplied with a pair of off-set shut off valves with ball check. For cold services where temperature is below 0 deg C a non-frosting gauge will be used. Glass tube level gauges shall be avoided.
5.3 Capacitance Level Transmitter

Overall shielded full probe capacitance level transmitters shall be used in carbamate service.

6.0 PRESSURE INSTRUMENTS

6.1 Pressure Transmitters

Pressure Transmitters and differential pressure transmitters shall be modern inherent motion-free type of the floating differential capacitance principle. Bodies shall normally be in stainless steel with pressure elements in SS316L. Pressure elements in austenitic stainless steel is requirement in hydrogen services. Two valve integral manifold of SS316L material in general shall be used with pressure transmitters.

The signal transmission should normally be a 2-wire system and shall be capable of delivering rated current into external load of atleast 600 ohms when powered with 24 V d.c. Protection against short circuit and reverse voltage shall be provided. The transmitter shall be furnished with an digital output meter or gauge with a sq.rt. scale. Smart type transmitters will be used with Hart V protocol. Overall accuracy for SMART transmitters shall be +/- 0.075% or better. Process connection size shall be 1/2" NPT.

All field transmitters shall be 2 wire type, 24 Volt DC, SMART with HART protocol, and shall be equipped with Local LCD type digital indicator. 2” pipe mounting, SS304 MOC brackets, Accuracy 0.075% of Span, Rangebility 1:100, Local Display configurable, SS MOC, Double Compression SS cable glands, EExib IIc/T6, IP67, Wetted MOC SS316L, SS316L MOC Manifold, Housing Die-Cast Aluminium, Epoxy Painted, Universal Hart Protocol with Latest Revision is required

6.2 Pressure Gauges

Gauges for process and utility services shall be industrial SS Bourdon gauge/diaphragm or spring bellows type as per process requirement with the case in stainless steel. The gauge for 60 kg/cm² above pressure shall preferably be a safety type with solid front where pointer and glass are partitioned off from the sensor by a solid disc. Pulsation dampeners shall be installed with the gauges where pulsating pressure occurs. Process connection shall be 1/2" NPT (M) bottom in general. Bezel rings shall be screw on pattern. Dial Size minimum 150mm

Blow-out discs are required for all pressure gauges except for instrument air services.

Vibration proof gauges or remote seal type shall be used if the surrounding environment is subject to vibration.
Minimum accuracy for pressure gauges shall be +/- 1%

6.3 Pressure Switch

Pressure shall be used only in case its not possible to use the pressure transmitter. Pressure switches shall be used for alarm, interlock, sequence system and will have electric switches SPDT with hermetically sealed contacts rated for 0.5 amp., 24 V d.c. All such contacts shall be gold plated. Process connection shall be 1/2” NPT(M). The pressure switches shall have electrical connection size of 3/4” NPT(F) for cable gland termination. The cables shall be terminated in terminal strips and flying leads shall be avoided.

Sensor and all wetted parts material as a minimum shall be 316 SS. Casing material shall either be stainless steel or die cast aluminium. Sensor shall normally be bourdon but special elements such as diaphragms and bellows can be selected where more suitable for the service than bourdon tubes.

6.4 Diaphragm seal

Diaphragm seals of the filled or mechanically type shall be furnished where plugging of the element may occur due to congealing and high viscous fluids or where suitable sensor material is not available in highly corrosive services.

Remote Seal PT/DPT shall be with min 5 mtr Capillary with SS armoured in PVC sheath of Protection with DRIP RING and with Ball type Isolation Valve.

DP transmitters with diaphragm seals are envisaged, where condensing leg required to be filled in normal DP transmitters, at all those locations, remote seal type DP transmitters are to be used. Also, wherever there is a control and interlock on level measurement, one transmitter shall be remote diaphragm seal type and one will be guided radar type with Material : Minimum Inconel. Guided Wave radar may be used for non-critical applications.

In general Remote seal DP transmitters shall be used for all tank levels, KO drum levels and all tower level applications.

7.0 TEMPERATURE INSTRUMENTS

7.1 Thermocouples

Thermocouples shall normally be the sheathed type with high purity magnesium oxide insulation. The hot junction shall be isolated from ground. Sheath diameter shall normally be 6mm (1/4”) Inconel 600 sheath material shall be used for design temperatures above 400 degree C, whereas ordinary SS material can be used below 400 degree C. The nominal wire diameter shall be approximately 0.19 x sheath OD.
In general type K thermocouples shall be used according to IEC 584. All temperature elements shall be duplex type, one connected and the second one shall be used as spares. Skin thermocouples as well as multipoint thermocouples shall be used as per licensor recommendation and process requirement.

7.2 Resistance Temperature Probes

Resistance Temperature Probes shall be considered for applications where very narrow spans and high accuracy are required as well as low temperature service. They shall be 6mm (1.4") stainless steel sheath type similar to the thermocouples and with a Pt 100 ohms (0 degree C) element. The sensors shall be duplex type and shall be spring loaded for vibration proof. The elements shall conform to DIN 43760 or IEC 751

7.3 Thermometers

Thermometers shall normally be bi-metallic, heavy duty, weatherproof (IP 55), adjustable angle connected type with 150 mm dial as a minimum, dials of smaller size may be used for auxiliary services on machinery. Liquid filled indicators will be used only where indication is required to be remote. Case and stem shall be in stainless steel. Dials shall be of white, non-rusting metal with black figures. For local temperature control upto a maximum scale range of 530 deg C, liquid filled sensors with capillary extension shall be used. Filled system instruments when used shall be fully compensated for ambient temperature variations. Capillary shall be SS armoured and length of which will not generally exceed 3 mtrs.

7.4 Thermowells

Flanged thermowells shall be of 1 1/2" ANSI RF. Screwed thermowells shall be of 1" NPT(M). Flanges rating facing and material shall be in accordance with the equipment or piping standard. Thermowell material in general shall be of AISI 316 SS.

8.0 SWITCHES AND SOLENOID VALVES

In general switches shall not be used unless its not possible to use transmitters.

8.1 Level Switches

Level Switches shall normally be the external float cage type. Body material and rating shall conform to piping specifications. Internal trim shall be stainless steel unless other materials are required for service.
8.2 Pressure Switches

Refer details in item 6.3

8.3 Temperature Switches

Temperature switches mounted in the control room and in the local panels shall be thermocouple actuated and be completely adjustable. They shall have cold junction compensation.

8.4 Flow Switches

Flow switches for direct operation by process fluids may be of the rotameter for low accuracy requirements. Orifice plate and differential pressure type transmitter shall be used for high accuracy requirements and the switch shall be an electric analogue switch. For alarm purpose, the switching shall be through DCS software.
STANDARD SPECIFICATION FOR

CONTROL & SAFETY VALVES
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1.0 CONTROL VALVES

1.1 Sizing

Cv of the valves shall be selected in such a way that the normal maximum flow is attained at about 70% valve opening.

Control valves shall be sized in compliance with standard ISA S75.01.

Butterfly valves shall be sized for a maximum opening angle of 60° with the exception of those provided with a characterised disc, which shall be sized for a maximum opening angle of 90°.

The fluid velocity at the trim outlet shall not exceed 6 m/sec for liquids whereas the velocity of gas or vapour shall not normally exceed 0.3 Mach under operating conditions. In order to reduce the fluid velocity below such limits use can be made of widely-sized valves equipped with reduced trims. Fluid velocity values could exceed the above-mentioned limits in the case of valves provided with a labyrinth plug, cage trim or angle body.

1.2 Valve Type

Valve types shall be selected in accordance with the guidelines below:

1. **Globe valves**: Single-seated is the standard valve type in sizes below 8" in non-severe service where the pressure drops and shut-off pressure can be handled. Cage-guided globe valves shall be used for more severe service. Balanced trims can be considered for larger sizes.

Globe valves with shut-off function shall generally be unbalanced.

If suitable, valves with rotating plugs can be used as an alternative to globe valves.

2. **Butterfly valves** shall be used in services with large volume flow and low-pressure drop (less than 5 kg/cm2). Triple offset butterfly valves shall be used for tight shut-off when more cost-effective than ball valves.

3. **Ball valves** shall generally be used as block valves. Characterised balls shall be used as control valves when the fluid tends to crystallise, or where a high Cv is required. Ball valves shall be trunnion-type suitable for bi-directional shut-off, unless otherwise specified.

4. **Angle valves** may be considered as an alternative to globe valves when the pressure drop is very high, where there is risk of accumulation of solids, or where the fluid velocity is extreme.
Soft-seated butterfly and ball valves for shut-off service shall be of a fire-safe design in accordance with ANSI/API STD 607 and metal-seated valves shall comply with API Spec. 6FA.

1.3 Body Material, Connections and Rating
The body material shall be chosen in compliance with materials required in the line specification and, in any case, shall be suitable for the process fluid.
Connections and pressure ratings: Globe valves shall have flanged connections with rating and facing in accordance with the Piping Specification. Welded ends shall be butt-welded as per ASME B16.25.

1.4 Valve Trim
Valve trim material shall be minimum as standard be SS 316, unless otherwise specified. Special material of construction of wetted parts of the valve trim shall be selected to withstand the process fluid and flow conditions.

In the presence of liquids which, because of particular operating conditions, can give rise to cavitations phenomena, use shall be made of special trims (e.g. multi-drops cage trim) so as to avoid that similar phenomena may take place or, at least, to reduce their effect.

Erosion-resistant trim with hardened or hard-faced surfaces are required when the pressure drop across the valve exceeds 10 kg/cm², the temperature is above 315°C, the pressure drop across the valve exceeds 5 kg/cm² in steam service, or when there is a risk of flashing/incipient cavitation. Cobalt-based alloys (Stellite) must not be used for hard-facing in boiler feed water and in amine service.
Anti-cavitation trim shall be selected for high-pressure drop applications.
The maximum acceptable noise level permanently produced by control valves (measured at one meter downstream from the valve and one meter from the pipe) shall not exceed 85 dB (A). In order to ensure that this limit is not exceeded when high pressure drops and large gas flow-rates are involved. Use shall be made of special trims (e.g. labyrinth plugs) or to suitably designed valves (e.g. multi-step angle valves). Levels in excess of 85 dB (A) can be accepted in the case of noise of limited duration in accordance with provisions envisaged in OSHA regulations.

On line replaceable trims shall be considered for all high pressure valves of butt-weld or socket weld connections.

1.5 Bonnet
Bonnets shall be bolted according to ASME B31.3 and material shall be the same as the body material. The requirement for an extended bonnet depends on the fluid temperature and the selected packing material. However, it shall be supplied as follows:

- extended if the fluid operating temperature is comprised between -40°C and 0°C.
- finned if the operating temperature is above 230°C and the packing is ‘Teflon’ based.
- extra-long if the operating temperature is below -40°C

1.6 Packing

PTFE shall be used as standard packing material for standard bonnet temperatures below 230°C and graphite for higher temperatures. Higher temperatures can be accepted for PTFE if the bonnet is extended. Packing design and material shall be selected carefully for minimum stem friction and live-loading packing boxes shall be considered for PTFE packing.

Vacuum service and special services like oxygen, require special packing materials and should be given special consideration. Double packing will be used on toxic services (wet H2S...etc.).

1.7 Leakage

Seat Leakage shall be chosen in accordance with process demands and safe operation of the plant and in accordance with AISI B16.104-1976. However, in general, the globe valves used shall be of class IV leakage minimum as per ANSI B16.104 in general.. For vent services the leakage class shall be class V or VI depending upon process requirement. Pump minimum flow valves must be class V to avoid leakage and seat damage. ESD valves shall be Class V metal to metal as minimum.

Safety shutoff valves must not be used in throttling service during normal operation.

1.8 Actuators

All actuators shall be sized for max shut off conditions. Air fail to close or open or stay put shall be as per the safety requirement and as defined by the process licensor.
Actuators shall be sized for a minimum operating air pressure of 1.4 Kg/ Cm2g and maximum air pressure of 6.0 Kg/ Cm2g.

The actuators shall be diaphragm or piston actuators in general. Yoke material for diaphragm actuator shall be carbon steel. Diaphragm actuators with single springs shall be used. Volume tank with airlock relay, booster relays shall be avoided as far as possible for piston actuators.

In general, if otherwise not specified in the valve data sheet the time for full travel shall not exceed 10 seconds.

Wherever hand wheel is required with a valve the same shall be side mounted type. Also, hand wheel shall not be provided for shutdown valves.

All split range functions for valve operations shall be carried out in DCS and split range provision in valve positioners shall not be necessary.

1.9 Positioner

All control valves shall be provided with SMART (HART Protocol) type electro pneumatic valve positioners, except for ON OFF shut off valves.

The positioner shall be supplied with a bypass and a set of pressure gauges.

The positioner shall provide valve position analog output as standard.

By-pass valve provision shall be as per process licensor requirement.

Air tubes and fittings shall be in stainless steel. Sizes shall be adequate for the stroking time required. Tubing shall be thin-walled with an OD of not less than 6 mm. The larger valves require tubing with a larger diameter.

1.10 Valves for emergency shutdown service (ESD)

Valves controlled by the emergency shutdown system (ESD) and used either for isolating or for depressurising the plant under emergency conditions shall be supplied in accordance with process requirements. These valves shall be fitted with actuators designed in such a way that, in the event of control air failure, they can drive the plant towards safe conditions even when the envisaged maximum pressure drop, caused by the process fluids, is applied to the valve ports. If there is no return spring (double acting actuators) provision shall be made for air accumulators with a storage capacity suitable for the execution of 2 strokes.

Each ESD valve shall be equipped with two proximity type limit switches for remote indication of the valve position.
ESD valves SHALL NOT HAVE MANUAL HAND JACK fitted.

ESD valves shall be provided with automatic pilots or solenoid valves for their remote control and, if required in the P&ID, with local facilities for manual reset.

Non destructive test like radiography, ultrasonic, die penetration and magnetic particle shall be carried out for cast and forged bodies conforming to procedures laid down in ANSI B16.34. Radiography or ultrasonic test, if not specifically mentioned in the data sheet, shall be carried out for cast or forged bodied of rating 900 lb. or above.

The control valve % opening shall be at minimum flow 10-20%, for normal flow 50 to 70%, for maximum flow 75 to 85%.

The ESD valves are installed in series with regular control valves, the ESD valves shall be installed downstream of control valve. The actuators of the ESD valves shall be designed in such a way that the time of response from full open to full close or vice versa, as may be required for safe shutdown, shall be fast enough for quick isolation or venting respectively.

1.11 **Flow Tendencies**

For valves in shut-off service, the fail safe condition of valve shall comply with the action required to put the plant in a safe condition in the case of power failure. In some cases it is the back-flow scenario that shall be considered.

Generally, the flow to open tendency is the most stable type of operation for modulating control valves. This is therefore the preferred flow direction for globe valves. For angle valves, the direction should be flow tends to close

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

1.12 **Isolation & Bypass Valves**

The critical control valves shall have bypass arrangement capable of handling 100% flow. If the bypass is not capable to handle 100 % flow, in such cases the control valve shall be supplied with hand jack assembly. Besides this, all the critical control valves and vent valves shall have hand wheel assembly with vendor standard locking feature, if bypass is provided. All the control valves having bypass shall also have isolation valves in upstream and downstream of control valve and suitable drains etc. for its isolation.
2.0 RELIEVING DEVICES

2.1 Pressure Relieving Devices

Pressure-relieving devices protecting pipes, vessels and equipment shall normally be sized in accordance with API RP 520 and/or API RP 521. ASME Code, Section I shall apply for steam drum and super-heater valves. Relieving devices protecting atmospheric or low-pressure storage tanks shall be sized according to API STD 2000.

Percent Overpressure and Accumulation used in calculation of sizes of relieving devices shall be:

2.2 Overpressure:

3% - Steam services where ASME Power Boiler Code applies.
10% - Gas or Vapour service.
15% - For liquids and pump discharge lines with 6% system accumulation (Power Boiler Code) and with 10% system accumulation (Pressure Vessel Code)
21% - Fire exposure on unfired pressure vessels.
10% - Liquids for thermal relief of pipelines or vessels Accumulation.
10% - Gas, Vapour and liquid where ASME Pressure Vessel Code applies.
16% - Gas, Vapour and liquid where ASME Pressure Vessel Code applies and the system is protected by means of multiple valves.

2.3 Accumulation:

6% - Steam service where ASME Power Boiler Code (Section I) applies.
10% - Gas, vapour and liquid where ASME Pressure Vessel Code (Section VIII) applies.
16% - Gas, vapour and liquid where ASME Pressure Vessel Code (Section VIII) applies and the system is protected by means of multiple valves
21% - Fire exposure on unfired pressure vessels

2.4 Blow-down:

4% - Maximum for steam service where ASME Power Boiler Code (Section I) applies
5-7% - For vapour, gas and steam service
10-20% - For liquid service
2.5 Nomenclature

Nomenclature used shall be in accordance with API RP 520.

2.6 Safety and Relief Valves

Safety and Relief Valves shall normally be flanged, direct spring loaded type. Balanced bellows valves shall normally be furnished for relief into closed flare and blowdown systems, if the developed back-pressure exceeds 10% of the set pressure or for toxic substances. Bellows shall also be specified where leakage of gas from the seals are not permitted during normal plant operation. Steam jacketing may be considered necessary to keep some valves and lines warm at all the times to avoid the solidification of the lading fluid.

Full nozzle types of valves shall be specified for sizes 1” or above.

Test gags shall be furnished on all safety and relief valves. Test gags shall be removed and transferred to Owners possession after testing, clearly labelled with the tag number of the valve.

Lifting levers shall be furnished for exposed spring bonnets on valves on steam and hot water services, on air valves and hot water service valves with closed bonnets.

Bonnet for toxic or inflammable gases and vapours and liquids shall be plain, closed and pressure-tight and in the same material as the body. Exposed bonnet shall be specified for steam service and in Boiler feed water service above 200°C. Bonnet extension shall be used above 400°C.

Materials for construction shall be selected in accordance with API STD 526, the process fluid characteristics and the Vessel and Piping Specifications.

However, in general springs shall be of carbon steel for normal process operating temperature of (-) 25°C to 200°C and tungsten alloy or high temp. alloy steel above 200°C. Stainless steel spring may be used for services below (-) 25°C. Carbon steel is permitted above 200°C for open bonnets.

All connections shall be flanged in general with facing and rating in accordance with the piping specification or API 526 whichever is higher.

Centre to Centre dimensions shall be in accordance with API 526.
3.0 RUPTURE DISCS
Rupture discs may be used in lieu of or in combination with safety and relief valves, where applicable or required. For disc rupture trip or alarm disc shall be with bursting sensors.

4.0 PRESSURE AND VACUUM RELIEF VALVES
Pressure and Vacuum Relief valves for storage tanks shall normally be of the weight loaded or pilot operated type, and sized in accordance with API RP-2000 Tank Venting Code, or Local Codes if they govern.

5.0 THERMAL RELIEF VALVES
For thermal relief of accumulated liquids in pipelines and vessels 1” x 2” size valves shall be used in general.

6.0 SOLENOID VALVES
Solenoid valves shall normally be used to actuate other instruments/valves connected directly to the process. The SOVs shall be direct acting type. Protective enclosure shall be IP 65 and the coil insulation suitable for continuous operation in 85 degree C ambient temperature (max. surface temperature in sun) for outdoor service and based on area classification. Body materials shall normally be stainless steel. Solenoid valves will be powered by 115V +/- 10%, AC 50 Hz +/- 3%, insulation class ‘H’ and orifice size 9 mm. The D.C. solenoids shall not have in built rectifier to operate with A.C voltage. The D.C. solenoids shall be used as an alternative to A/C solenoids only for low current intrinsic safe operations. Solenoid valves shall be de-energised for trip. All solenoid valves shall be of 110VAC 50Hz unless otherwise specified for any specific purpose.

All solenoid valves shall be fitted with 1/2” NPT (F) SS cable gland connection.