SECTION I2

GENERAL INSTRUMENTATION REQUIREMENTS

1. INSTRUMENTATION, GENERAL: Instrumentation components furnished with the Equipment shall be in accordance with the following Articles and shall be constructed to withstand the temperatures, pressures and other environmental conditions, including vibration, encountered in the actual service. Instruments and devices shall be suitably protected for shipment and the rigors of construction. Explosion proof construction shall be furnished where required by applicable code or the detailed Specifications.

The instrumentation shall be designed in such a way that no single control system, instrument failure, controller failure, fuse, or circuit breaker shall interrupt the operation of more than one piece of redundant equipment.

Instruments shall be provided from the manufacturers listed within each Article below. For instruments not specified below, refer to the approved equipment suppliers information within Section GR-A. For instruments that are not specified below or within the Approved Equipment Suppliers list, the Seller shall request Contractor approval.

All instrumentation shall be certified, labeled, designed, built, rated, and tested in accordance with the latest revision of the applicable ANSI standards. Components that are standard UL listed and labeled shall be provided where routinely available. Skid mounted instruments shall be wired to common junction boxes. Instrument analog signals for electronic instrument systems shall be 4 to 20 mA DC. Instrument analog signals for pneumatic instrument systems shall be 3 to 15 psig. Use of pneumatic controls shall be approved by Contractor prior to use.

All process control units of measurement shall be English. All instrumentation, devices, monitors and indicators shall be English. All instrument drawings, specifications, calculations and documentation shall be prepared in English units. All documentation shall be in the English language. The following table details specific units per measurement parameter. If measurements for something other than what is listed below are required, the units shall be submitted to the Contractor for approval.

| **Parameter** | **Units of Measurement** |
| --- | --- |
| **Temperature** | degrees Fahrenheit (o F) |
| **Pressure** | pounds per square inch gauge (psig) |
| inches of water column (in wc) or (inH2O) |
| pounds per square inch absolute (psia) |
| inches of mercury absolute (in HgA) |
| **Level** |  |
| General | Percent [Responsible Lead to review versus Contract and Front End Specifications. (inches vs ft-inches vs ft-tenths, etc) |
| Tank Gauge | linear feet, inches, and tenths of inches |
| Deviation from normal level | percent |
| **Flow** |  |
| Liquids | gallons per minute (gpm) |
| pounds per hour (pph or #/hr) |
| Gases and Vapors | standard cubic feet per minute at 60 OF (SCFM) |
| standard cubic feet per hour at 60 OF (SCFH) |
| Steam & Boiler Feedwater | pounds per hour (pph or #/hr) |
| Solids | tons per hour (tph) |
| tons per day (tpd) |
| **Steam & Water Sampling** |  |
| PH | pH (pH Units) |
| Specific conductivity | μS/cm |
| Cation conductivity | μS/cm |
| Degassed cation conductivity | μS/cm |
| Dissolved oxygen | parts per billion (ppb) |
| Silica or sodium | parts per billion (ppb) |
| Oxygen scavenger | parts per billion (ppb) |
| Sulfate, phosphate, chloride | parts per billion (ppb) |
| Turbidity | NTU |
| Total Suspended Solids (TSS) | mg/L |

* 1. Calibration: All instruments shall be factory calibrated and provided with certified calibration sheets as specified in Section GR-B, Engineering Data and Submittal Schedule.
  2. Instrument Tags: Each instrument shall have a stainless steel instrument tag permanently attached to them. If this is not possible, the instrument tag shall be fastened to the instrument with stainless steel wire. The instrument tag shall be stamped or etched with the instrument identification number (tag number). This tag is in addition to the nameplate, which provides the manufacturer's model number and other data. **Phenolic laminated nameplates shall be provided for each board or locally mounted instrument indicating tag number, service and pertinent information such as chart factors if required.**

1. TRANSMITTERS, GENERAL: All transmitters shall be loop powered, two-wire type, with 4-20 mA output signals and 12 to 42 VDC power supply capable of driving a load of up to 750 ohms. Transmitters using a digital signal based on HART Protocol shall be supplied. Transmitter housing shall have a minimum rating of NEMA 4X and shall be provided with local indication. Unless the process dictates otherwise; the body, wetted trim, and process connections materials shall be 316 stainless steel at a minimum. Accuracy of electronic transmitters shall be ±0.10% of range or better and repeatability shall be ±0.10% of range or better. Range span shall be a minimum ratio of 10:1. Wherever possible, conduit size shall be ½” NPT. Transmitters shall be suitable for the Area Electrical Classification, if specified.

Transmitters shall be **Rosemount** or Contractor approved equal. Pressure and differential pressure transmitters shall be Rosemount 2051 “Smart” transmitters.

* 1. Pressure Transmitters: All pressure and differential pressure transmitters shall be provided with B31.1 compliant instrument manifolds to permit isolation from the process, equalization, and calibration. Process connections on manifolds will be 1/2" FNPT. Static pressure transmitters shall be equipped with a two-valve manifold, and differential pressure transmitters shall be equipped with a three-valve manifold. Pressure transmitters with flanged connections shall be silicone filled and provided with flushing connection ring.

Vortex meters and magmeters shall be **Rosemount** or Contractor approved equal.

* 1. Level Transmitters: Sensing elements for level transmitters shall be as follows:

Atmospheric vessel level shall be measured using gauge pressure transmitters.

Radar, ultrasonic, guided wave radar or differential pressure transmitters, shall be used for enclosed pressurized vessel levels.

* 1. Flow Transmitters: Flow transmitters, in general, shall be differential pressure types. Square root extraction shall generally be performed electronically in the control system which receives the transmitter differential pressure output signal. However these differential pressure transmitters shall have square root extrapolation capabilities for local flow indication.

Flow measurements shall be taken from vortex shedding meters, magnetic flow meters, differential pressure type instruments as described later in this section, or other Contractor approved technologies as required by the process.

* 1. Position Transmitters: In general, valve position transmitters will not be required if the control valve is furnished in accordance with Section M1. When required, position transmitters shall be two-wire devices and produce an electrical DC signal in direct relationship to the position of the control valve stem. The output signal range shall be 4-20 mADC HART.

1. GAUGES, GENERAL: Gauges on process piping shall generally be visible **10 feet** from an operator's normal stance at floor or platform level and shall be resistant to Facility atmospheres. Gauge faces shall not be obstructed by equipment, other devices, piping, conduit or supports. Weep holes shall be provided on the case bottom of all gauges located in humid areas unless the case already has sufficient ventilation.
   1. Level Gauges: Level gauges shall be suitable for the design and the expected range of service conditions. Gauge glasses used in conjunction with level instruments shall cover a range slightly greater than the highest and lowest trip/alarm setpoints. Level glasses shall be visible from grade, platform, or the related instrument.

Materials of Construction: All metal parts of level gauge glasses and gauge cocks shall be rust proof. Brass and bronze are not acceptable for any wetted parts. Alloy construction (normally 304 stainless steel) shall be used for all wetted parts where the application requires it, and on applications below 20°F. Gauges shall have tempered borosilicate glass or equivalent material resistant to thermal and mechanical shock. Glass gauges for high temperature use shall be coated with Mica coating. Gauges for caustic, steam or water service greater than 200°F shall be furnished with Mica or approved shields.

Level gauges shall be of the following type:

Transparent glass for: Translucent or opaque liquids

Reflex glass for: Transparent liquids

Level gauges shall be supplied with drain valves, shut-offs valves, ball check valves and gauge guards. Upper and lower check valves shall be equipped with B31.1 compliant ball checks which, in the event of glass breakage, shall automatically seal to prevent the leakage of vessel contents. Gauge cocks shall be offset pattern type, unless required otherwise by the Seller’s design.

Level gauges shall be **Jerguson** or Contractor approved equal.

* 1. Pressure Gauges: Gauges for control air supply and signal pressures integral to the instrument shall be in accordance with the manufacturer's standards. All other gauges shall be 4-1/2 inch with markings for approximately 270 degrees of the dial. Ranges shall be selected so that the normal operating pressure appears in the middle third of the dial. Units of measurement shall be shown on the dial face. Dials shall be white with black markings. Accuracy shall be within 0.5% of full scale, per ASME B40.100 Grade 2A. All gauges shall have stainless steel movable parts and ½” MNPT process connections. Gauges shall have externally adjustable pointers. Each gauge case shall have shatterproof glass and a blowout disk in the back. Bourdon tubes shall not contain copper material. Pulsation dampers or manufacturer’s mechanical options shall be provided on all severe service applications such as pump discharge pressure measurements. Diaphragm seals shall be provided for freeze protection, corrosive fluids, and services that can clog the measuring element. Diaphragm seals shall have ½” FNPT process connections. Pressure gauge calibration reports showing tag numbers, full calibration information including when and where the calibration occurred shall be supplied. Pigtail siphon tubes shall be provided for all steam pressure measurements.

Pressure gauges shall be **Ashcroft** or Contractor approved equal.

* 1. Temperature Gauges: Temperature gauges for local mounting shall be bimetallic type with 5-inch dials minimum, white faces, black scale markings, and shatterproof glass. For high temperatures or for remote mounting, temperature gauges shall be minimum 5-inch dial gas actuated gauges. Ranges shall be selected so that the normal operating temperature appears in the middle third of the dial. Temperature gauges shall have an external zero adjustment and be of the “every angle” configuration. Thermowells shall be furnished for all temperature gauges and shall be as specified in this Section.

Temperature gauges shall be **Ashcroft EI case style** or Contractor approved equal.

1. SWITCHES, GENERAL: Switch elements shall be one DPDT or two SPDT set to actuate at the same set point. Switch elements shall be snap action hermetically sealed elements. Contact ratings shall be 5A at 120 VAC or 0.5 A at 125 VDC. Mercury type switch elements are not acceptable. Switch housings shall be rated NEMA 4X as a minimum. Switch conduit connections shall be 1” FNPT. In general, switches shall be applied such that the actuation point is within the center one-third of the instrument range. Switch action for alarms, shutdowns, and interlocks shall normally be closed circuit at normal operating conditions and open circuit for abnormal condition. Switches shall be suitable for the Area Electrical Classification, if specified.
   1. Limit Switches: Limit switches, when furnished on a control valve, shall be provided for the open and closed position (and intermediate positions where required) of the valve.

When specified, limit switches shall be securely fastened to the valve yoke in such a manner as to not interfere with any valve or accessory function.

Switch settings shall be factory calibrated based on the detailed requirements specified.

Motor and solenoid-operated valves and dampers shall have either two or three operator interface functions, i.e. open, close, and auto (if automatic operation is required). Open and closed indications (with both shown when the device is in its intermediate position) shall be indicated for operator feedback.

* 1. Pressure and Differential Pressure Switches: Pressure and differential pressure switches operating mechanisms shall be diaphragm actuator, force-balance piston actuated, or a combination diaphragm-piston actuated, or Contractor approved technology. Unless the process dictates otherwise; the body, diaphragm, wetted components, and process connection material shall be a minimum 316 stainless steel. All measuring elements shall be able to withstand the full rating of the switch in either direction without damage, without changing repeatability or any zero shifts. The switch set point shall be adjustable over the full range of the measuring element. Accuracy of switches will be 0.5% of range or better and repeatability will be 0.1% of range or better.

Pressure connections shall be 1/2 inch FNPT. Alarm and shutdown switch settings shall not be adjustable from outside the housing.

Pressure and differential pressure switches shall be **Ashcroft, Merriam, Midwest,** or Contractor approved equal.

* 1. Level Switches: In general, level switches shall be the external float cage type with side and bottom 1-inch socket weld connections, constructed to ANSI/ASME B31.1 requirements, and suitable for the pressure, temperature, and general service conditions and functions specified. Internal trim shall be stainless steel unless other materials are required for the service. For high temperature applications, more exotic switches may be required. [Constructability Note: Engineer to consider use of thermocouples in drip legs where possible instead of level switches for less space requirements. This is typically a Construction preference.]

Floats shall be fabricated of 316L stainless steel as a minimum and shall be encased in a cage. All cages shall have a flanged connection to permit removal of the float.

Switch element leads shall be of high temperature construction as required by the service and shall be terminated on terminal blocks within the switch housing.

Float switches shall be **Magnetrol, SOR**, or Contractor approved equal.

* 1. Temperature switches: Temperature switches, locally mounted in Division 1 or 2 locations, shall be filled system bulb type or expansion type. They shall meet the electrical classification and shall have micro switches. Separable sockets shall be furnished. Temperature switches mounted on a local panel shall normally be thermocouple actuated with cold-junction compensation and be completely adjustable. Thermowells shall be furnished for all temperature switches and shall be as specified in this Section.

Temperature switches shall be **Ashcroft** or Contractor approved Equal.

* 1. Flow switches: Flow switches for direct operation by process fluids may be of the sight flow, rotameter, or paddle type for low accuracy requirements. Orifice plate and differential-pressure type shall be used for high accuracy requirements.

1. TEMPERATURE DEVICES:
   1. Temperature Detectors: Temperature detectors shall be thermocouples or resistance temperature detectors (RTDs) as required by the following paragraphs and the technical Specifications.

Temperature detectors equipped with thermowells shall be spring-loaded and shall be furnished as complete assemblies, each including a thermowell, nipple, and weatherproof connection head with terminal block. Thermowells shall be as specified in this Section.

The cast aluminum or zinc plated cast iron head shall be approximately 4 inches in diameter with a weatherproof, screw cover that is chained to the head. The arrangement shall be such that rotation of the screw cover does not damage the internal components. A grounding terminal shall be provided in each connection head. The head should be “explosion-proof” rated where required for hazardous areas.

Thermocouples shall be duplex with ungrounded measuring junctions. The sheath shall have compacted magnesium oxide (ceramic) insulation and be made of be 304 stainless steel, 316 stainless steel, or inconel. Thermocouple assembly extensions shall be nipple union nipple type with the upper nipple the thermocouple spring loaded fitting.

Thermocouples shall be **ISA Type K (chromel-alumel) thermocouples with Type KX extension wire.**  Thermocouple and RTD wires shall be low voltage level code 4. Thermocouples and extension wire shall comply with special limits of error in accordance with the latest version of ANSI MC96.1, "Temperature Measurement Thermocouples." Color code shall be per ISA standard for ISA thermocouple types. [Constructability Note: Engineer to consider adding 4-20mA converters in the thermocouple heads to allow wiring to be normal twisted-shielded pair instead of the more costly KX extension wire. Analog input cards in the DCS will also be less expensive than thermocouple cards.]

Where the process accuracy demands cannot be satisfied by a thermocouple, a resistance temperature detector may by supplied. Resistance temperature detectors shall be 100-ohm platinum, metal sheathed, ceramic packed, ungrounded resistance temperature detectors. RTDs shall be duplex.

Temperature elements measuring inaccessible points shall be wired out to a place safely accessible to maintenance personnel while the unit is operating. Thermocouple transmitters shall be used in lieu of long thermocouple extension wire (>250 ft.). Where thermocouple transmitters are used, they shall be installed integral to the thermocouple head and convert the signal to a 4-20 mA DC signal. Multiple temperature elements located in close proximity should be wired out to junction boxes and terminal strips designed for the temperature element in use, located in a place safely accessible to maintenance personnel while the unit is running. Temperature elements used for monitoring only may also be wired to transmitters. If a thermocouple or RTD is inaccessible under normal operating conditions, the leads shall be brought out to an accessible junction box and terminated on terminal blocks suited for the purpose.

Thermocouples shall be Watlow, Pyromation, STI manufacturing, or Contractor approved equal.

* 1. Thermowells: Fluid system temperature sensors shall be equipped with stepless, tapered stainless steel thermowells manufactured to ASME PTC 19.3 standards. Thermowells shall be made of one-piece, solid, bored construction and be designed to withstand the maximum system pressure, velocity and velocity induced vibration. Thermowells installed in carbon steel pipe shall be constructed of 316 stainless steel. Thermowells installed in low and intermediate alloy pipe shall be constructed of matching alloy. The bore of each well shall be concentric with the outside diameter within ±10 percent of the wall thickness. Thermowells shall extend at least one-third (1/3) of the pipe diameter into the process stream is allowed by the ASME PTC-19.3 vibration analysis. The instrument tag number shall be stamped or etched on the upper hex or round portion of the thermowell.

Thermowells shall be threaded or socket welded (weld-in for allow piping) to fit the Seller’s process connection. Thermowells installed in alloy, steam, and boiler feedwater systems shall have 11/2” socketweld piping connections. All other thermowells shall have 1” NPT piping connections. Threaded connections shall be constructed to allow seal welding after installation, as required. Additionally, each thermowell shall have a lagging extension equivalent to the pipe insulation thickness and have wrench flats to facilitate removal. Thermowells shall be procured from the temperature element provider.

* 1. Test Wells: Test wells shall meet all the criteria for material, design, construction, and certification specified for thermowells. Test wells shall have a 0.385” bore. Each test well shall be supplied with a threaded brass plug that is to be connected to the upper portion of the thermowell with a stainless steel chain. Test wells shall be procured from the temperature element provider.

1. SOLENOID VALVES, GENERAL: Valves shall be selected to incorporate body construction, trim materials, and internal arrangements suitable to the application and shall be acceptable to the Contractor. Solenoid enclosures shall be NEMA 4X, unless otherwise specified. Solenoid coils shall be Class H high temperature construction and shall be suitable for continuous duty. Solenoid valves coils shall be 120 VAC unless otherwise specified. Solenoid valves shall be suitable for the Area Electrical Classification, if specified. [Engineering Note: Verify voltage requirements versus Contract and Vendor requirements. Many projects are seeing much more use of 48 VDC and 24 VDC.]

Solenoid valves shall be mounted on the valve yokes unless specified otherwise.

When required, solenoid valves shall be three-way, connected so as to vent the top works on loss of power unless specified otherwise. Minimum connection size shall be ¼” NPT. [Engineering Note: Verify versus a minimum of ½” NPT.]

Solenoid valves shall be by ASCO or Contractor approved equal.

1. FLOW DEVICES:
   1. Differential Pressure Flow Elements and Restriction Orifices: Sizing calculations shall be submitted for Contractor review before manufacturing of the instrument takes place. Calculations shall be certified and conform to the requirements of ASME MFC-3M, “Principles and Practices of Flow Meter Engineering” by L.K. Spinks or “Flow Measurement Engineering Handbook” by R.W. Miller. Piping layouts for flow elements used for performance testing shall comply with ASME PTC-19.5. Piping layouts for flow elements not used for performance testing shall comply with ASME MFC-3M.

Orifice plates shall be constructed of 316 stainless steel as a minimum. Orifice plates shall be one-piece construction and shall be concentric, square edge, paddle type. Orifice plates used for flow measurement shall be installed between raised face, weld neck, orifice flanges. Orifice plates used for flow measurement shall have a beta ratio between 0.2 and 0.7, inclusive. The beat ratio (d/D) is defined as the ratio of the orifice diameter (d) to the inside diameter (D) of the pipe.

For gas and vapor service, the differential pressure range in inches of water normally shall not exceed the static absolute pressure in psia.

Flange taps shall normally be used in accordance with ASME MFC-3M. For special alloys and 14-inch-and-larger pipe sizes, in Class 150 classification, throat taps may be used. One-half-inch NPT is the normal tap size for Class 300 through Class 600 flange rating. Three-quarter-inch is the tap size for Class 900 through Class 2500 flange rating. Where threaded connections are not permitted by the pipe class, socket weld connections shall be used.

The minimum orifice flange rating shall be ANSI Class 300. The use of higher rated flanges, or of facing type, shall be as called for in piping specifications.

Ring-type plate holders shall be manufacturer's standard plate mounting. Ring facing shall be oval ANSI standard unless otherwise required by piping specifications.

Flow element pressure taps for horizontal pipe runs shall normally be oriented horizontal for clean liquids and steam, and vertical-up for dry gases. Flow orifice plates shall be installed only after applicable piping has been flushed or blown down.

Venturi tubes, low-loss tubes, and flow nozzles shall be used where high-pressure recovery is necessary and/or where only low inlet pressure is available.

Integral orifice meters (combination primary element-measuring device) shall normally be used for meter runs of less than 1 ½” with a suitable strainer upstream of the meter. This type of flow meter shall not be used in outdoor installations where there is a risk of freezing temperatures.

Eccentric type orifice plates shall be used for fluids containing two phases. The eccentric-type orifice plates shall have the bottom of the orifice bore flush with the bottom ID of the pipe. Eccentric orifice plates shall be used only in horizontal runs.

Orifice, flow nozzles and venturis shall be **Daniel Industries Inc., Fluidic Technologies, Triad, PFS** or Contractor approved equal.

* 1. Other types of flow elements should be considered for non-critical services where their use is desirable and the above-mentioned elements are not applicable. Piping layouts shall be per manufacturer’s standard.

Averaging pitot tubes may be used where the pipe diameter is too large for acceptable orifice plate design in applications such as pump minimum flow bypass control, or where normal straight pipe requirements are not met. Pitot tubes shall be constructed of stainless steel material as a minimum.

Acceptable vendors are **Dietrich Standard, Deltabar/Midwest Instruments, Veris** or Contractor approved equal.

Magnetic flow meters shall be used in applications where the conventional flow instruments cannot be used or are not suitable (e.g., slurry applications).

1. INSTRUMENT VALVES AND MANIFOLDS, GENERAL: Each remotely mounted instrument shall be provided with both instrument and manifold valves as specified below. For local or in-line mounted devices, the instrument valve is not required since the root valve can be used for isolation.
   1. Instrument Valves: Instrument valves shall be provided to allow each individual instrument to be isolated for maintenance and calibration. The instrument valve shall be downstream of the root valve and upstream of the instrument manifold. The valve shall be a Swagelok SS-63TS8-JL or Contractor approved equal.
   2. Instrument Manifold Valves: Instrument manifold valves shall be provided as follows:
      1. Instruments with one (1) process connection shall be fitted with a 2-valve manifold.
      2. Instruments with two (2) process connections shall be fitted with a 3-valve manifold. [Engineering Note: Confirm with Contract that 5-valve manifolds are not required.]
2. INSTRUMENT INSTALLATION: All instrument, control, and sampling tubing installed by the Vendor shall be pressure tested for leaks. All tubing shall be 316 stainless steel and all tubing fittings shall be Swagelok, or Contractor approved equal.

Temperature, pressure, and differential-pressure transmitters, switches, and transducers shall be mounted on either stands or racks or in local instrument cabinets as long as instruments are properly protected, including environmental protection (heat traced). Instruments that can be logically grouped shall be installed on racks or in local instrument cabinets. Instrumentation, accessories, and all other equipment shall be located and mounted such that calibration, maintenance, and removal work can be performed on any one piece of equipment without disturbing another. Adequate clearance shall be provided so that calibration, adjustments, and connections are easily accessible without need of instrument removal. All instrument covers shall be provided with adequate clearance space for removal. Equipment shall be arranged such that work can be performed easily, without need for special tools.

Instruments, instrument valves, and manifold valves shall be easily accessible for calibration.

Each pressure connection, except for relief valves, shall have a root valve.

All external electrical connections of junction boxes and cabinets shall be made to terminal blocks. The wiring and terminal blocks for different voltage classes shall be physically separated in order to minimize electrical noise and hazard to personnel. Terminal blocks shall be provided with marker strips.

Instruments shall be mounted in a manner that prevents vibration effects. Where necessary, pulsation dampeners will be supplied.

Instrumentation installation shall be designed for proper sensing of process variables. Taps on process lines shall be located such that sensing lines do not trap air in liquid service or liquid in gas service. Calibration tees shall be provided for all instruments requiring calibration. In general, impulse lines measuring liquids shall be connected to the process piping at an angle between horizontal and 45º down from horizontal. In general, impulse lines measuring vapors, gas and air shall be connected to the process piping at an angle between vertical and 90º down from vertical. The height of the parallel legs of differential pressure elements must be identical and shall emanate from the same side of the pipe to facilitate the connection of winterization tubing bundles. The process connection shall be located to allow for correct orientation of the instruments while maintaining accessibility. Instruments measuring the pressure or flow of steam or liquids or measuring levels shall be located below the process connections. Instruments measuring the pressure or flow of vapors, gas or air shall be mounted above the process connections. Impulse lines connected to steam or hot water services shall be of sufficient length to allow for cooling of the liquids before they come into contact with the transmitter cell.

Sample tubing connection shall be 1/2” minimum nominal diameter.

Pressure transmitters, switches, etc. connected to steam lines shall be remote mounted. Inline instruments, including analyzers, shall be removable from the line for servicing without requiring a unit shutdown.

Sample tubing systems carrying high temperature samples shall be insulated in areas that require personnel protection. Personnel burn protection limit shall be at **180ºF** sustained.

1. HEATED INSTRUMENT ENCLOSURES: Where applicable, the instrumentation’s interface with the process shall be capable of being thermally insulated and heat traced to prevent freezing without damage or obstruction of instrument operation, readouts, or displays. All instruments installed outdoors shall be installed in heated enclosures as required. Heated enclosures shall contain a maximum of two (2) field devices.

Enclosures shall be **O’Brien** or Contractor approved equal.

The enclosures shall give total protection of the instrumentation, leaving no parts of the instrumentation exposed to the weather. The enclosure shall be designed to protect the transmitter and any direct mounted manifold from freezing at the plant low ambient design temp and maximum wind speed. The enclosures shall be complete with all other appurtenances necessary for freeze protection at the conditions noted. Enclosures shall include an instrument mounting system and mounting brackets as required for a complete installation suitable for manifold mounting each transmitter. Mounting brackets will not be provided with supplied instruments. A longitudinal mounting rail design shall be used to allow adjustment of the instrument position.

## Interior instrument supports shall be directly connected through the enclosure wall to the exterior support. Enclosures shall be the clamshell type with lid support and hinged at the top, rear. Enclosures shall be provided with a window for any local indicators clearly visible without opening enclosure lid. Sufficient room should be allowed for the instrument, the necessary heater element, thermostat, other required equipment, and space necessary to allow testing, calibration, maintenance, and replacement of the instrument or accessories. The enclosure heater shall not be mounted to the instrument or its manifold. Drainage for the enclosure is to be provided in the event of a leak or spill. Each enclosure shall be provided with drain hole and plug to maintain the weather tightness.

Each enclosure shall include a 2” pipe pedestal bracket and adequate hardware for the dual or single mounting of the enclosure on a 2” pipe stand.Enclosures shall have an outer fiberglass or ABS shell with integral urethane foam core to provide resistance from chemicals, water, and oil. Materials should be corrosion resistant, UV-protected, and suitable for outdoor installation. Latches and hinges shall be stainless steel. The number of latches should be sufficient for secure latching under the design conditions. A lid prop shall be provided to reliably hold open enclosures. The lid shall be required to be lifted to release the brace.

The enclosures shall be installed and anchored in place so that they are level, plumb, and properly aligned in accordance with the above mounting requirements.

1. HEAT TRACING: Drawings shall indicate the equipment, piping, tubing, and instruments that may freeze, become viscous, or have undesirable condensation/precipitation/hydrate formation that will require heat tracing for freeze protection. Heat tracing shall be supplied and installed by the Contractor.

END OF SECTION