<table>
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<tr>
<th>Revision</th>
<th>Description of Change – Replace, Add, and Delete Pages</th>
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<tr>
<td>0</td>
<td>Initial release On DCN-200W-052</td>
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<td>Revised per DCN-200W-125</td>
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<td>Sect 2.04.O removed reference to Mercury; Sect 2.04.F revised Carbon</td>
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<td>Tetrachloride Analyzer section; Sect 2.04.Q revised manufacturer/model to Hanford site standard</td>
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<td>2</td>
<td>Incorporate Redlines RLD-200W-142 and RLD-200W-230. Add specification section for temperature switch type T5 and renumber paragraphs</td>
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Authorized for Release:
- 07/06/10 CL Rambo
- 09/15/10 A Wiseman
- 01/12/2011 GV DeLisle

Approved for Construction
ISSUED BY
DOCUMENT CONTROL
Date: 1-14-2011
SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1    GENERAL

1.01    SUMMARY

A. This section gives general requirements for instrumentation and control components.

PART 2    PRODUCTS

2.01    GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

2.02    MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:

1. For air or water service, unless otherwise noted.
3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
5. Integral inlet needle valves.
6. Integral differential pressure regulators:
   a. For water service.
   b. For air service for level ranges greater than 10 feet of water.
7. Rotameters for water service.
8. Manufacturers and Products:
   a. Fischer & Porter; Series 10A3130.
   b. Brooks; Series DS-1350.

B. Manifold, Three-Valve Equalizing:
1. Type: For isolation and equalization of differential pressure transducers.
3. Manufacturers and Products:
   b. Evans.

C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
   a. Ashcroft Utility; Gauge Series 1000.
   b. Marsh; Standard Gauge Series.
   d. Acculite; Series 2000.

D. Valve, Needle:

1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
2. Size: 0.020-inch orifice.
3. Manufacturers and Products:
   a. Whitey; Model 21RF2.
   b. Hoke; 3700 Series.

E. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Flomite 7100 Series.

F. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Catalog No. RF or No. RS.
   b. Hoke; 3100 through 3300 Series.

G. Valve, Three-Way:
1. Type: Ball valve.
2. Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Selecto-Mite Series.

H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
   a. Body and Stem: Type 316 stainless steel.
   b. Handle: Black nylon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
   a. Whitey; Series 457.
   b. Hoke; Multi-Mite Series.

I. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
3. Port Connection: 1/4-inch outside diameter tube fittings.
4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO.

J. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
   a. Body: Brassed or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
   b. Valve Seat: Buna-N.
3. Size: Normally closed or opened, as noted.
4. Coil: 24V dc, unless noted otherwise.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

K. Pressure Regulator, Air:

1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 psi supply pressure.

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INSTRUMENTATION AND CONTROL COMPONENTS
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2. Setscrew for outlet pressure adjustment.
3. Integral filter and relief valve.
4. Manufacturers and Products:
   a. Masonellow; Series 77-4.
   b. Fisher; Series 67FR.

L. Pressure Regulator, Water:

1. Materials:
   a. Body: Bronze.
   b. Spring Case: Cast iron.
   c. Seat Rings: Brass.
   d. Valve Disk and Holder: Buna-N and bronze.
   e. Diaphragm: Buna-N diaphragm.
2. Sizing: For maximum of 7 psi offset pressure.
3. Manufacturers and Products:
   a. Fisher; Controls Type 95H or 95L.
   b. Masonellow; Series 17.

M. Test Tap:

1. Manufacturers and Products:
   a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
   b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
   c. Parker; CPI Series precision quick couplings.

N. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on Drawings.
3. Manufacturers:
   a. Parker-Hannifin.
   b. Swagelok tube fittings.

O. Plastic Tubing and Fittings:

1. Tubing:
   a. Polyethylene capable of withstanding 190 psig at 175 degrees F.
   b. Manufacturers and Products:
      1) Dekoron; Type P.
      2) Imperial Eastman; Poly-Flo black instrument tubing.
2. Fittings:
a. Type: Brass compression.
b. Manufacturers and Products:
   1) Imperial Eastman; Poly-Flo tube fittings.
   2) Dekoron; E-Z fittings.

P. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on Drawings.

Q. Stainless Steel Fittings:
   1. Compression Type:
      a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
      b. Manufacturers and Products:
         1) Parker Flodar; BA Series.
         2) Swagelok tube fittings.
         3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
   2. Socket Weld Type:
      a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
      b. Manufacturers:
         1) Cajon.
         2) Swagelok.
         3) Parker WELDLOK.

R. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

S. Purge Set:
   1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on Drawings and as required in this section.
   2. Pressure Gauge Scale Range: 150 percent of the process variable.
   3. Mounting:
      a. Within consoles, panels, or a separate enclosure as shown.
      b. For separate enclosure mounted purge sets, refer to paragraphs Nonfreestanding Panel Construction and Factory Finishing for enclosure requirements.

T. Tubing Raceways:
   1. Cable tray systems complete with tees, elbows, reducers, and covers.
   2. Size in accordance with manufacturer’s recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on Drawings.

4. Manufacturers:
   a. Globetray.
   b. Cope.

U. Air Supply Sets:

1. Parts, Integrally Mounted:
   a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
   c. Pressure gauge.
   d. Inlet filter muffler.
   e. Power: 120V ac.
   f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
   g. Manufacturers and Products:
      1) ITT Pneumotive; GH Series.
      2) Gast.

2. Simplex Air Supply Sets:
   a. Air Receiver: 2 gallons.
   b. Compressors: One.

3. Duplex Air Supply Sets:
   a. Air Receiver: 20 gallons.
   b. Compressors: Two.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. In general, wires shall run from initiating device to terminating device without intermediate termination. When intermediate terminations are necessary, coordinate with wire size, voltage, and current requirements.
   b. Connection Type: Screw compression clamp.
   c. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   e. Current Bar: Copper or treated brass.
   f. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
2) Two funneled shaped inputs to facilitate wire entry.

  g. Mounting:
  1) Standard DIN rail.
  2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
  3) End Stops: Minimum of one at each end of rail.

  h. Wire Preparation: Stripping only permitted.

  i. Jumpers: Allow jumper installation without loss of space on terminal or rail.

  j. Marking System:
  1) Terminal number shown on both sides of terminal block.
  2) Allow use of preprinted and field marked tags.
  3) Terminal strip numbers shown on end stops.
  4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
  5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

B. Relays:

  1. General:
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide holddown clips.

  2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: Two Form C contacts.
   c. Contact Rating: 5 amps at 28V dc.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (dc).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
   k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.

  3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc).
   g. Expected Mechanical Life: 10,000,000 operations.
h. Expected Electrical Life at Rated Load: 100,000 operations.

i. Indication Type: Neon or LED indicator lamp.

j. Push-to-test button.

k. Manufacturer and Product: Potter and Brumfield; Series KUP.

4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: Two Form C contacts.
   c. Contact Rating: 10A at 28V dc.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.

5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: Two Form C contacts.
   c. Contact Rating: 10A at 30V dc.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
   i. Time Delay Setpoint: As noted or shown.
   j. Mode of Operation: As noted or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.
   l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.

C. Surge Suppressors:

1. General:
   a. Construction: First-stage high-energy metal oxide varistor and second-stage bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
   b. Response: 5 nanoseconds maximum.
   d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.

2. Suppressors on 120V ac Power Supply Connections:
   a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
   b. First-Stage Clamping Voltage: 350 volts or less.
   c. Second-Stage Clamping Voltage: 210 volts or less.
d. Continuous Operation:
1) Power Supplies for One Four-Wire Transmitter or Receiver:
   5 amps minimum at 130V ac.
2) All Other Applications: 30 amps minimum at 130V ac.
3) Suppressors on Analog Signal Lines:
   a) Test Waveform: Linear 8 microsecond rise in current form 0 amps to a
      peak current value followed by an exponential decay of current
      reaching one-half the peak value in 20 microseconds.
   b) Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak
      test waveform.
      1) dc Clamping Voltage: 20 percent to 40 percent above operating
         voltage for circuit.
      2) dc Clamping Voltage Tolerance: Less than plus or minus
         10 percent.
   3) Maximum Loop Resistance: 18 ohms per conductor.
4. Physical Characteristics:
   a) Mounted in Enclosures: Encapsulated inflame retardant epoxy.
   b) For Analog Signals Lines: EDCO PC-642 or SRA-64 series.
   c) For 120V ac Lines: EDCO HSP-121.
   d) Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel
      pipe nipples. EDCO SS64 series.
   e) Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac
      circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
      1) Enclosure:
         a) NEMA 4X fiberglass or Type 316 stainless steel with door.
         b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   2) Manufacturer and Product: EDCO; SLAC series.

D. Power Supplies:
1. Furnish as required to power instruments requiring external dc power,
   including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with
   sufficient voltage regulation and ripple control to assure that instruments
   being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
   a) Protect instruments from damage due to power supply failure.
   b) Protect power supply from damage due to external failure.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
   a) Type: Indicating.
   b) Mount so fuses can be easily seen and replaced.
7. Capacity: Wire multiple units in parallel to provide sufficient current for total
   load.
8. Manufacturer and Product: PHOENIX CONTACT; MINI-PS-100-240AC/24V dc/C2LPS.

E. Direct Current Uninterruptible Power Supply:

1. For 24V dc control system panels, provide a short term power buffer module.
   a. Power Connections:
      1) Input: 24V dc.
      2) Output: 24V dc at 20 A maximum.
   b. On outage maintain load from 200 mS at 20 A to 4 S at 1 A.
   c. Power storage by capacitive system.
   d. Integrated input fuse.
   e. DIN rail mount.

F. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.

2.04 I&C COMPONENTS

A. AS ORP Element and Transmitter:

1. General:
   a. Function: Measure, indicate, and transmit ORP of process fluid.
   b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.

2. Performance:
   a. Element:
      1) Process Range: If and as noted.
      2) Range: Minus 1500 to plus 1500 mV.
      3) Operating Temperature: 32 degrees F to 185 degrees F.
      4) Operating Pressure: 100 psig maximum at 149 degrees F.
   b. Analyzer/Transmitter:
      1) Range: Minus 1400 mV to plus 1400 mV.
      2) Accuracy: Plus or minus 1 mV.
      3) Repeatability: Plus or minus 1 mV.
      4) Stability: Plus or minus 1 mV per month, noncumulative.
      5) Operating Temperature: Minus 32 degrees F to plus 122 degrees F.
3. Element:
   a. Process Connection: 1-inch MNPT.
   b. Body Style: Convertible with 1-inch NPT on both ends.
   c. Process Fluid: As noted.
   d. Wetted Materials: Compatible with process fluid.
   e. No field-replaceable parts, unless otherwise noted.
   f. Electrode Type: Flat glass or general purpose, unless otherwise noted.
   g. Integral Preampifier: Required, unless otherwise noted.
   h. Mounting/Process Connections: As shown on Drawings or as noted from among the following:
      1) Submersion:
         a) Sensor handrail assembly.
         b) Handrail mounting kit.
      2) Flow-Through:
         a) 3/4-inch NPT PVC tee.
         b) 1-inch NPT PVC tee.
         c) 1-1/2-inch NPT PVC tee.
      3) Insertion.
      4) Hot-Tap Retractable:
         a) Suitable for 64-psig line pressure, unless otherwise noted.
         b) 1-1/4-inch ball valve kit, unless otherwise noted.
         c) Titanium Tube: 21 inches (12-inch insertion), unless otherwise noted.
   i. Suitable for Installation in Class I, Division 2 Hazardous Locations: If noted or shown.
      1) Install in accordance with manufacturer’s instructions and applicable codes.

4. Analyzer/Transmitter:
   a. Display: Graphic LCD, with backlighting.
   b. Signal Interface:
      1) Analog Outputs: Two isolated 4 mA to 20 mA dc outputs (ORP and temperature).
      2) Discrete Outputs:
         a) Process Alarms: Two SPSTs minimum, normally open.
         b) Sensor/Analyzer and Process Fault Alarm: SPDT.
         c) Contact Rating: 120 volts, 5 amps, resistive.
   c. Enclosure.
      1) Type: NEMA 4X.
      2) Suitable for panel, 2-inch pipe, or wall mounting.
         a) Wall and 2-inch mounting kit, unless otherwise noted.
   e. Interconnecting Cable: Length as required.
   f. Suitable for Installation in Class I, Division 2 Hazardous Locations: If noted or shown.
5. Expendables (for each unit provided):
a. Chemicals:
   1) ORP reference solution.
   2) 32 ounces, minimum.
6. Accessories:
a. Junction Box: If noted.
   1) NEMA 4X box for cable extension.
7. Manufacturers and Products:
a. Rosemount Analytical; Model 399 (water) sensor and Model 54e ORP analyzer.
b. Hach; Digital Differential ORP sensor and sc100 controller.
c. Approved equal.

B. A7 pH Element and Transmitter:

1. General.
a. Function: Measure, indicate, and transmit pH of process fluid.
b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.
2. Performance:
a. Element:
   1) Range: 0 pH to 14 pH.
   2) Operating Temperature: 32 degrees F to 158 degrees F.
   3) Operating Pressure: 80 psig maximum at 149 degrees F.
b. Analyzer/Transmitter:
   1) Range: 0 pH to 14 pH units.
   2) Accuracy: Plus or minus 0.02 pH units.
   3) Repeatability: Plus or minus 0.05 pH units.
   4) Stability: Plus or minus 0.01 pH units per month, noncumulative.
   5) Operating Temperature: Minus 4 degrees F to plus 104 degrees F.
   6) Operating Humidity: 5 percent to 95 percent; relative humidity, noncondensing.
3. Element:
a. Process Connection: 1-inch MNPT.
b. Body Style: Convertible with 1-inch NPT on both ends.
c. Process Fluid: As noted.
d. Wetted Materials: Compatible with process fluid.
e. No field-replaceable parts, unless otherwise noted.
f. Electrode Type: Flat glass or general purpose, unless otherwise noted.
g. Integral Preamplifier: Required, unless otherwise noted.
h. Mounting/Process Connections: As shown on Drawings or as noted from among the following:
   1) Submersion:
      a) Sensor handrail assembly.
      b) Handrail mounting kit.
   2) Flow-Through:
a) 3/4-inch NPT tee.
b) 1-inch NPT tee.
c) 1-1/2-inch NPT tee.

3) Insertion.

4) Hot-Tap Retractable:
   a) Suitable for 64-psig line pressure.
   b) 1-inch ball valve kit.
   c) Titanium Tube: 21 inches (12-inch insertion).

i. Suitable for Installation in Class I, Division 2 Hazardous Locations:
   If noted or shown.
   1) Install in accordance with manufacturer’s instructions and
      applicable codes.

4. Analyzer/Transmitter:
   a. Display: Graphic LCD, with backlighting.
   b. Signal Interface:
      1) Analog Outputs: Two isolated 4 mA to 20 mA dc outputs (pH and
         temperature).
      2) Discrete Outputs:
         a) Process Alarms: Two SPSTs minimum, normally open.
         b) Sensor/Analyzer and Process Fault Alarm: SPDT.
         c) Contact Rating: 120 volts, 5 amps, resistive.
   c. Enclosure:
      1) Type: NEMA 4X.
      2) Suitable for panel, 2-inch pipe, or wall mounting.
   e. Interconnecting Cable: Length as required.
   f. Suitable for Installation in Class I, Division 2 Hazardous Locations:
      If noted or shown.

5. Expendables (for each unit provided):
   a. Chemicals: 1 pint each of buffer solution for pH 4, pH 7, and pH 9.

6. Accessories:
   a. Junction Box: If noted.
      1) NEMA 4X box for cable extension.

7. Manufacturers and Products:
   a. Rosemount Analytical; Model 399 (water) sensor and Model 1056 pH
      analyzer.
   b. Hach; Digital Differential pH sensor and sc100 controller.
   c. Approved equal.

C. A16 Turbidity Element and Transmitter:

1. General:
   a. Function: Continuously measure, indicate, and transmit a signal
      proportional to turbidity of a sample stream of process fluid.
   b. Type: Light scatter detection measurement using a 90-degree scatter
      photocell detector.
c. Parts: Element, transmitter (controller), interconnecting cable, mounting hardware, and expendables.

2. Performance:
   b. Range: 0 NTU to 100 NTU.
   c. Displayed Resolution:
      1) 0.0001 NTU up to 10 NTU.
      2) 0.001 NTU for 10 NTU and greater.
   d. Repeatability: Plus or minus 1 percent or plus or minus 0.002 NTU, whichever is greater.
   e. Initial Response Time: Within 75 seconds for a full-scale step change.
   f. Required Flow: 200 ml to 750 ml per minute.
   g. Sample Temperature: Zero to 60 degrees C.
   h. Operating Temperature:
      1) Single Sensor System: 0 degrees C to 50 degrees C.
      2) Dual Sensor System: 0 degrees to 40 degrees C.
   i. Operating Humidity: 5 percent to 95 percent, noncondensing.
   j. Accuracy:
      1) From 0 NTU to 40 NTU: Plus or minus 2 percent of reading or plus or minus 0.015 NTU, whichever is greater.
      2) From 40 NTU to 100 NTU: Plus or minus 5 percent of reading.

3. Element:
   a. General: Flow-through body using focused light and submerged photocell to measure 90-degree scattered light within the fluid.
   b. Submerged photocell that does not require glass windows and flow cells.
   c. Internal bubble trap and vent.
   d. Polystyrene body.
   e. Optical components mounted in a sealed head assembly that is removable without disturbing sample flow.
   f. Dimensions: 10 inches by 13 inches by 16 inches, nominal.
   g. Fittings:
      1) Sample Inlet: 1/4-inch NPT female, 1/4-inch compression fitting.
      2) Drain: 1/2-inch NPT female, 1/2-inch hose barb.

4. Transmitter:
   a. Features:
      1) Signal Average Time: User selectable from 6, 30, 60, 90 seconds with a 60-second default. 2) Four-digit LCD display.
      2) Mounting: Wall and floor stand.
   b. Enclosure:
      1) NEMA 4X (indoor).
      2) Dimensions, Nominal: 6 inches by 6 inches by 6 inches.
      3) Mounting: Wall, pole, panel, and floor stand.
   c. Signal Interface:
      1) Analog Output:
a) Two 4 mA to 20 mA dc suitable for load impedance of up to 500 ohms.

b) Span configurable over any portion of the 0 to 100 NTU range.

c) Output Span: As noted.

2) Alarm Contacts: Three independent alarm setpoints, each SPDT and rated 5A continuous at 230V ac, minimum. Each setpoint adjustable over full range.


6. Cabling: As required.

7. Accessories and Expendables:
   a. Calibration Kits:
      1) Stablecal Verification Standards:
         a) 1 liter of 20 NTU calibration standard.
         b) 1 liter of 1 NTU verification standard.
         c) Quantity: One each for each turbidimeter.
         d) Two Stablecal calibration cylinders, minimum.
      2) Formazin Calibration Standard:
         a) Kit including 0.5 liter of 4000 NTU Formazin, pipet, and calibration cylinder.
         b) Quantity: One for each turbidimeter.
      3) Order expendables just before startup.
   b. Verification Module: 1 NTU, unless otherwise noted.

8. Manufacturer and Product: Hach Company; Ultraturb Plus with sc100 controller.

D. A20 Dissolved Oxygen Element and Transmitter, Nonmembrane Luminescent (LDO):

1. General:
   a. Function: Continuous measurement of dissolved oxygen (DO) concentration of process fluid.
   b. Type: Luminescent or fluorescence sensor.
   c. Parts: Element (sensor), transmitter (analyzer), external power supply, interconnecting cable, mounting hardware, and ancillaries.

2. Performance:
   a. Range: 0 to 20 ppm.
   b. Sensor Accuracy:
      1) Measurement: plus or minus 0.2 ppm.
      2) Temperature: plus or minus 0.2 degrees C.
   c. Response Time: Less than 40 seconds to 90 percent of value upon step change.

3. Element:
   a. Luminescent or fluorescent sensor.
   b. Process Temperature Range: 32 degrees F to 122 degrees F.
   c. Submersion Depth: 350 feet maximum.
d. Sensor Cable: Integral 33 feet of cable. Provide additional length as required.
e. Junction Box: Provide junction or termination box and extension cable as required.
f. Mounting: 1-1/2 UNF - 12 UNF thread; as shown or as noted.
   1) Submersion:
      a) Sensor handrail assembly.
      b) Handrail mounting kit.
   2) Flow-Through: LDO flow cell accessory.
4. Transmitter:
   a. Display:
      1) Graphic dot matrix LCD to display DO.
      2) Auxiliary Readout:
         a) Temperature.
         b) Diagnostic warnings.
         c) Error messages.
         d) Other information.
   b. Ambient Conditions:
      1) Temperature minus 4 degrees F to plus 140 degrees F.
      2) Humidity: 0 to 95 percent, relative, noncondensing.
   c. Signal Interface:
      1) Analog Output:
         a) Two isolated 4 mA to 20 mA dc for load impedance up to 500 ohms.
         b) Either output configurable for DO or temperature.
      2) Relay Outputs:
         a) Three SPST; 5 amps resistive, 115V ac/230V ac/30V dc.
         b) Each relay assignable to either DO or temperature.
         c) Function:
            (1) Control: Settings for fail safe on/off, high/low phasing, setpoint, deadband, and on/off displays.
            (2) Alarm: Settings for fail safe on/off, high alarm point, high alarm point deadband, low alarm point, low alarm point deadband, and on/off relays.
      3) Serial Communication: If and as noted.
   e. Mounting Hardware: Suitable to support panel, surface, horizontal pipe, and vertical pipe mounting.
   g. Stainless steel equipment tag.
5. Accessories:
   a. Unless otherwise noted, provide submersion mounting hardware and mounting bracket as required to perform appropriate installation.
   b. Provide sun shield for transmitter display.
   c. Provide LDO flow cell where noted.
6. Manufacturers and Products:
A. Hach; sc100 LDO Analysis System.
B. Insite IG; Model 1000 Dissolved Oxygen Analyzer.
C. Environmental Instruments; FL-3 Dissolved Oxygen Analyzer.
D. Royce Technologies; Model 98/9810 Dissolved Oxygen Sensor/Analyzer.

E. A27 Free Chlorine Residual Analyzer, No Reagents:

1. General:
   a. Function:
      1) Measure and indicate free residual chlorine of sample.
      2) Transmit proportional analog signal.
   b. Type:
      1) Principle: Amperometric or polarographic membrane sensor.
      2) Reagents not required.
   c. Parts: Sensor, analyzer/transmitter, and accessories.

2. Performance:
   a. Species Measured: Free residual chlorine.
   b. Service: Potable water treatment unit processes, unless otherwise noted.
   c. Process Range: As noted.
   d. Analyzer Range: Single 0 mg/L to 20.0 mg/L range or multiple ranges within 0 mg/L to 20.0 mg/L.
   e. Linearity: 0.1 percent of full scale.
   f. Response Time to Step Change: Less than 60 seconds to 90 percent of final value.
   g. Sample Conductivity: Greater than 10 microS/cm.
   h. Sample Temperature Range: 32 degrees F to 104 degrees F.
   i. Operating Ambient Temperature Range: 32 degrees F to 122 degrees F.

3. Features:
   a. Sensor:
      1) Electrodes and either amperometric or polarographic membrane sensor.
      2) pH Sensor: Required, unless otherwise noted.
      3) Flow Cell:
         a) Constant head.
         b) 7 gph to 15 gph, minimum.
      4) Inlet Pressure: 3 psig to 65 psig.
   b. Analyzer: Two line display.

4. Enclosure:
   a. NEMA 4X (IP-66), polycarbonate.
   b. Suitable for wall mounting; furnish required accessories.

5. Signal Interface:
   a. Analog Output: 4 mA to 20 mA dc isolated outputs suitable for a load impedance up to 500 ohms.
   b. Discrete Outputs:
1) Two minimum SPDT, minimum 5 amps at 120V ac and 24V dc, resistive.
2) Selectable process alarms or fault.

6. Process Connections:
a. Sample Inlet: 1/4 inch.
b. Drain Connection: 1/2 inch or 3/4 inch.


9. Manufacturers and Products:
b. Rosemount Analytical, Model FCLi Free Chlorine Measuring System.

F. A30D Carbon Tetrachloride Monitor:

1. General:
a. Function: Continuously monitor the process stream or area atmosphere for carbon tetrachloride
b. Four sample points/tubes
c. Method: Fixed photoionization detector

2. Performance:
a. Range: 0 – 1000 ppm
b. Resolution: 1 ppm for 100.00 ppm range
c. Operating Temperature: Minus 0 - 50 degrees C
d. Humidity: 0 – 99 percent (non-condensing)
e. Sampling:
   1) Atmospheric and process monitor draws gas sample by means of internal pump
   2) Sample Flow:
      a) Atmospheric: ~0.6 liters per minute
      b) Process: 0.6 – 2.0 liters per minute up 200 feet
f. Response Time: dependant on sample line length.

3. Features:
a. Enclosure:
   1) NEMA 4
   2) Surface mount. Size 18"H x 16"W x 7" D, 40lbs
b. Local Display:
   1) front facing, full-length door with a window for viewing a 2 line x 20 character vacuum fluorescent display.
   2) Alarm LEDs.

c. Power: 115 or 220 VAC, 60 Watts
d. Process Connection:
   1) Provide flow-through unit where noted.
   2) Provide metering valve to limit sample flow to manufacturer specification where required.

4. Signal Interface:
a. Analog Output: 4 – 20 mA (process variable), Analog 0-10 VDC (channel indication)

b. Discrete Output:
   1) Alarm relay contacts for high and low levels.
   2) Rating: 30V dc, 2A.

5. Manufacturer and Product:
   a. MSA Chemgard, model A-3800 XX-4-1-1-0-1-4-0-D-0-N-C with removal of low end deadband.
   b. Approved equal.

G. A61D Nitrate Element and Transmitter.

1. General:
   a. Function: Continuously monitor the process stream for nitrates.
   c. Parts: Probe, bypass panel, transmitter.

2. Performance:
   a. Range: 0.1 – 50.0, 0.1 – 25.0 mg/L.
   b. Accuracy: Greater of plus or minus 5 percent of reading or plus or minus 0.5 mg/L.
   c. Resolution: 0.1 mg/L.
   d. Response Time: 5 Min.
   e. Operating Temperature:
      1) Probe: 36 -- 104 degrees F.
      2) Transmitter: Minus 4 – 104 degrees F.
   f. Humidity (Transmitter): 0 – 95 percent (non-condensing).
   g. Reagent: None.
   h. Cleaning Method: Integral wiper.
   i. Mounting: Bypass panel.

3. Transmitter:
   a. Enclosure:
      2) Mounting: Surface or pipe.
   b. Local Display: LED backlit LCD.
   c. Power: 24V dc, 125 mA at 24V.
   d. Memory: Non-volatile.

4. Signal Interface:
   a. Analog Output: 4 – 20 mA.
   b. Discrete Output:
      1) Three SPST alarm relay contacts, configurable.
      2) Rating: 100 – 230V ac, 5 A.

5. Manufacturers:
   a. Hach Co.
   b. Approved equal.

H. A160D Suspended Solids Sensor/Transmitter:
1. General:
   a. Function: Monitor the process stream for suspended solids content.
   b. Type: Scattered light measurement from pulsating IR LEDs.
   d. Parts: Sensor, Transmitter, and accessories.

2. Sensor:
   a. Process:
      1) Range: 0.001 – 500 g/L.
      2) Reproducibility: Less than 4 percent.
      3) Response: Adjustable, 1 – 300 seconds.
   b. Flow Rate: 3 meters/S maximum.
   c. Process Connection: Submerged, insertion.
   d. Pressure:
      1) 87 psi operating.
      2) 22 psi during insertion/extraction with ball valve fitting.
   e. Temperature:
      1) Process: 0 – 175 degrees F.
      2) Ambient: 32 – 140 degrees F.
   f. Material: Type 316 stainless steel.
   g. Cable: Integral 32 feet; maximum 325 feet.
   h. Additional Features:
      1) Clamp fittings for insertion.
      2) Wiper for lens cleaning.

3. Transmitter:
   a. Enclosure:
      2) Mounting: Surface or pipe.
   b. Local Display: Backlit LCD.
   c. Power: 24V dc, 125 mA.
   d. Memory: Non-volatile.
   e. Signal Interface:
      1) Analog Output: 4 – 20 mA.
      2) Discrete Output:
         a) Three SPST alarm relay contacts, configurable.
         b) Rating: 100 – 230V ac, 5A.

4. Manufacturers and Products:
   a. Hach Co.:
      1) TSS SC TriClamp sensor with wiper.
      2) Ball valve fitting and screwed branch connector.
      3) SC 100 controller.
   b. Approved equal.

I. FL Flow Element and Switch.
1. General:
   a. Function: Monitor pipe contents for presence/absence of fluid (75 – 100 percent full pipe).
   b. Type: RF electronic.
   c. Parts: Sensor flange and electronic unit.
2. Service:
   a. Water, wastewater, chemicals or mixed liquids.
   b. Pressure/Temperature: 200 psi at 100 degrees F.
   c. Ambient Temperature: Minus 40 to 150 degrees F.
3. Sensor Element:
   a. Type: Thin, cylindrical section that fits between pipe flanges without obstructing flow.
   b. Configuration: Partial ring.
   c. Material:
      1) Flange: Type 316 stainless steel.
      2) Wetted Surfaces: Teflon, Type 316 stainless steel.
   d. Process Connection:
      1) Connection: 150-pound ASTM flat face flange.
      2) Line Size: As noted.
4. Electronics:
   a. Alarm on absence of fluid.
   b. Relay energized normal, de-energize on alarm.
   c. Adjustable time delay.
   d. Contact:
      1) DPDT.
      2) 5 A continuous at 115V ac or 26V dc, resistive.
   e. Power: 12 – 34V dc, less than 1 W.
5. Electronics Housing:
   a. Cast aluminum.
   b. NEMA 4.
7. Manufacturers and Products:
   a. PRINCO Instruments; L3515, Model L642.
   b. Approved equal.

J. F4 Flow Element and Transmitter, Electromagnetic:

1. General:
   a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
   b. Type:
      1) Electromagnetic flowmeter, with operation based on Faraday’s Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
      2) Full bore meter with magnetic field traversing entire flow-tube cross section.
3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
   c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.

2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
   b. Flow Stream Descriptions: If and as described below.

3. Operating Temperature:
   a. Element:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Storage: 15 to 120 degrees F, typical, unless otherwise noted.

4. Performance:
   a. Flow Range: As noted.
   b. Accuracy: Plus or minus 0.2 percent of rate for all flows resulting from pipe velocities of 2 to 49 feet per second.
   c. Turndown Ratio: Minimum of 1000 to 1 when flow velocity at minimum flow is at least 1.6 foot per second.

5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.

6. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.


8. Element:
   a. Meter Tube Material: Type 316 stainless steel.
   b. Liner Material:
      1) PTFE.
      2) For potable water service, must have appropriate approvals.
c. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.

d. Electrode Material: Type 316 stainless steel—except for use with sodium hypochlorite where Tantalum electrodes shall be supplied.

e. Grounding Ring:
   1) Required, unless otherwise noted.
   2) Quantity: Two, unless otherwise noted.
   3) Material: Type 316 stainless steel, unless otherwise noted.

f. Enclosure: NEMA 4X, minimum, unless otherwise noted.

g. Submergence:
   1) Temporary: If noted.
   2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.

h. Direct Buried (3 to 10 feet): If noted.

i. Hazardous Area Certification:
   1) Class 1, Division 2, Groups A, B, C, D: If noted.
   2) Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
   3) Class 1, Division 1, Groups C, D, and FM approved: If noted.

9. Transmitter:
   a. Mounting: Bracket for surface or pipe mount.
   b. Display: Required, unless otherwise noted.
      1) Digital LCD display, indicating flow rate and total.
      2) Bi-directional Flow Display: Required, unless otherwise noted.
         a) Forward and reverse flow rate.
         b) Forward, reverse and net totalization.
   c. Parameter Adjustments: By keypad or non-intrusive means.

   d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
   e. Empty Pipe Detection:
      1) If noted.
      2) Drives display and outputs to zero when empty pipe detected.

10. Signal Interface (at Transmitter):
    a. Analog Output:
       1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
       2) Supports Superimposed Digital HART protocol: If noted.

    b. Discrete Outputs: If noted.
       1) Two discrete outputs, typical, rated for up to 30 volts, typical.
       2) Programmable as noted for the following typical parameters:
          a) Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.

    c. Discrete Input: If noted.
       1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.

    d. Other: As noted.

11. Cables:
a. Types: As recommended by manufacturer.
b. Lengths: As required to accommodate device locations.

12. Built-in Diagnostic System:
a. Features:
   1) Field programmable electronics.
   2) Self-diagnostics with troubleshooting codes.
   3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
   4) Initial flow tube calibration and subsequent calibration checks.

13. Factory Calibration:
a. Calibrated in an ISO 9001 and NIST certified factory.
b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.

14. Factory Ready for Future In situ Verifications: If noted.
a. Original meter parameter values available from vendor by request.

15. Accessories:
a. In situ Verification System: If noted.
   1) Quantity: One complete system provided for the project.
   2) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
   3) Physical access to the flow-tube not required.
   4) Meets standards established by the National Testing Laboratory.
   5) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
   6) Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
   7) Windows-based software
b. Primary Simulation System: If noted.
   1) Quantity: One complete system provided for the project.
   2) Verifies proper operation of the signal converter by simulating the flow meter's output signal.
      a) Generates pulsed dc excitation signal with a reference voltage of 70 mV.
      b) Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
      c) Switch selectable for forward, reverse and zero flow rate.
   3) Verifies various input and output signals.

16. Manufacturers:
a. ABB Automation MagMaster (includes Transmitter):
   1) 10D1475 Mini-Mag (size: 1/10 to 4 inches).
   2) MFE (size: 1/2 to 24 inches).
   3) Plus MFF (size: 8 to 84 inches).
4) Water Master F (size: 14 to 88 inches).
b. Emerson Process Management, Rosemount Division:
   1) Model 8705 (flanged) and Model 8711 (wafer) flow tubes.
   2) Model 8712 (surface) and Model 8732 (integral) transmitters.
c. Endress & Hauser, Inc. Flow Measuring System:
   1) Promag 50/53H (size: 1/12 to 4 inches).
   2) Promag 50/53P (size: 1/2 to 24 inches).
   3) Promag 50/53W (size: 1 to 78 inches).
d. Krohne [includes IFC 020K/IFC 090K (integral) or IFC 020F/IFC 090F
   (remote) signal converter].
   1) Aqua Flux Flowmeter (size: 3/8 to 120 inches).
   2) EnviroMag, IFS 4000 Flowmeter (size: 2 to 60 inches).
   3) IFS 1000 EcoFlux Flowmeter (size: 1/10 to 8 inches).
e. Siemens: Sitrans FM Mag3100 with transmitter.

K. F16 Flow Element, Rotameter:

1. General:
   b. Type: Variable area; float and tapered tube.

2. Service Conditions:
   a. Process Fluid: Water, unless otherwise noted.
   b. Temperature Range:
      1) Process Fluid: 33 degrees F to 250 degrees F.
      2) Ambient: 32 degrees F to 125 degrees F.
   c. Maximum Operating Pressure: As noted.

3. Performance:
   a. Flowrate Range: As noted.
   b. Accuracy: Plus or minus 2 percent of maximum flow, uncalibrated,
      over 12.5:1 turndown.
   c. Repeatability: 0.5 percent of full scale.

4. Features:
   a. Nominal Length: 10 inches.
   b. Float Material: Type 316 stainless steel.
   c. Tube: Borosilicate glass.
   d. Seal:
      1) Type: O-ring, unless otherwise noted.
      2) Material: Buna-N, unless otherwise noted.
   e. Polycarbonate operator protection shield.
   f. Mounting: In line, unless otherwise noted.
   g. Scales: Direct-reading external metal scale, unless otherwise noted.
   h. Pressure Drop Design: Standard, unless otherwise noted.

5. Size and Process Connections:
   a. Connection Size: As noted.
   b. Tube Size: As noted.
   c. Connection Material: Type 316 stainless steel, unless otherwise noted.
d. Connection Type: Threaded NPT, unless otherwise noted.
e. Connection Orientation: Vertical, unless otherwise noted.

6. Signal Interface: None, unless otherwise noted.
7. Manufacturers and Products:
   a. Emerson Process Management, Brooks; Series 1100.
   b. ABB; Series 10A4500.
   c. Approved equal.

L. F23 Flow Element and Switch, Thermal:

1. General:
   a. Function: Monitor process fluid flow and provide contact closure at setpoint.
   b. Type: Thermal dispersion flow switch using a heated active RTD and a reference RTD temperature sensor to detect rate of flow as a function of temperature difference between the two sensors.

2. Service:
   b. Process Pressure: As noted.
   c. Process Temperature: As noted.

3. Performance:
   a. Setpoint: As noted.
      1) Factory Calibration: Required.
   b. Accuracy: Greater of plus or minus 5.0 percent of reading or plus or minus 0.04 sfps (liquid) or plus or minus 2 sfps (gas).
   c. Repeatability: Plus or minus 0.5 percent of reading, at constant temperature and pressure.
   d. Temperature, Operating: Sensor Element: Minus 40 degrees F to plus 350 degrees F.
   e. Pressure, Operating: To 3,500 psig at 70 degrees F, to 2,350 psig at 500 degrees F.

4. Features:
   a. Wetted Surfaces Materials: Type 316 stainless steel.
   b. Temperature Compensation: Via factory calibration.

5. Process Connections:
   a. Type: 3/4-inch MNPT.
   b. Process Pipe Size: As noted.
   c. Connection Type: Insertion.

6. Conduit Connection: 1-inch FNPT.

7. Element Insertion Length: 2 inches from tip of probe to process connection, unless otherwise noted.

8. Electronics:
   a. Location: Integral.
   b. Operating Temperature: Minus 40 degrees F to 140 degrees F.
   c. Calibration Circuit: Built in for field adjustment of setpoint.
9. Signal Interface Contact: Field selectable two SPDT or one DPDT, rated 6 amps at 115V ac, 220V ac or 24V dc. SPDT with separate setpoints.
10. Enclosure:
   a. Type: NEMA 4X.
   b. Enclosure: Aluminum.
   c. Approval: Hazardous locations, Class I and Class II, Division 1 and Division 2, Groups B, C, D, E, F, and G.
13. Manufacturer and Product:
   a. Fluid Components, Inc.; Model FLT93S.
   b. Approved equal.

M. F51 Flow Element and Transmitter, Thermal Mass Flow:

1. General:
   a. Function: Directly measure, indicate, and transmit mass flow of gas in pipe.
   b. Type: Insertion type, thermal dispersion detection probe using platinum resistance temperature detectors (RTD).
   c. Parts: Elements, transmitter, and interconnecting cable.
2. Performance:
   a. Process Gas: As noted or shown.
   b. Range for Air at 70 Degrees F and 14.7 psia:
      1) As noted, within the following:
         a) 0.25 to 1,600 standard fps.
         b) 0.25 to 200 actual fps.
   c. Calibrated Span: As noted.
   d. Accuracy:
      1) Flow: Plus or minus 1 percent of reading plus 0.5 percent full scale.
      2) Temperature: Plus or minus 2 degrees F.
   e. Repeatability:
      1) Flow: Plus or minus 0.5 percent of reading.
      2) Temperature: Plus or minus 1 degree F.
   f. Temperature, Operating:
      1) Flow Element: Minus 50 degrees F to plus 350 degrees F, unless otherwise noted.
      2) Transmitter Housing: 0 degree F to plus 150 degrees F.
   g. Pressure, Operating, Flow Element: Up to 50 psig, unless otherwise noted.
3. Flow Element:
   a. Features:
      1) Insertion Length: As noted or manufacturer’s recommendation.
      2) Wetted Surfaces Materials: Type 316 stainless steel with nickel braze, unless otherwise noted.
b. Process Connection:
   1) Line Size: As noted or shown.
   2) Connection Type: Retractable sensor with graphite-packed gland with 1-1/4-inch MNPT, unless otherwise noted.
   3) Connection Material: Type 316 stainless steel, unless otherwise noted.

c. Sensor Enclosure:
   1) Type: Aluminum, NEMA 4X, rated for Classes 1 and 2, Divisions 1 and 2, Groups B, C, D, E, F, G, and Exd IIC; unless otherwise noted.

4. Transmitter:
   a. Features: 4-line by 20-character LCD, keypad programmable.
   b. Nonvolatile memory.
   c. Signal Interface:
      1) Outputs:
         a) Analog: Two isolated 4 mA to 20 mA dc for maximum 600 ohm load, unless otherwise noted.
         b) Discrete:
            (1) Two independently adjustable 10 amps at 115V ac or 24V dc.
            (2) Configurable as high or low flow or process temperature.
      2) Communication:
         a) RS-232C serial port enables remote adjustment and reading of process values and set points.
         b) Protocols: If and as noted.
   e. Electrical Connection: 1-inch FNPT.
   f. Transmitter Enclosure:
      1) Type: Fiberglass NEMA 4X, unless otherwise noted.
      2) Mounting: Remote from sensor.
   g. Single factory calibration, unless otherwise noted.

5. Cables:
   a. Length: As required.
   b. Cable Jacket: PVC rated for 220 degrees F, unless otherwise noted.

6. Manufacturers and Products:
   a. Fluid Components International; Model GF90.
   b. Kurz Instruments.
   c. Approved equal.

N. L5 Level Element and Transmitter, Ultrasonic:

1. General:
   a. Function: Continuous, noncontacting level measurement.
   b. Type: Ultrasonic.
c. Parts: Element, transmitter, interconnecting cable, and accessories as noted.

2. Service:
   a. Application: Liquid level in tank.
   b. Vapor Space Pressure: Atmospheric.
   c. Operating Temperature Range:
      1) Element: Minus 4 degrees F to plus 149 degrees F.
      2) Transmitter: Minus 4 degrees F to 122 degrees F.

3. Performance:
   a. Range: As noted.
   b. Zero Reference: As noted.
   c. Accuracy: Plus or minus 0.25 percent of maximum range or 6 mm, whichever is greater.
   d. Resolution: 0.1 percent of range or 2 mm, whichever is greater.
   e. Blanking Distance: Sensor dependent, typically 1 foot.

4. Element:
   a. NEMA 6P waterproof.
   b. Housing: PVDF.
      1) Other materials subject to Buyer’s Technical Representative (BTR) approval.
   c. Facing: None, unless otherwise noted
   d. Integral Flange: If noted.
      1) Face: PTFE.
      2) Size: As noted.
   e. Process Connection: 4-inch ASME 150 pounds, flat-faced flange.
   f. Beam Angle: 10 degrees or less.
   g. Integral temperature compensation.

5. Transmitter:
   a. Display.
   b. Integral keypad or nonintrusive external programming.
   c. Enclosure: NEMA 4X polycarbonate, wall mount.
   e. Isolated Analog Output: One minimum, 4 mA to 20 mA dc for load impedance of 0 to 750 ohms.
   f. Discrete Outputs:
      1) Minimum, two relay (SPDT) and four N.O. (SPST) rated for 5 amps continuous at 230V ac.
      2) Assignable.

6. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.

7. Accessories:
   a. Remote Programming Software: If noted.
      1) Allows remote programming via computer and echo traces for troubleshooting.
      2) One per lot of units furnished.
   b. Others: As noted.
c. If no integral keypad, furnish one handheld programmer per lot of units furnished.

8. Manufacturers and Products:
   b. Pulsar; Blackbox Series 13X and Sensor.
   c. Endress & Hauser; Model FMU90 and Sensor.

O. L8 Level Switch, Float (non Mercury type):

1. General:
   a. Function: Actuate contact at preset liquid level.
   b. Type: Direct-acting float with enclosed switch and integral cable.

2. Service (Liquid): Wastewater, unless otherwise noted.

3. Performance:
   a. Setpoint: As noted.
   b. Differential: 2.5 inches, maximum.
   c. Temperature: 0 degree F to 160 degrees F.

4. Features:
   a. Entire Assembly: Watertight and impact-resistant.
   b. Float Material and Size: Polypropylene body; 4-inch diameter and 6-inch length.
   c. Cable:
      1) Combination support and signal.
      2) Length as noted or as necessary per mounting requirements.
      3) PVC cable jacket.
   d. Mounting: Pipe, unless otherwise noted or shown on Drawings.
      1) Pipe Mounting:
         a) Cable clamp, suitable for connection to 1-inch pipe.
         b) Pipe-to-wall bracket, suitable for connection to 1-inch pipe.
      2) Suspended Mounting (internal weights): If noted.
         a) Wall mounting bracket, unless otherwise noted.
      3) Anchor Mounting Kit: If noted.
         a) Compatible with pipe-mounted floats.
         b) Stainless steel cable clips.

5. Signal Interface:
   a. Switch Type: non-Mercury tilt.
   b. Switch Contacts:
      1) Isolated, rated 5A continuous at 120V ac.
      2) Form C contact (one NO, one NC), unless otherwise noted.

6. Accessories: As noted.

7. Manufacturers and Products:
   a. Flygt, ENM-10.
   b. Approved equal.
P. L8D Level Switch, Float, Small:

1. General:
   a. Function: Monitor a liquid level in a vessel or open containment and provide a signal output based on mounted level.
   b. Type: Hermetically sealed, magnetically actuated reed switch.
2. Service: Water, wastewater, chemicals or mixed liquids, as noted.
3. Performance:
   a. Set Point: As noted.
4. Features:
   a. Assembly: Watertight and impact resistant.
   c. Cable: 24-inch lead wires.
   d. Mounting: X NPT fitting for direct connection to conduit.
5. Signal Interface: Reed switches with SPDT contact, wired fail safe.
6. Manufacturer and Product:
   a. Gems Sensors; LS 1900 TFE Series.
   b. Approved equal.

Q. L41 Level Element/Transmitter, Submersible, Water:

1. General:
   a. Function: Measure and transmit signal proportional to level.
   b. Type: Totally submersible pressure sensor (loop powered).
   c. Parts: Sensor, interconnecting cable, other parts as noted.
2. Service:
3. Performance:
   a. Process Range:
      1) As noted.
      2) Provide fixed factory range such that noted process range is between 40 percent and 80 percent of fixed factory range.
   b. Accuracy: 0.10 percent of full scale.
   c. Temperature, Operating: Minus 5 degrees F to plus 140 degrees F.
   d. Overpressure:
      1) Proof: At least 1.5 times full scale.
      2) Burst: At least 2.0 times full scale.
   e. Long Term Stability: Plus or minus 0.10 percent full scale/year, typical.
4. Features:
   a. Sensor:
      1) Silicon pressure-sensing element.
      2) Titanium or Type 316 stainless steel pressure module assembly.
      a) For titanium sensor only; 5-year corrosion warranty, replace sensor if it fails due to corrosion: If noted.
      3) NEMA 6/IP 68 rating (submersible).
      4) Temperature compensation.
5) Dimensions, Nominal:
   a) Diameter: 1 inch maximum.
   b) Length: 10 inches maximum.
6) Loop powered, 9-30V dc.

b. Interconnecting Cable:
   1) Length: As required.
   2) Tefzel or FEP sheathed.
   3) Kevlar strain relief cord.
   4) Integral vent tube.

c. Sensor Termination Enclosure: Required, unless otherwise noted.
   1) Enclosure: NEMA 4X.
   2) Houses such noted items as desiccant vent, filter, microfilter,
      aneroid bellows.
   3) Integral LCD display.
   4) 2-Inch Pipe Mounting Kit: If noted.

d. Accessories:
   1) Aneroid Bellows: If noted.
      a) Bellows shall be suitable for application.
   2) Desiccant Module: Required, unless otherwise noted.
   3) Spare Desiccant Modules: If noted.
      a) Quantity: As noted.
   4) Cable Hanger, Kellems Type Grip: Required, unless otherwise
      noted.
   5) Lightning Protection:
      a) Internal (protects against water lightning strike): Required.
      b) External (protects 4 mA to 20 mA dc output): Required.

5. Signal Interface: 4 mA to 20 mA dc output, for load impedance of 0 ohm to
   750 ohms; minimum for 24V dc supply without load adjustment.

6. Manufacturers (provided they can furnish the noted options):
   a. In-Situ PDXPXD-261 (site standard)

R. L50D Level Switch, Float, Flange Mount:

1. General:
   a. Function: Monitor a liquid level in a vessel by means of a hinged float
      and provide a signal output based on mounted level.
   b. Type: Hermetically sealed, magnetically actuated switch.

2. Service: Water, wastewater, chemicals or mixed liquids.

3. Features:
   a. Mounting: 3-inch flange.
   b. Action: Narrow differential.
   c. Materials:
      1) Process Connection: Type 316/316L stainless steel.
      2) Electrical Housing: Cast aluminum.
   d. Pressure: 1,400 psig.
   e. Temperature:
1) Process: Minus 65 to plus 650 degrees F.
2) Ambient: 0 to plus 100 degrees F.
   f. Electrical Connection: 3/4-inch NPT conduit.
   a. SPDT silver contact.
   b. Minimum 3 Amp at 24V dc.
5. Manufacturer and Product:
   a. Magnetrol; Tuffy II Series.
   b. Approved equal.

S. L90D Level Switch, Ultrasonic:

1. General:
   a. Function: Detect the presence of a liquid in a pipe.
   b. Type: Ultrasonic technology when liquid is present a signal is sent.
   c. Parts: Element complete with lead wires.
2. Service:
   a. Process Fluid: As noted.
   b. Repeatability: Plus or minus 2 mm.
   c. Operating Temperature: Minus 20 to plus 160 degrees F.
   d. Operating Pressure: To 1,000 psi.
3. Element:
   a. Type: Solid state circuitry.
   b. Housing: Stainless steel, unless otherwise noted.
   c. Connection: 3/4-inch NPT.
   d. Lead Wires: 14-inch, 22 AWG.
   e. Input: 9V dc to 36V dc.
   f. Output: Contact closure 1 amp, SPST, N.O.
4. Manufacturers and Products:
   b. Approved equal.

T. M26 Hand Switch and Light, Corrosion, Round:

1. General:
   a. Function: Select, initiate, and display discrete control functions.
   b. Type: Heavy-duty, corrosion-resistant, industrial.
2. General Features:
   a. Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to
      1/4 inch.
   b. Legend Plate: Standard size, square style laminate with white field and
      black markings, unless otherwise noted. Markings as shown, or as
      implied by P&IDs.
   c. Configuration: Light, pushbutton, or switch as noted or shown.
3. Light Features:
   a. Lights: For operation from 24V dc, unless otherwise noted.
   b. Lens Color: Color as specified.
   c. Push-to-test, unless otherwise noted.
   d. Additional: As noted.
4. Pushbutton Features:
   a. Operator: Single pushbutton, flush, unless otherwise noted.
   b. Color: Black, unless otherwise noted.
   c. Boot: None, unless otherwise noted.
   d. Contact Arrangement: As required or shown.
   e. Additional: As noted.
5. Selector Switch Features:
   a. Operator: Knob, unless otherwise noted.
   b. Color: Black, unless otherwise noted.
   c. Boot: None, unless otherwise noted.
   d. Positions: As required or shown.
   e. Return: Manual, unless otherwise noted.
   f. Contact Arrangement: As required or shown.
   g. Additional: As noted.
6. Signal Interface:
   a. Contact Block:
      1) Type: Standard, unless otherwise noted.
      2) Materials: Silver amalgam, unless otherwise noted.
      3) Rating: 2.5 amps switched at 24V dc, unless otherwise noted.
      4) Sequence: Break-before-make, unless otherwise noted or shown.
      5) Arrangement: Normally open or normally closed as required, or to perform the functions noted.
7. NEMA Rating: NEMA 4X, corrosion-resistant.
8. Manufacturers and Products:
   a. Allen-Bradley; Bulletin 800H.
   b. Square D Co.; Class 9001, Type SK.
   c. Eaton Corp.; Cutler-Hammer; Type E34.

U. M33D Audible and Visual Warning Device.

1. General:
   a. Function: Provide an audible and a visual indication of an alarm condition based on a contact closure input.
   b. Type: Flashing beacon and variable audible indication.
   c. Parts: Mounting bracket, one or multiple light modules (as specified) and one sound module capable of variable tones.
   d. Each light module shall receive individual signals for operation. The sound module shall operate with a single input signal.
2. Rating: Nema 4X, unless otherwise noted.
3. Performance:
   a. Operating Temperature: Minus 250 to 50 degrees C.
b. Voltage: 120V ac, unless otherwise noted.

4. Visual Module:
   a. Lamp Life: 3,000 hours.
   b. Lamp Type: Incandescent.
   c. Lens: Color as noted.

5. Audible Module:
   a. Audible Output: 103dB at 1 meter.

6. Manufacturers:
   a. Rockwell Automation; 855E Tower Lights with sound module.
   b. Approved equal.

V. M43 Intrusion Switch:

1. General:
   a. Function: Monitor actuation of pneumatic relief dampers.
   b. Type: Magnetic.
   c. Parts: Magnet, switch, and cabling.

2. Features:
   a. Type: Surface-mount suitable for door.
      1) Suitable for 1-inch working gap.
   b. Cable: Armored, 18 inches long.
   c. Magnet Length: 1.5 inches, nominal.
   d. Magnet and Switch Dimensions: Each, 1.5 long by 0.585 wide by 0.426 thick, nominal inches.
   e. Housing: Weather-resistant aluminum.
   f. Two holes on switch and magnet for fasteners.

3. Signal Interface:
   a. Switch: NC (close circuit on damper actuation), unless otherwise noted.
   b. Contact Rating: 5 watts dc, unless otherwise noted.
   c. Maximum Voltage: 175V dc.
   d. Maximum Switching Current: 0.25-amp dc.

4. Manufacturer and Product:
   a. George Risk Industries; Intrusion Switch, Model 4461, 4461A.
   b. Approved equal.

W. P2 Pressure Differential Switch:

1. General:
   b. Type: Diaphragm actuated switch.

2. Performance:
   a. Setpoint:
      1) As noted.
      2) Repeatability: Plus or minus 1 percent.
b. Range: Noted setpoint shall fall between 20 percent and 90 percent of range.

c. Static Pressure:
   1) Operating Static Pressure: As noted.
   2) Operating static pressure must be less than switch’s rated maximum static pressure.

d. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.

e. Operating Temperature Range:
   1) Dependent on actuator seal materials.
   2) Buna-N Seal: 0 to 150 degrees F.

3. Features:
   a. Actuator Seal: Buna-N, unless otherwise noted.
   b. Fixed differential, unless otherwise noted.
   c. Mounting: Surface, unless otherwise noted.

4. Process Connection:
   a. 1/4-inch NPT female connections, unless otherwise noted.
   b. Materials: Nickel-plated brass, unless otherwise noted.

5. Enclosure: NEMA 4X.

6. Signal Interface:
   a. Contact Type:
      1) SPDT, unless otherwise noted.
      2) Rated for 24V dc, 0.3A.
   b. Hermetically Sealed Switch: If noted.

7. Manufacturers and Products:
   a. Ashcroft; Type D400.
   b. United Electric; 400 Series.
   c. Approved equal.

X. P3 Pressure Differential Transmitter:

1. General:
   a. Function:
      1) Measure differential pressure.
      2) Transmit signal proportional to either differential pressure or square root of differential pressure, as applicable.

   b. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; “smart electronics”.

   c. Parts: Transmitter and accessories.

2. Performance:
   a. Range: As noted.
      1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.

   b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
e. Humidity: 0 to 100 percent relative humidity.

3. Features:
   a. Linear or square-root output, user-configurable.
   b. Factory preconfigure for square root output if transmitter tagged as “FT” or “FIT”.
   c. LCD indicator.
   d. Wetted Metallic Parts: Type 316 stainless steel.
      1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
   e. Wetted O-Rings: Glass-filled TFE, graphite-filled PTFE.
   f. Bolts and Nuts (if required): Type 316 stainless steel.
   g. Fill Fluid: Silicone.

4. Process Connections:
   a. Remote Diaphragm Seal: High-Low Connection:
      1) Factory assembled.
      2) Length of capillary to satisfy mounting detail.
   b. Line Size: 1/2 inch.
   c. Connection Type: FNPT.

5. Signal Interface:
   a. 4-20 mA dc output with digital signal based on HART protocol.
      2) Adjustable damping.

6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mount per Detail.

7. Accessories:
   a. Three-valve manifold, unless otherwise noted.
      1) Includes one equalization and two isolation valves.
      2) Type 316 stainless steel.

8. Manufacturers and Products:
   a. Rosemount; Model 2051 CD.
   b. Siemens; Sitrans P DS111.
   c. SMAR; LD30XD Series.

Y. P4 Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: Plus or minus 0.50 percent of full scale.

3. Features:
   a. Dial: 4-1/2-inch diameter.
   b. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
      1) Liquid filled gauge front, unless otherwise noted.
         a) Glycerine fill, unless otherwise noted.
   c. Case Material: Black thermoplastic.
   d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
      1) Stainless steel.
   e. Pointer: Adjustable by removing ring and window.
   f. Window: Glass or acrylic.
   g. Cam lock, thermoplastic ring.
   h. Case Type: Solid front with blow-out back.

4. Process Connection:
   a. Mounting: Lower stem.
   b. Size: 1/2-inch MNPT.

5. Manufacturers and Products:
   a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!.
   c. WIKA, Type 2XX.34.

Z. P6 Pressure Seal, Diaphragm:

1. General:
   a. Function: Isolate sensing element from process fluid.
   b. Type:
      1) Diaphragm.
      2) Fluid filled between diaphragm and sensing element.

2. Service:
   a. Pressure: Same as associated sensor.

3. Performance:
   a. Pressure: For threaded process connections, at least 2,500 psig at 100 degrees F.
   b. Temperature:
      1) Dependent upon fill fluid.
         a) Glycerin (Food Grade): Zero to 400 degrees F.
         b) Silicone: Minus 40 degrees F to plus 600 degrees F.
         c) Silicone (Food Grade): Zero to 375 degrees F.
         d) Halocarbon: Minus 70 degrees F to 300 degrees F.

4. Features:
   a. Materials:
      1) Lower Housing: Type 316 stainless steel.
2) Diaphragm Material: Type 316 stainless steel.
3) Top Housing: Steel.
b. Diaphragm: Welded to upper housing.
c. Filling screw in upper housing.
d. Fill Fluid:
   1) Silicone.
   2) Factory assembled and filled.
e. Flushing Connection: 1/4-inch NPT in lower housing.
f. Diaphragm Seal Displacement: 0.1 cubic inch, nominal.

5. Connections:
a. Instrument: 1/2-inch female NPT.
b. Process: 1/2-inch female NPT.

6. Manufacturers:
a. Ashcroft; Type 201.
b. Ametek; Mansfield and Green Division; Type SG.
c. WIKA; Type L990.10.

AA. P7 Pressure Switch, Adjustable Dead Band:

1. General:
a. Function: Monitor pressure, activate switch at setpoint, and deactivate switch at reset point.
b. Type:
   1) Piston-actuated.
   2) Both setpoint and deadband (the differential between setpoint and reset point) adjustable.

2. Performance:
a. Setpoint:
   1) As noted.
   2) Repeatability: Plus or minus 1 percent of range.
b. Reset Point: As noted.
c. Range: The noted setpoint shall fall between 20 percent and 80 percent of the range.
d. Deadband: Adjustable within nominally 25 percent and 85 percent of range.
e. Overpressure Proof Pressure:
   1) Pressure psi Ranges: At least 400 percent of rated maximum static pressure.
   2) Pressure Inches of Water Ranges: 20 psig.
   3) Compound Range: 250 psig.
   4) Vacuum Range: 250 psig.
f. Operating Temperature Range:
   1) Dependent on actuator seal materials.
   2) For Buna-N seal, 0 degrees F to 150 degrees F.

3. Features:
a. Actuator Seal: Buna-N, unless otherwise noted.
b. Adjustable deadband.
c. Mounting: Surface, unless otherwise noted.

4. Process Connection:
a. 1/4-inch NPT female connections, unless otherwise noted.
b. Materials:
   1) Pressure psi Ranges: Type 316 stainless steel, unless otherwise noted.
   2) Pressure Inches of Water Ranges: Epoxy coated carbon steel, unless otherwise noted.

5. Enclosure: NEMA 4X, unless otherwise noted.

6. Signal Interface:
a. Contact Type:
   1) SPDT.
   2) Rated for 5 amps minimum at 30V dc.
b. Hermetically Sealed Switch: If noted.

7. Manufacturers and Products:
a. Ashcroft; L or P Series.
b. United Electric; J6 Series.
c. If NEMA 7, explosion-proof enclosure specified; Ashcroft; P Series only.

BB. P9 Pressure Transmitter:

1. General:
a. Function: Measure pressure and transmit signal proportional to pressure.
b. Type:
   1) Electronic variable capacitance or silicon strain gauge.
   2) Two-wire transmitter; "smart electronics".
c. Parts: Transmitter and accessories.

2. Performance:
a. Range: As noted.
   1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
c. Ambient Operating Temperature: Minus 4 degrees F to plus 175 degrees F, with integral meter.
d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
e. Humidity: 0 to 100 percent relative humidity.

3. Features:
a. Type: Gauge pressure.
b. LCD indicator.
c. Wetted Metallic Parts: Type 316 stainless steel.
   1) Includes drain/vent valves; process flanges and adapters, and
      process isolating diaphragm.

d. Wetted O-Rings: Glass filled TFE, graphite filled PTFE.

e. Bolts and Nuts (if required): Type 316 stainless steel.

f. Fill Fluid: Silicone.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct Diaphragm Seal: Factory assembled.

5. Signal Interface:
   a. 4-20 mA dc output with digital signal based on HART protocol.
      1) Nominal Maximum Loop Resistance with External 24V dc Power
         Supply: 550 ohms.
      2) Adjustable damping.

6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mount per Detail.

7. Manufacturers and Products:
   a. Gauge Pressure Units:
      1) Rosemount; Model 2051 TG.
      2) Siemens; Sitrans P DS111.
      3) SMAR; LD30XM Series.

CC. P15 Pressure Seal, Annular:

1. General:
   a. Function:
      1) Sense pressure in a process line and transfer to pressure
         monitoring device.
      2) Protect attached pressure monitoring device from sludge or slurry.
   b. Type: Annular fluid-filled device that senses pressure through flexible
      sleeve around full pipe circumference.

2. Performance:
   a. Operating Conditions: Suitable for line pressures up to pipe flange
      rating.

3. Features:
   a. Construction:
      1) In-line, 8 Inches and Smaller: Full-faced thru-bolted with outside
         diameter same as mating flanges, unless otherwise noted.
      2) In-line, 10 Inches and Larger: Wafer style.
      3) Offline: Threaded, unless otherwise noted.
   b. Materials:
      1) Body: Carbon steel, unless otherwise noted.
      2) Flanges (where applicable): Carbon steel, unless otherwise noted.
3) Flexible Sleeve: Buna-N, unless otherwise noted.
4) Fill Fluid: Ethylene glycol/water or propylene glycol, unless otherwise noted.
   c. Factory Filled System:
      1) Filled and assembled with pressure monitoring device(s).
      2) Coordinate attached pressure monitoring device(s) with system integrator. Seal vendor’s standard pressure monitoring device(s) only acceptable if it meets specification of the related pressure monitoring device.

4. Process Connections:
   a. Mounting: In-line or offline, as noted or shown.
   b. Pipe Size:
      1) In-line: As noted or shown.
      2) Offline: 2 inches, unless otherwise noted.
   c. Connections:
      1) In-line, Full-faced through-bolted: ASME B16.5, 150-pound flanges.
      2) In-line, Wafer style: Compatible with Classes 150/300 flange drilling.
      3) Offline: Female NPT Threaded, unless otherwise noted.

5. Manufacturers and Products:
   b. Dover/OPW Engineered Systems; Iso-Ring.

DD. T3 Temperature Element and Transmitter, Resistance:

1. General:
   a. Function: Measure the temperature of a process fluid, and transmit analog signal proportional to temperature.
   b. Type: RTD.
   c. Parts: Element, thermowell, and transmitter.

2. Service:
   a. Process Fluid: As noted.
   b. Process Temperature Range: As noted.

3. Element:
   a. Type:
      1) Single-element, unless otherwise noted.
      2) Three-wire, RTD.
      3) Platinum, 100 ohm nominal at 0 degrees C.
   b. Performance:
      1) Accuracy: Greater of plus or minus 4 degrees F or plus or minus 0.75 percent of reading.
c. Features:
   1) Dimensions: 1/4-inch diameter.
   2) Length to accommodate thermowell insertion and extension lengths.
   3) Spring-loaded element when well is used.
   4) Sheath:
      a) Type 316 Stainless Steel, unless otherwise noted.
      b) Process Operating Temperature Range: Minus 50 to 400 degrees F.
   5) Terminal Connection Head:
      a) General purpose, NEMA 4 weatherproof, unless otherwise noted.
      b) Maximum Temperature: 220 degrees F, unless otherwise noted.
   6) Thermowell Connection: Union Coupler, unless otherwise noted.
   7) Sensitive Length: 1.6 inch minimum, measured from closed end.

4. Thermowell:
   a. Features:
      1) Inside Diameter: Sized to match thermocouple.
      2) Material: Type 316 stainless steel, unless otherwise noted.
      3) Insertion Length: As noted.
      4) Extension Length: 3 inches, unless otherwise noted.
   b. Process Connection: 1-inch NPT connection, unless otherwise noted.
   c. Well Type: Plain, threaded solid, unless otherwise noted.

5. Transmitter:
   a. Ambient Operation Conditions:
      1) Temperature: minus 20 to 158 degrees F, with display.
      2) Relative Humidity: 0 to 100 percent, noncondensing.
   b. Type: Two-wire, powered by a remote power supply.
   c. Performance:
      1) Accuracy: Greater of plus or minus 0.7 degree F or plus or minus 0.06 percent of span.
      2) Response Time: 1.2 second 90 percent response time for 80 percent input step, with minimum damping.
   d. Features:
      1) Indicator: Required.
      2) Automatic reference junction compensation.
      3) Failsafe Mode:
         a) User configurable ON, unless otherwise noted.
         b) Downscale, unless otherwise noted.
      4) Transient protection.
   e. Signal Interface: 4 to 20 mA dc.
   f. Power: 12-42V dc external power supply.
   g. Enclosure:
      1) Materials: Epoxy coated, low-copper aluminum.
      2) Type: NEMA 4X.
3) Mounting: Wall, pipe stand, or integral to thermowell, as noted.
   a) For wall or pipe stand, provide stainless steel mounting set, unless otherwise noted.
   b) For integral thermowell mount, provide zinc-plated steel union coupling, unless otherwise noted.

6. Manufacturers and Products:
   a. Rosemount; Series LTS Thermowell, 78 Series Platinum RTD and Model 3144P Transmitter.
   b. Endress&Hauser; TMT Series transmitter with TH Series RTD and thermowell
   c. Approved equal.

EE. T5 Temperature Switch:

1. General:
   a. Function: Provide change in contacts as temperature rises or falls through the noted set point.
   b. Type:
      1) Vapor pressure thermal bulb sensing element.
      2) Fixed differential, unless otherwise noted.
      3) Direct mount, unless otherwise noted.
   c. Parts: Switch/element assembly and thermowell.

2. Performance:
   a. Set Point: As noted.
   b. Range: Such that the noted set point falls between 30 and 70 percent of the range.
   c. Repeatability: Plus or minus 1 percent of span.

3. Switch:
   a. Type: Snap action, SPDT, sealed environment proof, unless otherwise noted.
   b. Rating: 125V ac 15A, unless otherwise noted.
   c. Differential: Fixed, unless otherwise noted.
   d. Reset: Automatic.
   e. Enclosure:
      1) Type: NEMA 4X, unless otherwise noted.
      2) Mounting: Direct mount, unless otherwise noted.

4. Element:
   a. Type: Bulb.
   b. Process Connection: Stem mounted in thermowell, unless otherwise noted.
   c. Length: Coordinate with thermowell insertion length.

5. Thermowell:
   b. Material: 316 stainless steel.
   c. Insertion Length: 3-1/2-inch minimum immersion for liquids and 5-1/2-inch minimum immersion for gases.
6. Electrical Connections:
   a. Conduit: 3/4-inch NPT(F).

7. Manufacturers:
   a. Ashcroft; B Series (Type 400 NEMA 4X, Type 700 NEMA 7 and 9).
   b. Barksdale; ML1H, MT1H.

T14 Thermometer, Bimetallic, Adjustable Angle:

1. General:
   b. Type: Bi-metallic, circular dial.
   c. Parts: Temperature gauge and thermowell.

2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: 1 percent of full scale.

3. Thermometer Features:
   a. Stem Length: 4 inches, unless otherwise noted.
   b. Stem Type:
      1) Every angle, unless otherwise noted.
         a) Adjustable 90 degrees vertical, 360 degrees horizontal.
   c. Dial:
      1) Heavy-duty glass, unless otherwise noted.
      2) 5-inch circular, unless otherwise noted.
      3) Hermetically sealed.
   d. Construction: All-welded, stainless steel.

4. Thermowell:
   a. Type: 1/2-inch NPT connection, Type 316 stainless steel.
   b. Extension Neck: When noted, with length as noted.

5. Manufacturers and Products:
   a. Ashcroft; Series EI bimetal thermometer.
   b. WIKA; Type S5301 bimetal thermometer.

Y12D Automatic Alarm Dialer:

1. General:
   a. Electronic monitoring system shall interface plant alarms to public
      telephone system or cellular phone network.
   b. Upon receipt of one or more critical alarm trips, electronic system will
      automatically dial out onto phone system (up to 16 specified telephone
      numbers from one of 16 phone lists) with pre-programmed messages.
   c. System shall continue calling until call completed and acknowledged.
   d. Description and Phone Number Dialing:
      1) The dialer shall be a solid-state component capable of dialing up
         to 16 phone numbers, each up to 50 digits in length. Phone
         numbers shall be user programmable via the system’s keypad,
         locally or remotely connected PC/laptop or Touch Tone Phone.

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c. Solid State Voice Message Recording and Playback:
   1) The unit shall have two different categories of speech message capability, all implemented with permanent non-volatile solid-state circuitry with no mechanical tape mechanisms. The unit shall allow for message recording from a remote telephone as well as from the front panel.
   2) User Field Recorded Messages: The user may record and re-record his own voice messages, for each input channel and for the Station ID.
   3) Permanent built-in messages shall be included to support user programming operations, to provide supplemental warning messages such as advising that the alarms have been disabled, and to allow the unit to be fully functional even when the installer has not recorded any messages of his own.

f. Nonvolatile Program Memory Retention: User-entered programming and voice message shall be kept intact even during power failures or when power is removed for up to 50 years.

g. Acknowledgment:
   1) Acknowledgment of an alarm phone call is to be accomplished by pressing a Touch Tone "9" as the alarm call is being received, locally at the keypad, and/or by returning a phone call after receiving an alarm call.
   2) An alarm phone call made to another alarm unit of the same manufacture, shall allow for positive and secure automatic acknowledgment between the units.

h. Input Monitoring Function:
   1) Each input channel shall also be independently programmable, without need to manipulate circuit board switches or jumpers, as Normally Open or Normally Closed, or for No Alarm (status only), or for Pulse Totalizing, or for Run Time Metering.
   2) Physical Inputs: Units requiring physical inputs shall be field upgradeable to incorporate from eight to 48 dry contacts or analog inputs in any combination.
   3) Any input in violation of a normal condition shall cause the unit to go into alarm status and begin the dial-out sequence.
   4) Dry contact inputs shall also be independently programmable, without need to manipulate circuit board switches or jumpers, as Normally Open or Normally Closed, or for No Alarm (status only), or for Pulse Totalizing, or for Run Time Metering.
   5) Analog inputs shall automatically detect and alarm on open current loop of any channel. All analog inputs shall be converted to engineering units as appropriate.
   6) Modbus Inputs: The unit shall support direct communication to one or more SCADA CCU or RTU devices via Modbus RTU over an integrated RS-485 or RS-232 connection. Each Modbus
channel shall be individually programmable for read coil, read input status, read holding, or read register.

7) For units that require physical inputs, the unit shall support up to 72 total channels, up to 48 of which can be physical. Any channels which are not physical shall be Modbus up to the maximum of 72 total channels.

8) For units that do not require physical inputs, the unit shall support 200 Modbus channels.
   a) Install inputs plus 25 percent spare points in accordance with the Contract Drawings.

i. Alarm Message:
   1) Upon initiating an alarm phone call, the system is to “speak” only those channels that are currently in “alarm status”.
   2) Upon initiating an alarm call to a fax, the system is to issue a system status report indicating the current value and alarm condition of all inputs and outputs of the system.
   3) Any alarm message shall be capable of being delivered only once regardless of whether it is acknowledged or not.

j. Diagnostics: The unit shall provide a complete verbal report of all programmable functions and their programmed values on command from any remote Touch Tone phone.

k. Remote Diagnostics: Each unit shall allow connection via remote PC over a modem connection. The remote connection shall allow complete programming of the unit with the exception of voice, real-time Modbus communication view of all transmitted and received packets of data, view of the 1000-entry event log and current status of all monitored conditions.

l. Speakerphone:
   1) The unit shall be capable of dialing any phone number on command and function as a speakerphone (full duplex).
   2) The unit shall have a two-key sequence that when pressed a toll-free speakerphone call is automatically made to the manufacturer’s customer service line.

m. Inquiry Message and Function: Inquiry phone calls can be made directly to the unit at any time from any telephone, locally or long distance, for a complete status report of all variables being monitored, including power status.

n. Status Notification:
   1) The unit shall be capable of issuing a status report to any phone, fax, modem and the Internet that contains the current value and alarm condition of all inputs and outputs.
   2) The status notification report shall be issued on a periodic basis starting anytime during a day.

o. Internet Monitoring:
   1) A user shall be able to view the current status of the remote unit through the Internet, request an immediate update of the status
and set pre-defined times that the status should automatically be transferred and stored on the Internet.

2) A user shall be able to view the event log of the remote unit via the Internet.

p. Unit-to-Unit Communication:
1) The unit shall be capable of communicating to other like units via a direct serial connection, over a public telephone system, over cellular network or via radio modem.
2) Each unit shall be capable of controlling relays on the other unit(s) based on locally monitored conditions transitioning into and out of alarm conditions.
3) Each unit shall be capable of determining if the communication with any remote unit is successful and if not then alarm calls to designated personnel shall be performed informing them of the failure condition.

q. SCADA: The unit shall be capable of being upgraded over a phone line to include Modbus RTU protocol support such that it can communicate with most available SCADA software packages over a phone line, cell phone, radio modem or direct RS-232/RS-485 connection.

r. Upgrades: The unit shall be capable of being upgraded with new features over the phone line with no requirement for a site visit from any personnel.

2. Dialer:
   b. Enclosure: Sub-panel/flush-door mount indoors or NEMA 4X outdoor surface mount.
   c. Remote Reset: Alarm acknowledged by either depressing touch-tone key or calling dialer back when alarm acknowledged from non-touch-tone telephone.
   d. The dialer is to use a standard rotary pulse or Touch Tone “dial-up” phone direct leased line not to be required) and is to be FCC approved. Connection to the telephone is through a four-pin modular jack (RJ-11).
   e. The dialer shall be covered by a 5-year warranty covering parts and labor performed at the factory.
   f. Operating Temperature: Minus 40 degrees F to 185 degrees F.
   g. Operating Humidity: 0 percent to 90 percent.
   h. Output: To standard phone line through integral FCC approved alarm coupler.
i. Power: 120V ac, 60-Hz.

j. 24-hour battery backup.

3. Manufacturers:
   a. Antx, Inc.
   b. Approved equal.

GG:HH Y401D Communications Network:

1. General:
   a. Function: The communications hardware, firmware, and ancillary
device and systems that allow the components and protocols of the
process control system, servers, workstations, Programmable Logic
Controllers (PLC), remote I/O (RIO) stations and other networked
components to exchange data.
   b. Type: Ethernet Local Area Network (LAN), dedicated industrial high
speed LAN, and serial communications using any or a combination of
unshielded twisted pair (UTP), coaxial cable, single mode and multi-
mode fiber optic cabling.
   c. Components: Communications components and ancillary devices and
systems used in the project:
      1) Industrial Ethernet components.
      2) Ethernet Radio Modems.
      3) Uninterruptable Power Supply (UPS).
      4) Solar Power System.
      5) Control Room SCADA Equipment Enclosure.
   d. Architecture: Reference the contract network drawings.

2. Industrial Ethernet (PROFINET) LAN:
   a. Function: Provide communication interconnection between SCADA
member devices.
   b. Components:
      1) Industrial Ethernet Switch:
         a) Features:
            (1) Remote Switch(es): Track mount, multi-port managed
            switch; capable of single mode or multimode fiber
            optic and/or copper multiple twisted pair cable
            connection as required.
            (2) Master Switch(es): Rack mount modular managed
            switch; provide two switch racks with 48-port total
            capacity; minimum one module (2 ports) for
            termination of fiber media, minimum 20-module
            (40 ports) for UTP media.
            (3) Configurable for bus, star, ring, or combination
            topology.
            (4) Configuration and diagnostics support by SIEMENS
            Step 7 programming software. Direct diagnostics
            support by Step 7 Programmable Logic Controllers.
(5) Swap media element for configuration transportability to replacement unit.

(6) Power: 24V dc.

b) Installation:
(1) Provide switches with port configuration to satisfy contract drawings.
(2) Locate switches as required by contract drawings.
(3) Provide cabling and termination using “Fastconnect” hardware and tools for Siemens devices.
(4) Provide two sets of termination tools; minimum six spare termination hardware.

c) Manufacturer and Product:
(1) Siemens; Scalance X-200 for remote(s).
(2) Scalance XR324 for master.

2) Fiber Optic Patch Panel:
   a) Devices:
      (1) Enclosure arranged for 19-inch equipment rack mounting and equipped to hold adapter connector panels and cable mounting accessories.
      (2) Enclosure arranged for panel mounting and equipped to hold adapter connector panels and splice holder.
      (3) Adapter connector panels provide termination means for facility fiber optic cable and connection of media pairs to local equipment.

   b) Installation:
      (1) Provide rack mount or wall mount panel as shown on contract drawings.
      (2) Capacity: 12 fibers minimum.
      (3) Connector Type: ST.
      (4) Provide connection cables (type and size defined elsewhere) for local devices of sufficient length to make connection by means of neat and orderly routing and drop loop at local device.

   c) Manufacturer and Product:
      (1) Corning:
         (a) WCH wall mount panel.
         (b) SPH wall mount panel.
         (c) CCH connector panel.

3) Ethernet Radio Modems:
   a. Function: Radio to transmit and receive Programmable Logic Controller remote I/O data; operates in the unlicensed and unprotected spread spectrum band.
   b. Environmental:
      1) Operating Temperature Range: Minus 40 to 167 degrees F.
      2) Relative Humidity: 95 percent, non-condensing.
c. Performance:
   1) Frequency Band: 902-928 MHz, Part 15 Spread Spectrum Band.
   2) FCC Part 15.247 approved.
   3) Rated Range: To 25 miles.
   4) Data Rate: GFSK 144 Kbps or 188 Kbps.
   5) Throughput: To 108 Kbps in point to point mode; assuming
      75 percent frequency availability.

d. Features:
   1) User configurable operating modes as point to point, point to
      multipoint, store and forward repeater, or repeater/remote.
   2) Master radio controls network parameters of remote radios.
   3) Frequency Hopping: 15 selectable patterns using 112 channels.
   4) Interface: 10 base-T (UTP) data connection; RS-232 DB9 for
      configuration.


f. Transmitter Power Output: 0.1 to 1 watt, programmable.

g. Receiver:
   1) Sensitivity: Minus 108 dBm.
   2) Selectivity: 40 dBm @ fc plus or minus 230 KHz.

h. Primary Power:
   1) Voltage: 10 to 28V dc.
   2) Transmit Current (Peak): 700 mA @ 12V dc, 1 W.
   3) Receive Current: 100 mA @ 12V dc.

i. Diagnostics:
   1) Radio Alarm and Status Indication: Front panel LEDs indicate
      power, RF link, RF in, RF out, LAN in, LAN out, LAN collision,
      Overrun error.
   2) Serial Port Data: Stored signal strength, noise and disconnect
      information.

j. Installation:
   1) Configure radios in functional sets.
      a) One radio master at the control room for one
         remote/repeater at a transfer building and the population of
         well remotes associated with the transfer building.
      b) Provide and install antennas of the type and style required
         to satisfy the requirements of the path study performed by
         the CHPRC.
      c) Antenna location and mounting means is to be carefully
         coordinated with the Engineer and the CHPRC.
   2) Ensure that the installed system complies with all FCC
      regulations.

k. Manufacturer and Product: Data-Linc; Model SRM6210E.
4. Solar Power System:
   a. Function: Provide 24V dc Power derived from solar exposure for operation of designated SCADA system Remote I/O (RIO) stations and their associated instruments and radio. In keeping with SCADA availability requirements, power must be available at least 99.5 percent of the time.
   b. Type: Package system comprised of a solar panel array, battery pack and controller.
   c. Components:
      1) Solar Panel Array:
         a) Encapsulated to resist harsh weather conditions.
         b) Pole or ground mounted.
         c) Fixed position.
      2) Power Components:
         a) Battery Pack: Scaled lead-acid batteries designed for deep cycle service.
         b) Controller: Solid state electronic unit providing continuous control and monitoring of battery condition and power supply to the load.
      3) Accessories:
         a) Lightning protection.
         b) Circuit breakers for the solar array, battery pack and load.
         c) Load distribution block.
      4) Enclosure: All power components and accessories are to be mounted in a NEMA rated enclosure with provision for locking.
   d. Design:
      1) System Components:
         a) The solar system must support the entire SCADA equipment load for the site at all times.
            (1) The load must be determined from the nameplate power draw of supplied devices under worst case conditions.
            (2) The design must account for the variable solar exposure throughout the year and corresponding variable weather conditions.
            (3) Provide for a minimum of 4 days backup.
            (4) Provide Loss of Load Probability analysis of .5 percent maximum.
   e. Installation:
      1) The system is to be assembled, installed, and tested as a complete package.
         a) Provide mounting means as defined by the manufacturer.
         b) The installation is to be designed to withstand harsh environmental conditions including high wind and temperature extremes.
c) If the installation is ground mounted, provide an enclosing fence with gate to prevent wind-blown debris from interfering with system operation.
d) The solar panel array must be aligned as instructed by the manufacturer for optimum performance.

f. Manufacturer and Product:
   1) Sunwize Power Ready Systems.
   2) Approved equal.

5. Control Room Component Enclosure.
   a. Type: Industry standard 19-inch cabinet for mounting of rack configured and shelf mounted equipment. The enclosure can be factory fabricated or modular.
   b. Construction:
      1) Minimum 14-gauge metal sides, top and doors with metal angle or channel mounting structures.
      2) Mounting structures are to be predrilled and tapped at standard intervals for securing equipment and shelves.
      3) The assembly is to be permanently floor mounted.
      4) Provide solid sides and full width front and rear doors with keyed locks.
   c. Accessories:
      1) Shelves for mounting non-rack configured components, minimum two.
      2) Provide power strips with a minimum of 16 outlets on UPS load connection.
      3) Provide roof mounted and/or door mounted fans sized for adequate cooling of equipment.
   d. Anticipated Load: The following equipment is expected to be installed. Adequate space, power distribution and cooling must be provided. Make allowance for additional equipment.
      1) UPS, Rack Mount: 1 each.
      2) UPS Bypass Switch: 1 each.
      3) SCADA Servers (Rack Mount): Two each.
      4) Client Computers (Tower): Two each.
      5) KVM Switch/Extender: Three tot.
      6) Provide circuit connection(s) for UPS power to remote monitors.
   e. Manufacturers and Products:
      1) Hoffman PROLINE.
      2) Dell.
      3) Approved equal.

Y402D Process Computer Control System (CS):

1. General:
   a. Function: Workstation/server that the operators use to interact with the process control system.

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b. Type: General top-of-the-line, off-the-shelf workstation/server, Windows based with high performance Intel processors, large amounts of memory and configured for business use.

c. Components: All of the workstation/servers will be configured identically by the OEM and then customized with communications adapters and software for a specific purpose. The CS system consists of:

1) Generic OEM supplied workstation/server (configured to function as one of the following).
2) Configuration Server.
3) Runtime Server.
4) Client workstation.

d. Architecture: Reference the Control System Block Diagram.

2. Generic OEM supplied workstation/server. All workstation/servers of a specific type will be identical in hardware configuration so that they are interchangeable. The workstation/servers will be the same model, from the same manufacturer, ordered at the same time so they are as identical to each other as possible with serial numbers as close to each other as possible. Requirements include, but are not limited to:

a. Client Workstation: 19-inch rack mount chassis and heavy duty power supply.

b. Server: 19-inch rack mount chassis and heavy duty power supply.

c. Intel XEON Processor, Nehalem X5560, minimum.

d. RAM, 6 GByte, minimum.

e. SAS Hard drive, 200 GByte, minimum.


g. Graphics: 32 Mbyte 1920 by 1200 resolution, minimum. Support two monitors as noted.

h. QWERTY keyboard and mouse, USB 2.0.

i. Audio on motherboard with internal speaker.

j. TCP/IP Ethernet port, 10/100BaseT fast Ethernet, UTP connector.

k. USB 2.0 ports, four minimum or USB 2.0 four-port (minimum) hub.

l. 16x DVD/CD Read/Write drive.

m. Operating system (OS) and other software:

1) Workstation/server OEM installed OS, including all original OEM installation and recovery CDs and diskettes.

2) Microsoft Server 2003, XP Professional, or Vista Ultimate OS, per workstation/server configuration requirements.

3) All workstation/server OEM supplied drivers and software, original install CDs.

4) All updated software and drivers, with the latest set on one CD.

5) Microsoft Office, including Word, Excel and Access, original install CD.
n. Manufacturer and Product:
1) SuperMicro; No. 7046A-3.
2) Dell.
3) Hewlett-Packard.
4) Siemens.
5) Approved equal.

3. Configuration Server: Add the following hardware and software to the generic PC specified above:
   a. Microsoft Server 2003 OS in lieu of XP Professional or Vista. Minimum 5 CALs.
   b. SAS hard drive capacity 1 TB, minimum.
   c. Configuration/Runtime version of the HMI Software.
   d. Single monitor, mouse and keyboard for operation of the Configuration Station/Server or the Runtime Server.
   e. KVM switch with USB 2.0 and video connections to provide remote interface for mouse, keyboard and monitor to Configuration Station/Server and Runtime Server over UTP cable.
   f. Any other hardware of software components required for a complete and totally operational system.

4. Runtime Server. Add the following hardware and software to the generic workstation/server specified above:
   a. Microsoft Server 2003 OS in lieu of XP Professional or Vista. Minimum 5 CALs.
   b. SAS hard drive capacity 1 TB, minimum.
   c. Full-function run-time version of the HMI software.
   d. Any other hardware or software components required for a complete and totally operational system.

5. Client Workstation. Add the following hardware and software to the generic workstation/server specified above:
   a. Full-function runtime version of the HMI software. 128 I/O tags.
   b. Dual Monitors.
   c. KVM extender with USB 2.0 and video connections to provide remote interface for mouse, keyboard and dual monitors over UTP cable.
   d. Any other hardware or software components required for a complete and totally operational system.

II. Y403D Programmable Logic Controller (PLC) System:

1. General:
   a. Function: Process controller using hardware and software which emulate relays, timers, counters, calculation modules, signal conditioners, PID controllers and drum sequencers.
   b. Type: Microprocessor based controller programmed with Function Block Diagram (FBD), Statement List (STL), Ladder Diagram (LAD) and Structured Control (SCL) programming languages.
   c. Components:
1) Facility PLC: Modular PLC family.
   a) CPU with 1.4 MB ram, two PROFIBUS port and one PROFINET port.
   b) 24V dc.
   c) Siemens CPU 319-3 PN/DP.
   d) With memory card.
   e) No substitution.

2) Distributed PLC: Modular PLC design using rail mounted, interconnected terminal modules populated with electronic I/O modules.
   a) CPU with three PROFINET ports and expandability for one PROFIBUS port.
      (1) 24V dc.
      (2) Siemens IM 151-8 PN/DP.
      (3) With memory card.
      (4) Siemens IM 151-7 Profibus DP master interface, where required on the Drawings.
      (5) No substitution.

3) Remote I/O: Modular PLC design using rail mounted, interconnected terminal modules populated with electronic I/O modules.
   a) Interface module with two PROFINET ports.
      24V dc.
   b) Siemens IM 151-3 PN High Feature.
   c) With memory card.
   d) No substitution.

4) Power supply.
5) CPU modules.
6) Communication modules.
7) Remote I/O (IM) interface modules.
8) Profibus DP Master (IM) modules.
9) Digital input (DI), digital output (DO), analog input (AI) and analog output (AO) modules with terminal modules.
10) Programming software.
11) Functional spare PLC.
12) Shelf spare components.
13) Other components required for a complete and totally operational system.

2. Architecture:
   a. Reference the Control System Block Diagram in the Drawings for PLC system configuration and PLC quantities.
   b. Reference PLC I/O List, see Section 40 90 00, Instrumentation and Control for Process Systems, for anticipated list of field installed I/O interface for PLC(s).

3. The following provides generalized specifications for the components that make up a specific PLC system:
a. Power Supply, as required for each rack:
   1) Distributed PLC, Remote I/O:
      a) Supply Voltage: 24V dc.
      b) Provide quantity of power modules (PM) to support required loads as well as future loads.
   2) Facility PLC:
      a) Supply Voltage: 24V dc.
      b) Capacity: 3 Amp at 24V dc.

b. CPU Module: With memory card.
c. Distributed CPU: With memory card.
d. Communication module, CP-343-1 (as required).
e. Remote I/O (IM) module (as required).
f. Profibus DP master module (as required).
g. Input and output (I/O) modules, quantity of each at each PLC location determined by the I/O List and spare requirements specified below:
   1) Analog Input (AI) module, 4-20 mA, 12-bit resolution, four-channel.
   2) Analog Output (AO) module, 4-20 mA, 12-bit resolution, two-channel.
   3) Digital Input (DI) module, 24V dc, four-point.
   4) Digital Output (DO) module, normally open relay, two-point, 2 amp, each individually isolated.
   5) Additional specialized I/O modules as may be required to provide a fully functional system as intended.
   6) Spare I/O Requirements: For each PLC location, install 25 percent additional spare points and channels for each I/O type, rounded up, with a minimum of two.

4. Spare Functional PLC Stations: Provide three spare fully functional PLC systems consisting of the following components:
   a. Facility PLC Station:
      1) CPU with memory card.
      2) Power supply.
      3) Communication module.
      4) Mounting rail and required accessories.
   b. Distributed PLC Station:
      1) CPU with memory card.
      2) Power supply (PM).
      3) PROFIBUS DP master module (IM).
      4) One each AI, AO, DI, DO module with appropriate terminal module.
      5) Mounting rail and required accessories.
   c. Remote I/O Station with one each AI, AO, DI, DO.
1) Interface module (IM).
2) Power supply (PM).
3) One each AI, AO, DI, DO module with appropriate terminal module.
4) Mounting rail and required accessories.

5. Additional Spare Components, Loose or Shelf:
   a. Power Supply: One of each type used for this project.
   b. CPU Module: One of each type used for this project.
   c. Communication Module: One of each type used for this project.
   d. Remote I/O (IM) Module: One of each type used for this project.
   e. I/O Modules: Two of each type used for this project.
   f. PROFIBUS DP Master Interface Module (IM): One of each type used for this project.

6. Manufacturers and Products:
   a. Siemens; S7-300, S7-200S.
   b. No substitute.

PART 3 EXECUTION (NOT USED)

END OF SECTION