SECTION 17110
INSTRUMENTATION AND CONTROL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: This section provides specifications for all instrumentation and control system equipment, panels, and necessary appurtenances for an integrated control system. These Specifications and Drawings include descriptions of functional operation and performance, as well as standards, but do not necessarily enumerate detailed specifications for all components and devices which are necessary. However, all components and devices shall be furnished and installed as required to provide complete and operable systems capable of providing the functions and meeting the performance set forth hereinafter.

B. The work of this section shall be performed by a qualified System Integrator. The contractor shall retain the services of a System Integrator to provide complete, assembled, installed, setup and testing of all instrumentation and control system components. The System Integrator shall have a minimum of ten systems in water or wastewater applications based on the approved SCADA system software and the PLC software that is submitted. The System Integrator shall also be responsible for the SCADA System, PLC System, Control Panels, Motor Control Centers, and field instrumentation. The System Integrator shall be Tesco Controls, Meyer Controls or pre-approved equal.

C. Related Sections: All provisions of this Section shall apply to the Contract Documents including the following Sections:

1. Section 17010 – GENERAL REQUIREMENTS, INSTRUMENTATION
2. Section 17506 – EXTENDED WARRANTY AND MAINTENANCE
3. Section 17510 – FACTORY ACCEPTANCE TESTS
4. Section 17512 – SITE ACCEPTANCE TESTS

D. QUALITY ASSURANCE

E. Performance and Design Requirements: For the purpose of standardization, all components shall be manufactured or furnished by one manufacturer, except as noted or approved.

F. Codes and Standards: Unless specifically noted, the following organizations may be quoted in this specification and are listed here for reference:

1. ANSI - American National Standard Institute
2. ASTM - American Society for Testing and Materials
3. ASME - American Society of Mechanical Engineers

4. IEEE - Institute of Electrical and Electronic Engineers

5. ISA - Instrument Society of America

6. JIC - Joint Industrial Council

7. NEMA - National Electrical Manufacturers Association

8. OSHA - Occupational Safety and Health Administration

9. SAMA - Scientific Apparatus Makers Association

10. UL - Underwriters' Laboratories, Inc.

11. EIA - Electronic Industries Association

12. NEC - National Electrical Code, 2002.

1.02 ENVIRONMENTAL CONDITIONS

A. The Instrumentation and Control System (ICS) shall be installed in a Water Treatment Plant which will be subjected to environmental conditions where temperatures may vary from 20 to 115 degrees F; relative humidity may vary from 10 to 100 percent; and trace quantities of moisture and dust may be present.

1.03 SUBMITTALS

A. General: Submittals for all ICS equipment shall be prepared and submitted in accordance with Section 01300 and as described in Section 17010.

1.04 OPERATION AND MAINTENANCE MANUALS

A. General: The CONTRACTOR shall provide Operation and Maintenance (O&M) manuals in accordance with Section 01730 and as described in Section 17010.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. These specifications describe equipment of a specific manufacturer and are not designed to limit competition. The naming of the manufacturer on which the specifications and plans are based is not an endorsement of that manufacture, but is instead intended to describe a level of quality and demonstrate the functionality of the system.

B. Materials and equipment shall be ARRA compliant.

C. The ICS components specified in these Specifications and shown on the Drawings are based upon the use of equipment, devices and panels manufactured by the companies specified in the following Sections of these Specifications.

1. The use of substitute or "or ENGINEER approved equal" equipment will be considered. Such equipment will be acceptable only on the basis that any revisions in the engineering, design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc., required to accommodate such a substitution, shall be made at no additional cost to the City.

2.02 MATERIALS

A. General:

1. All furnished instruments and control system components shall be as specified in these Specifications. Equals or exceptions shall be approved by ENGINEER prior to procurement

2. All products shall be new and approved for the specific applications shown on Contract Drawings or specified in these Specifications and in compliance with ARRA.

3. Same products shall be of a single manufacturer.

4. Products furnished for modification of existing control panels, except for the PLCs, shall be compatible with the existing products and from the same manufacturer, unless the existing products are no longer available.

5. Products installed in classified areas shall be approved for that classification and meet all the pertinent Standards and Code requirements.

B. Equipment Surge Protection:

1. All electronic equipment shall successfully withstand surges in AC power circuits as specified in IEEE C62.41. Successfully withstanding transients requires that none of the following conditions occur as a result of the transient:

2. Erroneous output.

3. Component failure.

4. Calibration change exceeding normal tolerances.

C. Accessories:

1. Provide instruments with manufacturer's identification nameplate showing:

2. Manufacturer's model number.

3. Manufacturer's serial number.

4. Range. (English units)

5. Power supply requirement.

D. Control Panels:

1. The Control Panels shall be of same construction and configuration as shown on the Drawings and specified in these Specifications. All indicator lights, switches, recorders and digital displays shall be mounted on the doors. All Operator Interface Terminals (OITs) shall be accessible from the front door.

2. The backpanel and side-panels shall be used to install instrument modules, signal conditioners, relays, power supplies and other associated components within the Control Panel.

3. The Control Panels shall be fully gasketed and NEMA rated for the specific Plant areas. The panels shall be completely factory assembled, wired and tested. All field wiring shall be terminated in terminal blocks. All components shall be mounted so as to facilitate easy removal for service.

4. The panels shall be provided with adequate forced ventilation to ensure that the temperature rise within the panel section does not exceed design temperatures for the components within the panel section. The panels shall also be provided with heaters, as required, to prevent condensation.

E. Programmable Logic Controllers:

1. The Programmable Logic Controller (PLC) system shall operate in ambient conditions of 20 to 120°F temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.

2. Where the PLC is utilized to control multiple trains of equipment, the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of one component does not affect equipment of all trains. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.

3. The PLC program modules shall dictate control outputs to a known and safe state prior to running of control program, under PLC fault conditions, and PLC runtime errors.

4. Access to the PLC program, downloading, uploading and diagnostic functions shall incorporate password protection or key lock operation.

5. The PLC system shall be designed with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, harmonic distortions, relay and circuit breaker noise or conducted and radiated radio frequency interference.

6. The PLC system shall be grounded to the panel ground bus with a separate ground conductor sized per the manufacturer's grounding requirements. The minimum ground connection shall be AWG #12.

7. The PLC central processing unit (CPU) shall be of solid-state design. All CPU operating logic shall be contained on plug-in modules for quick replacement. Chassis wired logic is not acceptable. The controller shall be capable of operating in a hostile industrial

environment (i.e., heat, electrical transients, RFI, vibration, etc.) without fans, air conditioning, or electrical filtering (up to 60 degrees C and 95 percent humidity).

8. The PLC shall be furnished as a complete assembly with I/O (input/output) modules and peripheral equipment suitable for the interface with the new and existing PLC equipment, components and field devices.

9. The PLC chassis shall contain all I/O modules, communications equipment, and power supplies required to provide the specified functions. PLC chassis shall be sized to house the required PLC modules plus an additional two slots for future expansion capability.

10. The PLC power supplies shall be sized to provide power for the maximum total module load plus an additional 40 percent for future expansion. The PLC power supply shall provide the following operational characteristics:

11. 120 VAC RMS plus or minus 15 percent continuously.

12. 120 VAC RMS plus or minus 30 percent maximum 30 seconds.

13. 120 VAC RMS plus or minus 100 percent maximum milliseconds.

14. Line spikes at 1000V ac (5000 micro-seconds duration; 0.05 percent maximum duty cycle).

15. The central processor shall contain all firmware logic, relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions. It shall be capable of interfacing sufficient discrete inputs, analog inputs, discrete outputs, and analog outputs to meet the specified requirements plus an additional 25 percent excess capacity. The power supply shall contain capacitors to provide orderly shutdown in the event incoming power does not meet specifications. If this occurs, the processor shall cease operation, forcing all outputs off. The processor shall have a key type memory protect switch to prevent unauthorized program changes. The central processor shall be 32-bit, minimum.

16. The programmable controller memory shall be Complementary Metal Oxide Semi-conductor (CMOS) based memory with battery backup or Erasable Programmable Read-Only Memory (EPROM) based memory. The CMOS memory shall be a minimum of 64K with sufficient battery backup to retain the program during power interruptions of up to 1 year. An indicator shall show the status of the batteries. A reference shall be available through the discrete outputs to alarm the operator that the batteries should be changed.

17. The PLC shall be supplied with sufficient memory to implement the specified control function plus a reserve capacity of 25 percent of the total provided. This reserve capacity shall be totally free from any system use. Memory size shall be 1.5 MB minimum. However, System Integrator shall calculate the memory size based on the program requirements and provide PLCs with memories adequate for the Project.

18. The PLC shall be provided with a Flash Memory module for memory back-up.

19. The PLC shall provide internal fault analysis with a fail-safe mode and a dry contact output for remote location alarming, and a local indicator on the PLC frame in the event of a fault in the PLC.

20. The PLC shall have provision for programming, besides other common programming languages, in "ladder diagram" language. It shall be easily reprogrammed with a portable programming unit. Two documented copies of the operating program shall be furnished which shall allow direct, step-by-step, reloading of the system program.

21. The PLC system shall have provisions for RS-232; ControlNet, Profibus DP or Interbus Fieldbus; Data Highway Plus or Modbus Plus; and Ethernet 10/100BaseT communications network interfaces.

22. The PLC processor shall be Allen Bradley ControlLogix L6 Series, Schneider Electric Modicon Quantum or approved ARRA Compliant equal, as shown on the Contract Drawings.

23. All Input/Output (I/O) module housings and I/O modules shall be of rugged construction with modules installed in I/O chassis. Sufficient input and sufficient output modules shall be provided with the PLC to implement the specified control functions plus a reserve capacity of 25 percent of the total provided.

24. All Discrete Input (DI) Modules, defined as contact closure inputs from devices external to the programmable logic controller module shall be shielded from short time constant noise and 60-Hz pickup. Individual inputs shall be optically isolated for low energy common mode transients to 1500 volts peak from user's wiring or other I/O Modules. The modules shall have LED lights to indicate a discrete input. Input modules shall be supplied with a maximum of 16 points per module, except where 32-point modules are required. Input voltage rating shall be provided as indicated on the Contract Drawings. Discrete input modules shall be Allen Bradley 1756-IA16/32, Schneider Electric Modicon Quantum, or approved ARRA Compliant equal.

25. All Discrete Output (DO) Modules, defined as contact closure outputs for ON/OFF operation of devices external to the programmable logic controller module shall be rated for 10 through 256 V ac and fused with blown fuse indicator lights. The output modules shall be optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volt peak. All output modules shall have LED lights to indicate output has been cycled ON by the controller.

Output contact rating shall be 2 amps at 30 degrees C. Interposing relays shall be provided when controlled equipment current exceeds the contact output rating. Output module shall be supplied with a maximum of 16 points per module. Voltage shall be supplied as indicated on the Contract Drawings. Relay output module shall be Allen Bradley 1756-OA16I, Schneider Electric Modicon Quantum, or approved ARRA Compliant equal.

Isolated Contact Output Modules shall be provided as indicated on the Contract Drawings. Relay contacts shall be individually isolated per channel and shall be provided with a maximum

of 8 points with each point having form C contacts. The Isolated Contact Output Modules shall be Allen Bradley 1756-OX8I, Schneider Electric Modicon Quantum, or approved ARRA Compliant equal.

26. All Analog Input (AI) Modules, defined as analog inputs for 1 to 5 VDC or 4 to 20 mA dc signals, where an analog to digital conversion is performed and the digital result is entered into the processor. New inputs shall be provided for every scan. Analog inputs shall be supplied with a minimum resolution of 14 bits. Each Analog Input Module shall accept 6 isolated inputs. Each analog input shall be isolated from common. Analog input modules shall be Allen Bradley 1756-IF6I, Schneider Electric Modicon Quantum, or approved ARRA Compliant equal.

27. All Analog Output (AO) Modules, defined as analog output to output 1 to 5 VDC or 4 20 mA dc signals, where a digital to analog conversion is performed and the analog result is produced on every scan. Analog output resolution shall be 14 bit minimum. Each Analog Output Module shall have 6 isolated outputs. Each analog output shall be capable of driving into a 1500 ohm load. Analog Output modules shall be Allen Bradley 1756-OF6CI, Schneider Electric Modicon Quantum, or approved ARRA Compliant equal.

28. All Combination Analog Input/Output Modules shall be provided with four high-speed differential analog input channels and two high-speed voltage or current analog output channels. Combined modules shall be Allen Bradley 1756-IF4FXOF2F, Schneider Electric Modicon Quantum, or approved ARRA Compliant equal.

29. Remote Input/Output Communications Modules shall be used for the PLC to communicate with remote chassis utilizing Ethernet Communication modules. Ethernet Communication Modules shall be Allen Bradley 1756-ENBT, Schneider Electric Modicon Quantum, or approved ARRA Compliant equal.

30. The integrated PLC system shall be Allen Bradley ControlLogix series, Schneider Electric Modicon Quantum, or approved ARRA Compliant equal.

F. Operator Interface Panel:

1. An Operator Interface Panel shall be provided that will be capable of display information and implement actions via a communications network (i.e. Data Highway Plus) to the programmable controller. The Operator Interface Panel shall be configured to serve as the primary operator interface to the programmable controller in the Control Panel Section of the Main Switchboard.

    1) The Operator Interface Panel shall utilize a minimum 8.3 x 6.2 -inch TFT active matrix color display, with minimum 640 x 480 pixel resolution. Operator input shall be accomplished by a 16 function key, numeric keypad, and cursor control keys.

    2) The Operator Interface Panel shall be Allen Bradley PanelView 1000 Color, Wonderware Compact, Modicon Magelis XBT GT, or approved ARRA Compliant equal.

G. Level Switch – Ultrasonic:

1. Provide single-point level switch with an ultrasonic transducer and temperature compensator as indicated on the Drawings.

2. The ultrasonic transducer emits a series of ultrasonic pulses. Each pulse is reflected as an echo from the material and sensed by the transducer. Filtering methods shall discriminate between the true echo from the material and the false echoes from acoustical and electrical noises and agitator blades in motion. The time of the pulse to travel to the material and back shall be temperature compensated and then converted into distance for display and relay actuation.

    1) The switch outputs shall be programmable for high-high, high, low, low-low level actions and be fail-safe programmable. The switch outputs shall be 2 Form C (SPDT) contacts, rated 5A @ 250 VAC, non-inductive.

    2) The unit shall have a liquid crystal display using a 3-digit value for reading of distance between sensor face and material, multi-segment graphic for operation status.

    3) The sensor shall be either Tefzel or Kynar Flex and utilize a 2"NPT treaded mounting.

    4) The unit shall be rated CSA/FM Class 1, Division 1, Group A, B, C, D: Class II, Group E, F, G, Class III.

        a) Switching Range (Liquids): 0.8 to 16.4 feet.

    5) Ambient temperature: -40° to 60° C.

3. Enclosure shall be suitable for outdoor and indoor applications.

4. Power requirements shall be 120-230 VAC. The unit shall produce a 4-20 mA DC non-isolated into 750 ohm output. Unit accuracy shall be 0.25% of full scale with a resolution of 0.125".

    1) The Ultrasonic Switch shall Siemens Milltronics Pointek ULS200, Flow Corp or approved ARRA Compliant equal.

H. Level Switch – Float Type:

1. Float material shall be Polypropylene or Teflon coated type 316 stainless steel.

2. Cable jacket shall be PVC, neoprene, or approved equal.

3. Cable clamps shall be Polypropylene or 316 stainless steel.

4. Design and Fabrication:

5. Hermetically sealed non-mercury microswitch in float.

6. Provide level switch complete with flexible electrical cables.

7. SPDT contact rated at 4.5 amps at 120 VAC.

8. Direct acting float switch that actuates on rising level and deactivates when liquid falls one inch below actuation level.

9. Terminate cable in junction box.

10. Install level switches per Contract Drawing details.

    1) The Float type level switch shall be a Magnetrol T10, Flygt EMN-10 or approved ARRA Compliant equal.

J. Submersible Level Measurement:

1. The level measurement system shall consist of a submersible transducer, electronic transmitter, support cable and interconnecting cable. The submersible transducer shall be a piezoresistive-micromachined silicon strain gauge type suitable for sensing pressure equivalent to the liquid level range indicated on the contract drawings. The transducer shall have all-titanium construction and shall be equipped with a polyurethane vented cable rated for submergence in corrosive and hazardous environments. A corrosion resistant cable as recommended by the manufacturer shall suspend the transducer. The installation shall allow easy removal of the transducer and cable assembly for maintenance purposes. The electronic transmitter shall produce a 4-20 mA DC signal linearly proportional to the level range required by the contract documents.

2. Submersible level transducer shall be GE Druck PTX 1290, Global Water Instrumentation, KPSI or approved ARRA Compliant equal.

H. Electromagnet Flow Measuring Systems:

1. The electromagnetic induction flow meter shall generate a voltage linearly proportional to flow for full-scale velocity settings from one to 33 feet per second. Standard accuracy of the pulse output shall be ± 0.2% of rate ± 0.02% of full scale (33 ft/sec) for all meters.

2. The meter shall incorporate a high impedance amplifier of 1012 ohms or greater, eliminating the effect of buildup on the electrodes. The meter shall utilize bipolar pulsed DC coil excitation with automatic coil-current fine tuning by the microcontroller to adjust the sensor current within a tolerance of ±100mA. The amplifier shall incorporate 3-stage signal processing to maintain system accuracy by the use of a 26 bit analog/digital converter. The first stage will adjust the common-mode rejection ratio to filter out noise. The second stage will incorporate an INTEGRATED AUTOZERO function which compensates for any external interference signals and eliminates zero drift. Manual zero adjustments shall not be required -- even at start-up. In stage three, the measuring signal will be amplified by an AUTOGAIN function, depending on the actual amplitude of the flow signal, to automatically increase the measurement resolution at various flow rates, providing a turndown of at least 1000:1. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation. Power consumption shall be no more than 15 VA, independent of meter size. Upon any power failure, the unit will retain all setup parameters and accumulated measurements internally in non-volatile memory. All units will be protected against voltage spikes from the power source by utilizing internal transient protection.

3. The magnetic flow meter shall be microprocessor based with integral electronics. The electronics shall be interchangeable for all sizes from 1/12" to 78". Remote-mounted electronics up to 650 feet shall be available where noted on the contract drawings

4. The flow meter shall have optical Touch Control programming that can be operated through the enclosure window, without opening the electrical enclosure. The flow meter shall have a 4-line x 16 character backlit LCD display used for programming as well as for simultaneous display of flow rate and total flow in user-selectable engineering units, and readout of diagnostic error messages, selectable from 12 standard languages. The microprocessor shall safeguard against entering of invalid data for the particular meter size, and all programming parameters shall be access-code protected. The electronics shall include infinitely adjustable low flow cutoff.

5. The flow meter shall have the capability of being programmed remotely using HART, Foundation Fieldbus or Profibus PA/DA protocol. RS.

    1) Output selections shall include an isolated 4-20 mA DC into 700 ohms load, proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output operating at frequencies up to 10 kHz with an adjustable pulse width (0.05 to 2 sec).The analog output shall have an adjustable response time from 0.05 to 100 seconds. A digital filter will be integral for compatibility with the process fluid. The transmitter housing shall be powder coated cast aluminum of NEMA 4X rating.

    2) Both auxiliary (open collector) and current inputs shall be available. Aux input shall be configurable for re-setting totalizer(s), measured-value suppression, error message reset, and start/pause batching. Current input shall be selectable as either active or passive 4-20mA.

    3) The magnetic flow meter shall provide with 2 programmable relay outputs, for diagnostic error output, MAX/MIN flow rate set points, empty pipe detection, flow direction or for batching.

    4) The meter body shall be available for submersion where specified. The meter body shall include grounding and empty pipe electrodes of the same material as the measuring electrodes. Ground probes, rings, or straps will not be acceptable, except on sanitary meters or meter sizes ≤ 1".

    5) The meter body shall be available in flanged or wafer styles, or with custom connectors (NPT fittings, Tri-Clamps, hose fittings, adhesive couplings, or butt-weld connectors) as required by the contract drawings.

    6) Liner and electrodes shall be chosen to be compatible with the process fluid. All fluids require a minimum conductivity of 5µS/cm (20µS/cm for deionized water).

6. The standard meter will be FM approved non-incendive Class I, Div. 2 Groups A-D, with units available that have FM Class I, Div. 1 approval.

    1) The Electromagnetic flow measuring system shall be Endress+Hauser Promag 53 W series, ABB Magmaster, or approved ARRA Compliant equal.

I. Pressure and Differential Pressure Switches:

1. Pressure and differential pressure switches shall have an adjustable (10` percent) differential (deadband) to eliminate instability due to pressure cycling. Pressure tap connections shall be 1/2-inch NPT and conduit connection shall be 3/4-inch NPT or larger.

2. Materials:

3. Bourdon tube: 316 stainless steel.

4. Diaphragm seal housing: 316 stainless steel.

5. Pulsation dampeners: 316 stainless steel.

6. Switch isolating ball valves: 316 stainless steel.

7. Accessories:

8. Provide ball valve to isolate pressure switch from source.

9. Provide pulsation dampeners on all pressure switch applications which involve positive displacement equipment including positive displacement plunger pump systems, positive displacement lube pump systems, diaphragm pump systems and positive displacement blower or compressor systems.

10. Provide protector to separate process fluid from the pressure element,

11. System fill applications – diaphragm seal and sealed sleeve.

12. System fill material: Utilize halocarbon fill for process applications involving strong oxidizing agents. Agents include but are not limited to: Chlorine (CL2), Potassium Permanganate ($KMNO_4$), Ferric Acid (FeCl), Sodium Hydroxide (NaOH), Sodium Hypochlorite (NaOCl), and Aluminum Sulfate, ($A1_2(SO_4)14\ H_20$). Utilize manufacturer's standard fill for other applications. Ensure fill is suitable for application temperatures

13. On applications where a pressure switch and a pressure gauge are used at the same location, it is permissible to utilize one pulsation dampener and diaphragm seal to isolate both elements from the process fluid.
    1) Design and fabrication:
        a) Pressure Switches shall be hermetically sealed non-mercury contact switches.
        b) Two (2) SPDT contacts rated 1 amp inductive at 125 VDC and 5 amp inductive at 120 VAC. Set points between 30 and 70 percent of switch rated working range Operating pressure not to exceed 75 percent of switch rated working range.
        c) Accuracy: Better than 1 percent of full scale.
        d) The pressure switches shall have a watertight enclosure.

14. Pressure switches shall be United Electric Controls with appropriate diaphragm seals, Mercoid, Automatic Switch Company or approved ARRA Compliant equal.

J. Differential Pressure Transmitter:

1. The differential pressure sensor shall provide a two-wire, loop-powered, 4-20 mA signal proportional to the process pressure.

2. Service: Air and non-combustible, compatible gases.

3. Accuracy: ±2% of full span output including linearity, hysteresis and repeatability.

4. Temperature Limits: 0 to 140°F

5. Pressure Limits: 30 psig continuous, 50 psig surge.

6. Power Requirements: 10-35 VDC (2-wire)

7. Output signal: 4-20 mA

8. Zero and Span Adjustments: Internally accessible potentiometers.

9. Loop Resistance: DC; 0-1250 ohms maximum.

10. Current Consumption: DC; 38 mA maximum.

11. Electrical Connections: Terminal Block.

12. Process connections: Barbed, for 3/16" I.D. tubing.

13. The pressure measuring system shall be Dwyer Series 604A, Rosemount 3051 Series, IPS Foxboro IDP Series, . No Substitutions, to match existing equipment.

K. Pressure Transmitter:

1. The gauge/ absolute pressure sensor shall provide a two-wire, loop-powered, 4-20 mA signal proportional to the process pressure. Optionally the transmitter shall be capable of providing a simultaneous digital signal superimposed on the analog output, but shall not affect this analog value. The digital signal shall utilize the HART protocol. The unit shall operate with 11.5 to 45 VDC in non-hazardous applications and 11.5 to 30 VDC in FM approved installations.

2. The sensor shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm construction for measuring range up to 600 PSIG/ A. The sensor shall utilize a polysilicon 316 SST diaphragm construction for measuring ranges up to 6000 PSIG/A .The ceramic diaphragm shall be immune to damage due to full vacuum and shall have an overpressure (overload) pressure rating of:

3. 60 PSIG for URL of 0.075 to 1.5 PSIG.

4. 150 PSIG for URL of 0.3 to 6 PSIG/A

5. 300 PSIG for URL of 1.5 to 30 PSIG/A

6. 600 PSIG for URL of 7.5 to 150 PSIG/A

7. 850 PSIG for URL of 30 to 600 PSIG/A

8. The polysilicon sensors shall have an overpressure (proof) pressure rating of:

9. 6000 PSIG for URL of 75 to 1500 PSIG/A

10. 9000 PSIG for URL of 300 to 6000 PSIG/A

11. The ceramic sensor type transmitter accuracy shall be 0.2% of calibrated span over an entire 10:1 turndown. The polysilicon sensor type transmitter accuracy shall be 0.3% of calibrated span over an entire 10:1 turndown. This accuracy shall include the effects of linearity, hysteresis, and repeatability. The transmitter shall have a Long Term Stability of 0.1%.per 12 months. The electronics shall be replaceable by, module exchange. The transmitter electronics housing shall be constructed of 304 Stainless Steel with no dead volume and meet the hygienic requirements of the food and pharmaceutical industries. The housing shall be rated NEMA 4X.

12. The transmitter shall have versions which allow the ceramic sensor to be mounted flush with the process connection, including but not limited to, threaded versions, flanged versions, and Tri-Clamp compatible versions. The process connection and process seal gasket wetted parts shall be interchangeable and replaceable on-site. There shall also be options which allow no metal contacting the process.

13. The transmitter shall have an optional digital LCD display showing both the digital value and a 0-100 % bar graph if used with Hart electronics or 0-100% bar-graph when used in conjunction with analog electronics. The display shall be universal to all ranges and incorporate a plug-in modular design to allow field retrofit.

14. Diaphragm seal versions shall be available to expand the operating parameters of the transmitter.

15. The transmitter shall be Factory Mutual (FM) Approved Intrinsically Safe Class I, II, and III, Division 1, Groups A thru G with appropriate barriers and FM approved Non-Incendive Class I and II, Division 2 without the need for barriers.

16. The pressure measuring system shall be Endress + Hauser cerabar M; Rosemount 3051 Series; IPS Foxboro IAP or IGP; or approved ARRA Compliant equal.

L. Turbidimeters:

1. General: A turbidity monitoring system shall include one Turbidimeter and one interface unit. The system shall be capable of functioning as a single sensor system and also be easily expanded up to two turbidimeters per interface unit. The connections between the turbidimeter and interface unit shall include plug and play connections.

2. Manufacturer and Model: Hach Low Range, Model No. 1720E, Endress+Hauser, or approved ARRA Compliant equal.

3. Safety and Electrical Design Standards:

4. Compliance: Standard Methods 2130B, USEPA 180.1, Hach Method 8195.

5. Certification Safety: Listed by ETL to UL 61010A-1: Certified by ETL to CSA C22.2 No. 1010.1: CE Certified by Hach Company to EN 61010-1

6. Immunity: CE certified by Hach Company to NE61326 (industrial levels)

7. Emissions Class A: EN 61326, CISPR 11, FCC Part 15, Canadian Interference-Causing Equipment Regulation ICES-003.

8. Range: 0.001-100 Nephelometric Turbidity Units (NTU)

9. Operation: Microprocessor-based, continuous-reading, on-line nephelometric instrument meeting all design and performance criteria specified by USEPA method 180.1. Light shall be directed through the surface of the sample and the detector shall be immersed in the sample, eliminating glass windows and flow cells.

10. User selectable signal averaging, bubble removal, alarm and recorder output hold, and self-test diagnostics shall be provided.

11. Required Sample Flow: 200 to 750 mL/minute (3.1 to 11.9 gal/hour).

12. Calibration Method: The turbidimeter shall offer the choice of formazin-based (20 or 1 NTU) or instrument comparison-based calibration method.

13. Required Sample Flow: 200 to 750 mL/minute (3.1 to 11.9 gal/hour).

14. Calibration of the turbidimeter shall be either formazin-based (20 or 1 NTU) or instrument comparison-based calibration method.

15. Construction: Optical components shall be mounted in a sealed head assembly that can be removed easily for calibration/service, without disturbing sample flow. The turbidimeter body shall be constructed of corrosion-resistant polystyrene, and shall include an internal bubble removal system to vent entrained air from the sample stream.

16. Dimensions: Turbidimeter Body and Cap: 10 x 12 x16 inches, Sc100 Controller: 5.67 x 5.67 x 5.91 inches.

17. Mounting: Turbidimeter Body and Head Assembly: Wall and floor stand; Sc100 Controller: wall, pole, panel, and floor stand.

18. Connections between the turbidimeter(s) and the controller shall be "plug and play".

19. Accuracy: Accuracy shall be ±2% of reading or ±0.015 NTU (whichever is greater) from 0 to 40 NTU; ±5% of reading from 40 to 100 NTU.

20. Display Resolution: Displayed resolution shall be 0.0001 NTU from 0 to 9.9999 NTU; 0.001 NTU from 10.000 to 99.999 NTU and repeatability shall be better than ± 1.0% of reading or ± 0.002 NTU (whichever is greater).

21. Response Time: For a full scale step change, initial response in 1 minute, 15 seconds.

22. Storage Temperature: -20 to + 60 degrees C (-4 to 140 degrees F).

23. Operating Temperature: 0 to 50 degrees C (32 to 122 degrees F) for single sensor system, 0 to 40 degrees C (32 to 104 degrees F) for two sensor system.

24. Operating Humidity: 5 to 95% non-condensing.

25. Sample Temperature: 0 to 50 degrees C (32 to 122 degrees F).

26. Recorder Outputs: Two selectable for 0-20 mA or 4-20 mA. Output span programmable over any portion of the 0-100 NTU Range; built into the Sc100 Controller.

27. Alarms: Three (3) set point alarms, each equipped with an SPDT relay with unpowered contacts rated 5A resistive load at 230 VAC; built into the Sc100 Controller.

28. Power Requirements: 100-230 VAC, 50/60 Hz, auto selecting; 40 VA.

29. Sample Inlet Fitting: Provide ¼ inch NPT female, ½ hose barb.

30. Drain Fitting: Provide ½ inch NPT female, ½ inch hose barb.

31. Enclosure: NEMA-4X/P66 Controller.

32. Digital Communication: Network card compatible; MODBUS/RS232, LonWorks protocol (optional).

33. Wireless Communication: IR Port on the Sc100 Controller to download into a handheld Personal Digital Assistance (PDA) or laptop computer via MODBUS,

34. The Interface Module shall allow operators to control sensor and interface functions with user-friendly, menu-driven software, and shall provide data logging of measurement data from up to two turbidimeters for optional interval of 15 minutes, 1 hour, 24 hours, 30 days, or 180 days and the capability to transfer data to a computer or printer via direct MODBUS communications or directly into a Personal Digital Assistant (PDA) via a wireless IR Port. The Interface Module shall also have a built-in data logger with the storage capacity to store data on 15-minute intervals for up to 6 months with two sensors per controller. Each Interface module shall also include two (2) Analog Outputs and three (3) un-powered SPDT Alarm Contacts. The Interface Module and the DC power supply shall be housed in a NEMA-4X industrial plastic enclosure. The DC power supply shall automatically accept input power in the range of 100 to 230 VAC, 50/60 Hz.

M. Residual Chlorine Analyzer

1. Direct sensing, DPD colorimetric sensor to monitor free chlorine residual.

2. Digital display of chlorine concentration; 0-5 mg/l range

3. Display sensitivity 0.01 mg/l.

4. Unit repeatability ±0.05 mg/l.

5. Output 4-20mA signal.

6. Power supply 110 VAC, 60 Hz.

7. Enclosure: Wall mount, NEMA 4X.

8. Alarms: Two adjustable, selectable high or low, 5 amp rated SPDT contacts.

9. Sample water requirements: Continuous flow, 100 to 500 mg/minute.

10. Reagent metering pumps integral with analyzer units.

11. Provide 12-month supply of indicator and buffer reagents as required for each unit.

12. The Residual Chlorine Analyzer shall be Hach CL-17, ATI or equal.

N. pH Meter – Flow Through Type

1. The pH measurement system shall consist of a flow through sensor, sensor holder, electronic transmitter, and interconnecting cable. The sensor shall be a differential pH sensor with glass process electrode, suitable for sensing pH range of 0 to 14pH. The sensor shall be furnished with an integral waterproof interconnecting cable. The electronic pH transmitter shall be 120V with digital display and produce a 4-20mA DC signal linearly proportional to the range indicated. The measurement system shall be suitable for operation over a temperature span of -4° to +140°F with a sensitivity of ±0.05pH. The pH sensor shall be Horiba K8 EDHF. The transmitter shall be Horiba K-8 TD4113 or approved equal.

O. Pilot Devices:

1. Indicating lights, pushbuttons, and selector switches shall be miniature oil-tight units. Time clocks in control circuits shall be NEMA IC1, B150, rated 5 amperes inductive at 120 volts AC. Contact blocks for signal circuits shall be rated at 0.06 amperes at 30 volts AC or DC and shall be hermetically sealed reed switches. Pilot lights for 120 volt AC circuits shall be transformer type with 6.3 volt lamps. Pilot lights of 24 volt circuits shall be rated 28 volts. Individual pilot light assemblies shall be "push-to-test" type. Allen Bradley 800MR Series, Cutler Hammer or approved ARRA Compliant equal.

P. Relays:

1. All relays used for instrumentation work shall be plug-in types utilizing EIA standard tube socket configuration plugs. Sockets shall be heavy-duty, surface mounted, industrial type with barrier protected screw type terminals and shall be a one-piece melamine

plastic molding. Sockets shall be rated not less than 5 amperes at 125 RMS working volts.

2. As a minimum, relays for general purpose use shall have double-pole, double-throw (DPDT) contacts. They shall bear ratings of 10 amperes at 120 volts AC and 28 volts DC. Relay frames shall be constructed of laminated phenolic and shall be provided with a clear polycarbonate dust cover. Relays for switching high level signal circuits (4 to 20 mA) shall be similar to the above; except the contacts shall be rated 3 amperes and the relays shall be hermetically sealed.

3. Relays for switching power or control loads with in-rush currents in excess of 5 amperes shall be similar to the above except the contacts shall be single-pole, single-throw (SPST), double-break, rated 20 amperes at 120 volts AC and 28 volts DC, and 1 horsepower at 120 volts AC.

4. Relays shall be IDEC, Allen Bradley or an approved ARRA compliant equivalent.

Q. Signal Isolator:

1. Signal isolators shall have complete isolation of input, output and power input. Signal input shall be 4-20 mA into 50 ohms maximum, signal output shall be 4-20 mA into 1000 ohms minimum. Power input shall be 120 VAC, 60 Hz. Span and zero shall be adjustable. Accuracy shall be plus or minus 0.1 percent of span. Units shall be surface or rack mounted. Signal isolators shall be Moore Industries Model SCT, Rochester Instrument Systems Model SC-1302-LZ, AGM Electronics TA-4000, an approved ARRA compliant equivalent.

R. Current Alarm Trip (Switches):

1) Current alarm trips shall be single- or multi-channel type as required. Units shall accept voltage or current input signals. Dead band shall be factory set at 1 percent of full span for single trips. Alarm trips shall be equipped with 10 AMP DPST contacts.

2. Alarm trips shall include set point dials calibrated 0-100 percent for each trip point. Single alarm trips shall include a dead band adjustment dial calibrated 0-100 percent.

3. Alarm trips shall be AGM Electronics Model TA-4030, Moore Industries Model DCA, an approved ARRA compliant equivalent.

S. I/I Converters:

1. Current to Current (I/I) converters shall accept one 4-20 mA DC signal and convert to two (2) 4-20 mA DC signals with an uncertainty not exceeding 0.25 percent of full scale. Each output signal shall be independent of each other, and isolated from input signal. The units shall be AGM Series 4000, Moore Industries, or an approved ARRA compliant equivalent.

T. DC Power Supplies:

1. Twenty-four volt units shall be used to supply instrument controls and loops as required in the plans and detailed specification schedules. Power output shall be free of noise, have negligible ripple, and remain stable under varying system load conditions.

2.03 NAMEPLATES

A. Machine engraved laminated phenolic nameplates shall be provided for all panel mounted equipment. Nameplate engraving shall be as shown on the Drawings. The nameplates shall also include the instrument tag number in small size lettering on the last line of the nameplates. Nameplates shall be attached to the panel with a minimum of two self-tapping stainless steel sheet metal screws. Adhesive attachment is not acceptable. The OWNER reserves the right to review and change nameplates wording at no additional cost prior to the engraving. Machine embossed adhesive labels shall identify the tag number of instruments inside panels. All nameplates shall be included in CONTRACTOR's submittal for review and approval.

2.04 TERMINAL BLOCKS AND WIRING

A. Terminal blocks shall be screw terminal type with box-clamp type pressure plates. Terminal blocks shall be rated minimum 300 volts. Each terminal block shall be identified by a distinct number (TB-1, TB-2, etc.) designated by the panel manufacturer. All terminal points shall be assigned a distinct number. All terminal points for "Common" bus shall be designated by "COM." Terminal points dedicated for 120 VAC buses shall be identified by L-1, L-2, etc. Terminal points for the ground wires shall be labeled "GND."

B. All interconnecting wiring between panels or between panels and field devices shall be connected to terminal blocks. All panel internal wiring shall be installed in plastic raceways (Panduit). Unless otherwise shown on the Drawings, all 120 VAC wiring shall be No. 14 AWG. All wiring for analog signals shall be No. 16 AWG. All wiring for 24 VDC discrete signals shall be No. 16 AWG. All wire shall be standard copper. Conductors shall be individually identified using colored thermoplastic insulation or distinct labels.

C. Conductor Identifications: Identify each conductor by a consecutive unique number, letter, or number-letter combination. Each conductor shall have the same identification at all terminals and tie points. Conductors connected to the same terminal or tie point shall have the same identification. Conductor identification shall be as shown below with modifications necessary to provide a unique conductor number for each interconnecting conductor:

   OPNLTB #T #/DPNLTB #T #/C #, where

   OPNL is Origination Control Panel, TB # is Terminal Block Number, T # is Terminal Number, DPNL is destination Control Panel, and C # is the three digit conductor sequential number. The following example is shown as the guidance for clarification:

   BBCPTB01T12/ASCPTB01T12/100, where

   BBCP is Blower Building Control Panel, TB01 is Terminal Block 01, T12 is Terminal Point 12, ASCP is Activated Sludge Control Panel, and 100 is the conductor unique number.

Use filed device Tag Numbers for connections between two filed devices and between a field device and a panel.

All relay contacts which will be connected to external panels or devices shall be wired to terminal blocks.

PART 3 - EXECUTION

3.01 GENERAL

A. Field instruments shall be mounted on 2-inch pipe stands unless shown adjacent to a well or otherwise noted. Instruments attached directly to concrete shall be spaced minimum two inches from the mounting surface by use of phenolic spacers or framing channel. Expansion shields or cast-in-place inserts shall be used for securing equipment or supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform. All instruments shall be installed so that taps, parts, and the like, are available for in-place calibration and test without removal.

B. The instruments shall be field calibrated and tested. Field testing shall be provided for verification of contract requirements and pertinent manufacturer published performance specifications for performance parameters essential to the proper operation of the system. As required by the OWNER, any instrument of suspicious operation shall be recalibrated and retested until proved satisfactory to the OWNER at no addition cost.

C. Elements such as controllers, electronic function modules, and the like, shall be tested and exercised to demonstrate correct operation, first individually and then collectively as part of a functional network system.

****END OF SECTION****