DIVISION 17

INSTRUMENTATION

SECTION 17311 - PLC HARDWARE AND SOFTWARE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes Programmable logic controllers for control of process equipment, process oriented machinery, and process systems.

1.02 RELATED WORK

A. Refer to Section 17410.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.03 SUBMITTALS

A. Refer to Sections 01300 and 17410.

B. Product Data: For each type of PLC include dimensions, mounting arrangements, and weights. Also, include manufacturer's technical data on features, performance, electrical ratings, characteristics, and terminal connections.

C. Operation and Maintenance Data: Provide literature detailing routine maintenance requirements (if any) for each PLC component including:

1. System specifications
2. Electrical power requirements
3. Application considerations
4. Assembly and installation procedures
5. Power-up procedures
6. Programming procedures
7. Explanation of internal fault diagnostics
8. Shut down procedures
9. Recommended spare parts list

1.04 REFERENCE STANDARDS

A. ASTM D999-91: Vibration

B. (CFR) Title 47, Part 18 (European EN 55011 (formerly C1SPR 11))

C. CSA Certification Class I, Division 2, Group A, B, C, D Hazardous or non-hazardous locations

D. IEC 60068-2.1 Environmental testing — Part 2-1: Tests - Test A: Cold, 2.2 Environmental testing - Part 2: Tests. Tests B: Dry heat, 2.3, 2.6 Environmental testing - Part 2: Tests - Test Fe: Vibration (sinusoidal) and 2.27 Environmental testing. Part 2: Tests. Test Ea and guidance: Shock

E. IEC 61000 Electromagnetic compatibility (EMC) - Testing and measurement techniques

1. Part 4-2: Electrostatic discharge immunity test
2. Part 4-3: Radiated, radio-frequency, electromagnetic field immunity test
3. Part 4-4: Electrical fast transient/burst immunity test
4. Part 4-5: Surge immunity test
5. Part 4-6: Immunity to conducted disturbances, induced by radio-frequency fields

F. IEC 61131-3: Programmable controllers - Part 3: Programming languages

G. IEC 801-3: RFI Immunity

H. IEC 801-5: Ground Continuity

I. IEC 801-2: Electrostatic Discharge

J. IEEE 472-1974/ANSI C37.90/90A-1974 (Surge Withstand) IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus

K. MIL STD 461B CS02: RFI/EMI Susceptibility

L. NEMA Pub No ICS2-230.42: Showering Arc Test

M. NSTA Project 1 A

N. UL 508 and CSA Standard C22.2 No. 142 (Isolation Voltages)

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer shall be capable of providing training, parts, and coordination of emergency maintenance and repairs.

B. The programmable controller and all of the corresponding components within the family of controller products shall be manufactured by a company that regularly manufactures and services this type of equipment.

C. The manufacturer shall comply with IS09001 standards for "Quality Systems- Model for Quality Assurance in Design/Development, Production, Installation, and Servicing".

D. The manufacturer shall provide complete technical support for all of the products. This shall include factory or on-site training, regional application centers, local or factory technical assistance, and a 24/7/365 technical support phone service.

E. A factory representative shall provide a minimum of four (4) days, with eight (8) hours each day for a total of thirty-two (32) person-hours of training to the Owner’s operations staff concerning the recommended operation and maintenance of the equipment. Training shall be performed after substantial completion of the project with the use of operating equipment.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver PLC components in packaging designed to prevent damage from static electricity and physical damage.

B. Store PLC equipment according to manufacturer requirements. At a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect PLCs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the PLC from all forms of electrical and magnetic energy that could reasonably cause damage.

1.07 NOMENCLATURE AND IDENTIFICATION DEFINITIONS

A. AI: Analog Input

B. AO: Analog Output

C. Fixed I/O: A PLC style consisting of a fixed number of I/0, a processor, and a power supply all in one enclosure. Some fixed PLCs have limited expansion ability.

D. CPU: Central Processing Unit

E. DI: Discrete Input

F. Distributed I/O: Hardware specially designed to function as Remote I/O.

G. DO: Discrete Output

H. HMI: Human-Machine Interface

I. I/O Input and/or Output

J. Modular: A PLC style consisting of cards that are assembled to comprise a complete unit. All I/O, CPU, and Power Supply are dedicated cards. Typically, these cards are inserted into a chassis.

K. Master/Slave: Communication between devices in which one device, the master, controls all communications. The other devices, the slaves, respond only when queried by the master. Typically used in a Remote I/O application.

L. Peer to Peer: Communication between two or more devices, typically PLC's, in which each device can control the communication exchange.

M. PID: Control action, proportional plus integral plus derivative.

N. PLC: Programmable Logic Controller

O. Remote I/O: I/O that is located remotely from the processor. Remote I/O can communicate over a variety of communication protocols and can use standard rack based I/O, or special Remote I/O hardware referred to as Distributed I/O.

P. SCADA: Supervisory Control and Data Acquisition

1.08 SPARE I/O

A. Each I/O drop and I/O location shall include at least 20 percent (minimum of four) points of each type (AI, AO, DI, and DO) for future use, regardless of whether any of those point types are used in that drop or location or not. The spares shall be the same type of I/O modules supplied.

B. Spare output points that require the use of an external relay shall be supplied with the external relay.

C. Regardless of the spare requirement, all installed unused points on all I/O modules shall be wired to terminal blocks in the order that they occur on the I/O modules. Unwired spares shall not be acceptable.

1.09 SPARE PARTS

A. General requirements for spare parts are specified in section 17490.

B. The following PLC spare parts shall be furnished:

1. Processors: Provide spare processor unit(s) for each unique processor installed.

2. Memory Cards: Provide spares for each type of card installed.

3. I/O Cards: Provide spares for each unique I/O module type installed. Provide two or 10 percent of installed quantity, whichever is greater.

4. Network interface, remote I/O, and communication modules: Provide one spare communication module for each unique communication module installed.

5. Specialty Modules: Provide as a minimum a spare of each type of module identified. Provide an additional spare for every ten modules of a specific type installed.

6. PLC Power supplies: Provide spare power supplies for each unique power supply installed.

7. Chassis: Provide spare chassis for each unique chassis installed.

8. Fixed PLCs: Provide spares for each unique type of PLC installed.

9. Miscellaneous components (including cables): Provide spares for each unique component installed.

1.10 MANUFACTURER SUPPORT

A. Provide a written proposal for a manufacturer support agreement for PLC hardware and software for a minimum of 12 months starting at final completion of the project. The cost of this manufacturer support agreement shall not be included in the Contract Price. The support agreement shall be executed in the name of, and for the benefit of, the Owner. At a minimum, this agreement shall provide the Owner with:

1. Twenty-four hour, 7 day per week manufacturer telephone support

2. Access to the manufacturer's technical support web site

3. Software and firmware updates.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide Programmable Logic Controller equipment with the required memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.

B. Processor Systems shall include processor, power supply, input/output modules, communication modules, redundancy modules, and remote interface modules as required to meet system requirements.

C. Furnish products listed and classified by Underwriters Laboratories (UL), CSA, or FM approval as suitable for purpose specified and indicated.

D. All equipment and devices furnished hereunder shall be designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production.

E. All equipment furnished shall be designed and constructed so that in the event of power interruption the systems shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored.

F. The PLCs shall communicate between the operator workstation and field-mounted transducers, switches, controllers, and process actuators. Communications protocol shall be completely transparent to process operators at the Human Machine Interface (HMI).

G. The PLC shall be capable of stand-alone operation in the event of failure of the communication link to the HMI subsystem.

H. Backup Processor Systems, if indicated on the drawings, shall consist of two chassis with power supplies, each containing a processor, redundancy module and communications module(s). Remote chassis shall be provided with communication modules to meet I/O and communication requirements.

I. Remote Input/Output Units shall include input/output modules, interface modules, communication modules, and power supply to meet system input and output requirements.

J. Agency and environmental specifications:

1. Electrical supply voltage to the PLC shall be 120 Vac, plus or minus 15 percent, 48-63Hz. PLC system power supplies shall be fused for overload protection.

2. Vibration: 3.5 mm Peak-to-Peak, 5-9 Hz: 1.0G, 9-1501Hz. The method of testing is to be based upon IEC 68-2-6 and JIS C 0911 standards for vibration. The system is to be operational during and after testing. Vibration Rating of 2.0G maximum peak acceleration for 10 to 500Hz. in accordance with at least one of the following:

    a. Installed rating: DIN rail mounted PLC: 10-57 Hz, amplitude 0.075 mm, acceleration 25-100 Hz, and

    b. Panel or plate mounted PLC: 2-25 Hz, amplitude 1.6mm, acceleration 25-200 Hz.

    c. In compliance with IEC 60068 and IEC 61131.

3. Shock: 15G, 11 msec. The method of testing is to be based upon IEC 68-2-27 and JIS C 0912 standards for shock. The system is to be operational during and after testing.

4. Temperature: All PLC hardware shall operate at an ambient temperature of 0 to +55 degrees C (+32 to +140 degrees F), with an storage ambient temperature rating of -25 to +70 degrees C (-40 to +185 degrees F).

5. Relative Humidity: The Programmable Controller hardware shall function continuously in the relative humidity range of 30 percent to 95 percent non-condensing.

6. Noise Immunity: The Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.

7. Altitude:

a. Operation: 0-6,500 feet

b. Storage: 0-9,800 feet

8. Degree of protection: NEMA 1 (IP20)

9. All products shall have corrosion protection.

K. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings indicating:

1. Modules product type such as analog or digital

2. Modules catalog number

3. Modules major revision number

4. Modules minor revision number

5. Module manufacturer vendor

6. Module serial number

L. All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer recommendations.

M. Manufacturers

1. Provide all PLCs from a single manufacturer. If the PLC manufacturer has authorized third party vendors to provide modules that are compatible with their platforms, then products manufactured by these authorized third party vendors will be acceptable.

2. Provide the PLC system by one of the following:

a. Rockwell Automation Allen-Bradley

1) 1756 L71 ControlLogix (at plants)
2) MicroLogix 1400 (small PS/WWS)

b. Or Engineer approved equal

N. Central Processing Unit (CPU)

1. The CPU shall be, at a minimum, a 16-bit microprocessor that provides system timing and is responsible for scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O.

2. The CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers, and service special function modules every scan. The CPU shall process the I/O with user program(s) stored in memory, then control the outputs based on the results of the logic operation.

3. Supply the CPU with a battery-backed time of day clock and calendar.

4. The CPU family shall allow for user program transportability from one CPU model to another.

O. Diagnostics

1. The CPU shall perform on-line diagnostics that monitor the internal operation of the PLC. If a failure is detected, the CPU shall initiate system shutdown and fail-over. The following, at a minimum, shall be monitored: Memory failure, memory battery low, and general fault, communications port failure, scan time over run, I/0 failure, and analog or special function I/O module failure.

2. All diagnostic information shall be accessible to the host communications interfaces and to the PLC program.

3. The PLC shall have indicators and on board status area to indicate the following conditions:

   a. CPU run

   b. CPU error or fault

   c. I/O failure or configuration fault.

   d. Battery good

   e. Communications indicator

P. Memory

1. The user program and data shall be contained in non-volatile battery backed memory, of type CMOS RAM program memory.

2. Memory Backup System: provide lithium battery backup capable of retaining all memory for a minimum of three months and a Flash memory system capable of reloading program in the event of memory loss.

   a. Backup Battery: The backup battery shall be capable of being replaced without disrupting memory integrity. Provide a visual indication of low battery voltage and a low battery alarm contact.

   b. Flash Memory Card: Memory card storage capacity shall be a minimum of processor memory capacity. Memory cards shall be installed in processors for factory testing.

3. The operating system shall be contained in non-volatile firmware. The memory containing the operating system shall be field updateable via a separate update tool.

Q. Programming Environment

1. Programming port: The PLC shall utilize a serial USB or Ethernet port for programming.

2. On-Line programming: Application programs may be modified or stored while the CPU is running, with minimal impact on the scan time.

3. Online programming including runtime editing

4. IEC 61131-3 programming languages supported: Ladder logic, function block, sequential function chart, and structure text.

5. Supply all hardware and software necessary to program the CPU in these languages.

R. Communication Ports

1. The CPU shall be expandable and supplied with additional modules to support the required communication interfaces.

S. Remote I/O Communications

1. The CPU shall be capable of communicating with up to 12 remote base locations at a combined distance of 2500 feet. The CPU shall automatically sample and update all local and remote I/O modules each scan cycle of the CPU.

2. The communication link between the CPU and any RIO chassis shall be as recommended by the PLC manufacturer. For racks located on a link of less than 2500 cable feet, the speed of the communications link shall be greater than 230K baud with RIO scan rate of less than 5 millisecond per RIO.

3. Diagnostic and equipment status information shall be available from each RIO.

4. It shall be possible to communicate with remote I/O racks or other PLCs via fiber optic cable.

5. The remote I/O system shall have available a remote input/output arrangement capable of operation at locations physically separated from the PLC CPU by up to 5,000 feet as detailed on the drawings.

6. Communication with the remote I/O arrangement shall be through cable as recommended by the PLC manufacturer and provided by the PLC system supplier under this specification section.

2.02 REDUNDANCY

A. The PLC shall be supplied with all hardware and software required to produce a completely operational redundant system if shown in the Drawings. Redundancy shall be implemented using a minimum amount of user programming. Warm backup, which is not a standard offering from the PLC manufacturer, is not acceptable.

B. The backup system shall consist of redundant controllers located in separate chassis.

C. The back-up system shall provide bumpless switchover for system outputs. All remote I/O shall maintain their last position until either communications is re-established or the remote I/O watchdog timer expires.

D. Switch-over between the on-line PLC and the back-up PLC shall occur within 100 milliseconds if any of the following conditions occurs in the on-line unit: Power failure, CPU fault, communications module fault, or change in the on-line unit's mode from RUN to PROGRAM.

E. The switchover shall be transparent to any devices networked to the redundant controller chassis.

F. The system shall automatically cross-load the primary controller's program to the secondary controller.

G. System diagnostics and debugging tools shall be provided to assist in troubleshooting all redundancy equipment.

2.03 POWER SUPPLIES

A. The PLC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules.

B. Power supplies shall have a clearly visible LED to indicate that the incoming power is acceptable and the output voltage is present.

C. Power supplies shall feature over-current and over-voltage protection and should be designed to operate in most industrial environments without the need for isolation transformers.

D. Power supplies shall be sized to accommodate the anticipated load plus 30%.

E. DC power supplies shall be capable of handling ripple up to 2.4V peak to peak.

F. AC Line Voltage rating of 85 to 265Vac, 47-63Hz

G. The power supplies shall allow for brown outs of at least 1/2 of a cycle, a harmonic rate of 10%, and will sustain continuous operation through momentary interruptions of AC line voltage of 10ms or less.

H. Automatically shut down the Programmable Controller system whenever its output power is detected as exceeding 125% of its rated power

I. Provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

J. Redundant power supplies will comply with all the requirements of non-redundant power supplies in addition to the features stated below.

1. The redundant power supplies shall be designed to share the current required by the chassis. In the event of a failure of one redundant power supply, the remaining supply will accommodate the entire load of the chassis without disruption to the chassis activity.

2. Provide a failsafe fuse that is not accessible by the customer.

3. Provide a solid state relay connection to allow for failure annunciation when wired to an input module.

4. Diagnostic LED status indicators for Power and redundancy.

2.04 CHASSIS

A. Medium and large PLC models shall be chassis based.

B. All system and signal power to the CPU and support modules shall be distributed on the backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable.

C. All system modules, main and expansion chassis shall be designed to provide for free air flow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.

D. All system modules including the processor shall be removable from the chassis or inserted in to the chassis while power is being supplied to the chassis without faulting the processor or damaging the modules.

E. Modules shall be designed to plug into a chassis and to be keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying shall perform an electronic check to insure that the physical module is consistent with what was configured.

2.05 DISCRETE INPUT AND OUTPUT MODULES

A. General

1. Digital input and output modules shall provide ON/OFF detection and actuation.

2. The I/O count and type shall be as required to implement the functions specified plus an allowance for active spares, as noted below.

3. Modules shall be designed to be installed or removed while chassis power is applied.

4. Modules shall have indicators to display the status of communication, module health and input / output devices.

5. Each module shall have the following status indicators.

   a. The On/Off state of the field device.

   b. The module's communication status.

6. I/O modules shall contain a maximum of 16 points per module.

B. Module Specifications (120Vac Isolated Input Module)

1. Nominal Input Voltage of 120V ac

2. On-State Current of 15inA @132V ac, 47-63Hz maximum

3. Maximum Off-State Voltage of 20V

4. Maximum Off-State Current of 2.5mA

C. Module Specification (120Vac Isolated Output Module)

1. Each triac type discrete output shall have an associated interposing relay located in the same control panel. 120 VAC power for relay outputs shall be provided from the associated motor starter control circuit (when used with motor starters) or other 120 VAC source (when I/O is not associated with a particular motor starter).

2. Output Voltage Range of 74-265V ac, 47-63Hz.

3. Output Current Rating:

   a. Per Point - 2A maximum @ 30 degrees C; 1.0A maximum @ 60 degrees C; Linear Derating

   b. Per Module - 5A maximum @ 30 degrees C; 4A maximum @ 60 degrees C; Linear Derating

4. Surge Current Per Point of 20A for 43ms each, repeatable every 2s @ 60 degrees C

5. Minimum Load Current of 10mA per point

6. Maximum On-State Voltage Drop of 1.5V peak @2.0A and 6V peak @load less than 50mA

7. Maximum Off-State Leakage of 3mA per point

D. Module Specifications (Contact Output Module)

1. Output Voltage Range of 10-265V ac, 47-63Hz

2. Output Current Rating:

    a. Resistive - 2A @ 125V ac

    b. Inductive - 2A Steady State, 15A make @125V ac

3. Power Rating (Steady State) of 250VA maximum for 125V ac inductive output

4. Maximum Off-State Leakage of 0 mA per point

5. Configurable States

    a. Fault Per Point - Hold Last State, ON or OFF

    b. Program Mode Per Point - Hold Last State, ON or OFF

2.06 ANALOG INPUT AND OUTPUT MODULES

A. General

1. Analog input modules shall convert an analog signal that is connected to the module's screw terminals into a digital value. The digital value representing the magnitude of the analog signal shall be transmitted on the backplane. Analog output modules shall convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals.

2. Modules shall be designed to be installed or removed while chassis power is applied.

3. Modules shall have indicators to display the status of communication, module health and input / output devices.

4. Each analog module shall provide both hardware and software indication when a module fault has occurred. Each module shall have an LED fault indicator and the programming software shall display the fault information.

5. Analog modules shall be software configurable through the I/O configuration portion of the programming software.

6. The following status shall be capable of being examined in ladder logic

    a. Module Fault Word — Provides fault summary reporting.

    b. Channel Fault Word — Provides under-range, over-range and communications fault reporting.

    c. Channel Status Words — Provides individual channel under-range and over-range fault reporting for process alarm, rate alarms and calibration faults.

7. The 24 VDC power for analog instrument loops shall be provided as a part of the system. The 24 VDC power supply shall be derived from the 120 VAC input power circuit to the PLC. The field side of the 24 VDC power sources(s) shall have individual or grouped (of logically associated circuits) fusing and be provided with a readily visible, labeled blown fuse indicator.

B. Isolated Analog Input Module

1. Input Range of 4-20 mA

2. Resolution of approximately 16 bits across range

3. Input Impedance of Greater than 249 Ohms

4. Overvoltage Protection: 8V ac/dc with on-board current resistor

5. Normal Mode Rejection of 60dB at 60Hz

6. Common Mode Noise Rejection of 120dB at 60Hz, 100dB at 50Hz

7. Isolation Voltage

    a. Channel to Channel - 100% tested at 1700V dc for ls based on 250V ac

    b. User to System - 100% tested at 1700V de for is based on 250V ac

C. Isolated Analog Output Current Module

1. Output Current Range of 4 to 20 mA

2. Current Resolution of 12 bits across 20 mA

3. Open Circuit Detection — None

4. Output Overvoltage Protection - 24V ac/dc maximum

5. Output Short Circuit Protection — 20 mA or less (electronically limited)

6. Calibration Accuracy - Better than 0.1% of range from 4mA to 20 mA

7. Calibration Interval - 12 months typical

2.07 COMMUNICATION INTERFACES

A. The PLC will be capable of the following communication protocols as shown on the drawings:

1. 10BASE-T/100BASE-TX Ethernet communication.

2. Modbus (RTU and ASCII) for up to 247 slaves

3. Rockwell Automation's RIO Protocol

4. DeviceNet

5. Asynchronous serial link capable of communicating up to 19.2Kbps

B. When required provide a Communications Interface Module mounted in the chassis or the equivalent port directly on the CPU.

2.08 PLC SOFTWARE

A. Provide a PLC configuration and application development software package complete with documentation and disks. The PLC software package and associated licensing and/or activation shall be installed on the computers shown on the drawings.

B. The software package shall allow on-line/off-line program development, annotation, monitoring, debugging, uploading, and downloading of programs to the PLCs.

C. All required hardware (including cables, cable adapters, etc.) for connection to PLCs shall be furnished.

D. All software licenses required to achieve the functionality described in the Specifications shall be provided.

E. The software package shall include a software license agreement allowing the Owner the right to use the software as required for any current or future modification, documentation, or development of the PLCs furnished for this project.

F. The software provided shall be capable of the following IEC 61131-3 functions:

1. Ladder logic.

2. Function block.

3. Sequential function chart.

4. Structure text.

G. In addition to the above editors, an add-on instruction editor shall work with any of the above-mentioned editors to create custom reusable function blocks. This software shall allow any of the derived function blocks to be modified on-line.

H. The software shall be Microsoft Windows-based and run on the supplied computers.

I. The software shall include a security feature to prevent unauthorized personnel from modifying and downloading the programs.

J. Provide an I/O simulator which allows the PLC application load program to be tested on a PC with simulated analog and digital inputs and outputs, allowing I/O testing and debugging to be performed in a safe, isolated environment without the need for running the PLC CPU and process I/O boards.

2.09 OPERATOR INTERFACE TERMINALS (OIT) and WORKSTATION TERMINALS

A. OITs shall be mounted on control panels, refer to Section 17431 Operator Interface Specification.

B. Operator Workstation Terminals shall be desk mounted with 1500watt UPS backup, refer to Section 17431 Operator Interface Specification.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Maintain area free of dirt and dust during and after installation of programmable controller products.

B. Anchor PLCs within enclosures as recommended by the PLC manufacturer.

C. Ventilation slots shall not be blocked, or obstructed by any means.

D. Examine areas, surfaces, and substrates to receive PLCs for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Install in accordance with manufacturer's instructions.

F. Unload, unpack and transport equipment to prevent damage or loss.

G. Replace damaged components as directed by Engineer.

3.02 PANEL LAYOUT

A. Coordinate size and configuration of enclosure to meet project requirements. Drawings indicate maximum dimensions for PLCs, minimum clearances between PLCs, and adjacent surfaces and other items.

B. Comply with indicated maximum dimensions and clearances, or with PLC vendors required distances if they are greater than the distances indicated.

1. Provide spacing around PLC as required by the PLC manufacturer to insure adequate cooling. Insure that the air surrounding the PLC has been conditioned to maintain the required temperature and humidity range.

2. Wires entering and exiting PLC components shall be sized to comply with the PLC manufacturers requirements. Doors on all components shall be able to be fully closed when all the wires are installed.

3. For chassis mounted PLCs, no wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack.

4. PLC lights, keys, communication ports, and memory card slots shall be accessible at all times. Lights shall be visible at all times when enclosure door is opened.

C. Control panel designer shall provide independent line fuses or circuit breakers, per the PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements.

D. Control panel designer shall insure that communication signals, 4-20mA signals (including those with embedded HART), are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics.

E. Each PLC (including all I/O) shall be powered from the UPS power conditioning system in Section 17430.

F. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single module will not disable all mechanical components associated with the process redundancy (e.g., inputs and outputs for redundancy device 1 shall reside on different modules than the inputs and outputs for redundancy device 2, etc.), irrespective of the number of used points resulting from this configuration.

G. Provide all required cables, cords, and connective devices for interface with other control system components.

END OF SECTION

17350- HAZARDOUS GAS MONITORING SYSTEM

PART ONE – GENERAL

1.01 THE REQUIREMENT

A. Basis of design is MSA Ultima XE series.

B. A hazardous gas monitoring system shall be an FM or UL approved system and shall measure and display gas concentration and provide local and remote alarms when preset limits are exceeded in an area. It shall consist of: gas controllers, combustible gas modules (sensors and transmitters) to detect methane gas, toxic gas modules (sensors and transmitters) to detect hydrogen sulfide (H2S), oxygen depletion (O2), carbon monoxide (CO), sulfur dioxide (SO2), chlorine (Cl2), ammonia (NH3), and sensor extension kits (where shown).

C. System shall communicate to SCADA via 4-20mA analog signal.

D. Sensor/transmitter shall have LED's viewable from 50 feet.

E. Sensor/transmitter shall have three alarm levels and one fault relay rated 220VAC, 5 amps.

F. Provide calibration unit and controller.

G. Provide optional wall mounted outdoor visual warning signals at two doors entering the truck bay, three doors entering the bar screen area, one door at the grit pump entry.

1.02 HAZARDOUS GAS MONITORING SYSTEM - GAS DETECTION SYSTEM CONTROLLER

A. Functional Requirements:

1. FM or UL Approval
2. Display: Backlit LCD screen rated NEMA 4X.
3. Indicator Lights: High intensity LED lights for Safe, Warning, Alarm.
4. Trouble LED for controller with diagnostics.
5. Outputs:
    a. 4-20 mA DC retransmission
    b. Discrete outputs:
    c. Programmable SPDT relay contacts (NO and NC) rated minimum 6 amps (optional 10 amp) at 120 VAC for common warning, common alarm, and common fault.
6. Calibration: Software driven calibration requiring no mechanical adjustments at the modules.

B. Enclosure: NEMA 4X wall mount

C. Power:

1. Loop feed on sensors and 24 VDC for pump.
2. Channel power: 24 VDC
3. Monitor Power: Provides loop power to gas measurement instruments monitored by the controller.

D. Battery Backup Capability: If required, it shall be capable of seamless power transfer and

up to 24 hour duration.

1.03 HAZARDOUS GAS MONITORING SYSTEM – DETECTION MODULES

A. Methane Gas Module:

1. Sensor Type: Catalytic Bead.
2. Sensor Mounting: Remote from transmitter up to 50 feet.
3. Module Enclosure: Epoxy coated aluminum, NEMA 7/4X or stainless steel as required.
4. Range: 0-100 percent lower explosive limit (LEL).
5. Repeatability: Plus or minus 1 percent full scale.
6. Temperature Range: Minus 40 to 176 degrees F.
7. Response Time: Less than 12 seconds to read 60 percent of step change.
8. Drift: Plus or minus 5 percent of full scale per year.
9. Integral Display: Fixed and scrolling LED with gas reading in %LEL.
10. Standard Analog/Digital Outputs: 4-20 mA DC.
11. Non-intrusive Calibration: Module shall be capable of being calibrated without the need to open the enclosure.
12. Power: 24 VDC nominal. 10 – 30 VDC.
13. Power Consumption: Maximum 2 W.
14. Connection type: 3-wire.
15. FM Standard 3600: Class 1, Div. 1, Groups B, C, & D.
16. FM Standard 6320: Combustible Gas Detection Performance – allows 6 month calibration interval.
17. Sensor Life: Typically greater than 2 years.
18. Warranty: 2 years
19. Rain Shield/Dust Shield: to protect sensor from splashing liquids and hose down and debris.

B. Hydrogen Sulfide (H2S) Gas Module:

1. Sensor Type: Electrochemical.
2. Sensor Mounting: Remote from transmitter up to 15 feet.
3. Module Enclosure: Epoxy coated aluminum, NEMA 7/4X or stainless steel as required.
4. Range: 0-100 ppm.
5. Repeatability: Plus or minus 2 percent full scale.
6. Temperature Range: Minus 4 to 122 degrees F.
7. Response Time: Less than 100 seconds to read 90 percent of step change.
8. Drift: Less than 2 percent of full scale per month.
9. Integral Display: Fixed and scrolling LED with gas reading in engineering units
10. Standard Analog/Digital Outputs: 4-20 mA DC.
11. Non-intrusive Calibration: Module shall be capable of being calibrated without the need to open the enclosure.
12. Power: 24 VDC nominal. 10 – 30 VDC.

13. Connection type: 3-wire.
14. FM Standard 3600: Class 1, Div. 1, Groups B, C, & D.
15. FM Standard Gas Detection Performance – allows 6 month calibration interval.
16. Sensor Life: Typically greater than 2 years.
17. Warranty: 2 years
18. Rain Shield/Dust Shield: to protect sensor from splashing liquids and hose down and debris.

C. Oxygen Depletion (O2) Gas Module:
1. Sensor Type: Electrochemical.
2. Sensor Mounting: Integral.
3. Module Enclosure: Epoxy coated aluminum, NEMA 7/4X or stainless steel as required.
4. Range: 5 – 25 percent by volume.
5. Repeatability: Plus or minus 2 percent full scale.
6. Temperature Range: Minus 4 to 122 degrees F.
7. Response Time: Less than 100 seconds to read 90 percent of step change.
8. Drift: Less than 2 percent of full scale per month.
9. Integral Display: Fixed and scrolling LED with gas reading in engineering units
10. Standard Analog/Digital Outputs: 4-20 mA DC.
11. Auxiliary Connections: To allow daisy-chaining modules.
12. Non-intrusive Calibration: Module shall be capable of being calibrated without the need to open the enclosure.
13. Power: 24 VDC nominal. 10 – 30 VDC.
14. Connection type: 3-wire.
15. FM Standard 3600: Class 1, Div. 1, Groups B, C, & D.
16. FM Standard Gas Detection Performance – allows 6 month calibration interval.
17. Sensor Life: Typical up to 2 years.
18. Warranty: 2 years
19. Rain Shield/Dust Shield: to protect sensor from splashing liquids and hose down and debris.

D. Calibration Equipment:
1. Calibrator: The calibrator shall provide a quick and convenient method of checking the response of the gas monitoring system. The calibrator shall be a non-intrusive hand held unit. When local calibration cannot be achieved due to inaccessibility of a sensor, remote calibration equipment (1/4" tubing running down from the module display to the sensor, remote adapter, etc.) shall be furnished and installed.

END OF SECTION

SECTION 17410 - BASIC MEASUREMENT AND CONTROL INSTRUMENTATION MATERIALS AND METHODS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish all materials, labor, tools, equipment, supplies and services necessary to install all process control and instrumentation equipment complete as specified herein and shown on the Drawings. The Contractor shall be responsible for the expense of changing Drawings or structures, or any other expense necessitated by reason of installing alternative equipment. The Contractor will assume the responsibility for the satisfactory operation of any and all equipment offered.

B. The following equipment specification is included to establish the quality of equipment to be obtained. It is the intent of these Specifications to obtain industrial quality instrumentation and control equipment. Equipment furnished shall be accepted by the Engineer, prior to purchase by the Contractor.

C. Auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with equipment provided under other Sections of this Specification, shall be included whether specified or not, at no extra cost.

D. In order to ensure proper integration and compatibility of the plant instrumentation and control systems, the systems must be supplied by a single provider of instrumentation and control equipment. This is not to say that all equipment being supplied shall be manufactured by a single manufacturer, but rather that a single provider of instrumentation and control equipment shall be responsible for supplying the complete system. To facilitate the Owner's future operation and maintenance, products performing the same function shall all be of the same manufacturer, type, and model number.

E. Substitutions on functions or equipment specified will not be acceptable. In order to ensure the interchangeability of parts, the maintenance of quality, the ease of interfacing between the various subsystems, and the establishment of minimums with regard to ranges and accuracy, strict compliance with the above requirements shall be maintained. In order to ensure compatibility between all equipment, it shall be the responsibility of the system supplier hereunder to coordinate all interface requirements with mechanical and electrical system suppliers and furnish any signal isolation devices that might be required.

F. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer as accepted by the Engineer.

G. The instrument supplier for this Contract shall be responsible for making the modifications shown on the Drawings and for recalibrating all instruments and placing them in proper working order.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 – PLC Hardware and Software
Section 17420 - Instruments
Section 17430 - Boxes, Panels and Control Centers
Section 17480 - Instrument Lists and Reports

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

1.03 QUALITY ASSURANCE

A. The system supplier shall be required to demonstrate a minimum of 4 years recent, past experience in the design, manufacture, and commissioning of instrumentation and control systems of comparable size, type, and complexity to the proposed project. Further, the manufacturer must have at least 10 similar systems in operation currently. The system supplier shall be required to have his own in-house capability to handle complete system engineering, fabrication, and testing.

B. The system supplier shall have in his employ the capable personnel for detail engineering, coordination, drafting, procurement and expediting, scheduling construction, testing inspection, installation, start-up service for calibration and commissioning, and warranty compliance for the period specified.

1.04 REFERENCES

A. The Contractor is referred to Standards and Practices for Instrumentation published by the International Society of Automation (latest edition), for terminology, symbols, methods and practices used or described herein or on the Drawings.

1.05 SUBMITTALS

A. General

1. Complete detail Drawings of the instrumentation and control systems and all components shall be submitted in 3 copies in a 3-ring loose-leaf cardboard reinforced vinyl binder to the Engineer for preliminary review. They shall include installation instructions, operation and maintenance instructions, descriptive literature, connection drawings, and parts list for each item as well as individual control schematic drawings for each item.

2. The Contractor shall make any corrections or changes required by the Engineer, within the scope of the Drawings and Specifications, and return copies in 3-ring loose-leaf cardboard reinforced vinyl binders for final review and distribution. Number of copies shall be as specified in Special conditions and as agreed at the pre-construction conference.

3. Should any system submitted in the shop drawings not meet with the Engineer's acceptance as to conformity with requirements of the Drawings and Specifications, it shall be the responsibility of the successful Contractor to make whatever changes are necessary for acceptance at no extra cost to the Owner.

B. Detailed Requirements - Instruments/Hardware

1. Detailed information for each instrument or control device shall be submitted, including manufacturer's descriptive literature and a specific data sheet for each device which shall include as a minimum:

a. Tag number assigned by the Contract Documents.

b. Product (item) name used herein and on the Contract Drawings.

c. Manufacturer's complete model number.

d. Location of the device.

e. Input - output characteristics.

f. Electrical characteristics.

g. Range, size, and graduations.

h. Physical size with dimensions, enclosure NEMA classification, and mounting details.

i. Materials of construction of all components.

j. Instrument or control device sizing calculations where applicable.

k. Certified calibration data on all flow metering devices.

2. Submit a detailed loop diagram, for each monitoring or control loop, each on a single 8 ½ in. x 11 in. sheet. The format shall be the Instrument Society of America, Standard for Instrument Loop Diagrams, ISA-S5.4.

3. The data sheets shall be provided with an index and proper identification and cross-referencing. Partial submittals will be rejected.

4. Submit detailed drawings concerning control panels and/or enclosures including:

   a. Cabinet assembly and layout drawings to scale.

   b. Fabrication and painting specifications.

   c. I/O layout.

   d. Elementary panel wiring diagrams

   e. Point to point wiring diagrams depicting wiring within the panel as well as connections to external devices.

   f. Color samples for paint selection by the Engineer and/or Owner.

   g. Panel submittal drawings shall be on 11 in x 17 in. sheets.

5. Exceptions to the Specifications or Drawings shall be clearly indicated in the submittal by the system supplier. Data shall contain sufficient details so a proper evaluation may be made by the Engineer.

6. Prior to final acceptance, the final shop drawing submittal, which is to include Installation, Operation, and Maintenance instructions, shall be updated to reflect "As Constructed" status, and shall provide at least the following as a minimum:

   a. A comprehensive index.

   b. A complete "As Constructed" set of accepted shop drawings.

   c. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

   d. Full specifications on each item.

e. System schematic drawings “As Constructed”, illustrating all components, piping and electrical connections of the systems supplied under this Section.

f. Detailed service, maintenance, and operation instructions for each item supplied.

g. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

h. The operating instructions shall also incorporate a functional description of the entire system, with reference to the systems schematic drawings and instructions.

i. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping Precautions:

1. After completion of shop assembly, factory test, and acceptance, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

2. Special instructions for proper field handling, storage and installation required by manufacturer for proper protection, shall be securely attached to each piece of equipment proper to packaging and shipment.

B. Identification:

1. Each component shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on the outside of the package.

2. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment supplied under this Section.

C. Storage:

1. Equipment shall not be stored out-of-doors. Equipment shall be stored in dry permanent shelters including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor at his own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such tests as directed by the Engineer. This shall be at the cost and expense of the Contractor, or the apparatus shall be replaced by the Contractor at his own expense.

1.07 WARRANTY (MAINTENANCE CONTRACT)

A. A written total instrument maintenance contract shall be provided to the Owner, executed by the system supplier as a part of the work under this Section. The maintenance contract shall include all labor, parts, and emergency calls providing on-site response within 48 hours, to provide complete instrument system maintenance for a period of one year after the date of final acceptance of the system. The maintenance contract shall also include a minimum of 2 semi-annual preventive maintenance visits by a qualified serviceman of the supplier who is familiar

with the type of equipment provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of all system equipment and verification of correct operations. Emergency maintenance procedures or plant visits may coincide with a scheduled preventive maintenance visit, however, they shall not replace the work intended to be performed during a preventive maintenance visit. The system supplier shall have full responsibility for the preventive and corrective maintenance including replacing of defective components, maintaining sufficient spare parts on-site, and complete calibration of all components under this section, all at no cost to the Owner. The maintenance contract shall not begin until both the instrumentation training course and the system acceptance test have been successfully completed, at which time the Owner shall be capable of performing necessary preventive maintenance, and all instruments shall be functional.

B. During the one-year maintenance period, observation of maintenance operations by designated Owner personnel, and the instruction of said personnel in the details of the maintenance work being performed shall be provided.

C. A complete written report shall be furnished the Engineer and Owner after each scheduled and unscheduled visit, giving problems corrected, systems needing recalibration, and recommendations to prevent recurrence, if applicable.

D. The costs for the one-year maintenance service contract shall be included in the Contract price.

1.08 TRAINING

A. A training program shall be set up and conducted by the major equipment manufacturer furnishing the instrumentation package. The training under this section is included in the thirty-two (32) hours of training required by Section 17311.

B. A course outline showing the material to be covered shall be submitted to the Engineer for review. The training program shall include both classroom and “hands-on” instruction for each instrument supplied under this group of the Specifications and shall furthermore include operational training, maintenance training, and training on use of calibration equipment.

C. As the equipment installed at the plant shall be used for the “hands-on” training, the training program shall not be conducted until all of the systems are operational, and operational related “punch list” items are corrected.

D. Training on equipment supplied by a manufacturer other than the major equipment manufacturer shall be by the original equipment manufacturer, and shall be scheduled in the training programs by the major equipment manufacturer. Exceptions may be granted if the instructor demonstrates adequate knowledge on the care and operation of the other manufacturers’ equipment.

E. The training programs shall be conducted at a time mutually agreeable to the Engineer, Owner, Contractor, and Supplier. The Owner shall decide how many of his personnel shall attend the training. A representative of the Engineer may observe the training in progress. The Owner shall have the right to videotape all training as it is conducted.

F. The supplier shall make use of audio-visual aids in the training courses and shall provide the Owner’s staff his undivided attention (i.e., shall not conduct his company business during training hours) for the full 1 day. The supplier shall furnish training participants with written handouts, preferably copies of the shop drawing submittal books, up to a maximum of 6 copies, for purposes of familiarization with the shop drawings, and to assist in explanations.

PART 2 - PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals which are established standards for the water industry.

B. All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mAdc (milliampere direct current), however, signals between instruments within the same panel or cabinet may be 0-10 V.d-c (volts direct current), or other manufacturer standard.

C. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed for remote transmission.

D. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

E. All indicators and LED readouts shall be linear, direct reading in process units, unless otherwise noted. Percentage scales and indicators are prohibited.

F. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent, unless otherwise noted.

G. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 95 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

H. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, in-so-far as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

I. All equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 115 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

J. All analog transmitter and controller outputs shall be 4-20 milliamperes into a load of 0-750 ohms, unless higher load capacity is required.

K. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless specifically noted otherwise.

L. Materials and equipment used shall be UL listed (or other independent lab listed) wherever such listed equipment and materials are available.

M. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

N. All circuit boards in instruments mounted in damp locations or mounted outdoors shall be fungus proofed. All field transmitters mounted outside shall be equipped with sunshields and shall be capable of operation to -20^{o} Fahrenheit.

O. Equipment installed in a hazardous area shall meet Class, Group and Division as shown on the contract drawings, to comply with the National Electrical Code. All power supply and signals coming from and going to hazardous areas shall have intrinsic safety barriers provided.

2.02 INSTRUMENTS AND ACCESSORY EQUIPMENT

A. Refer to other Division 17 Instrumentation Specification Sections for equipment requirements for field mounted primary devices, transmitters and secondary instruments, receivers and central control equipment.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 17420 - INSTRUMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish and install all primary devices, transmitters, primary and secondary receivers, analyzers and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 - PLC Hardware and Software
Section 17410 - Basic Measurement and Control Instrumentation Materials and Methods
Section 17430 - Boxes, Panels and Control Centers
Section 17480 - Instrument Lists and Reports
Section 17490 - Measurement and Control Commissioning

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

PART 2 - PRODUCTS

2.01 INSTRUMENTS AND ACCESSORY EQUIPMENT

A. Product Descriptions

1. Loop Isolator/Signal Converter:

a. Loop isolators or signal converters shall be furnished and installed where indicated, to isolate signals or to increase the load capacity of a system required to have many devices in the loop. Isolators shall provide 3-way isolation, and shall have a power supply voltage of 115 VAC unless otherwise indicated. 2 wire style isolators are not acceptable. Isolators shall be Moore SCT, AGM, RIS, or equal, enclosed as appropriate for the application, or as indicated.

2. Computing Relays/Integrators:

a. Computing relays or integrators for such purposes as batching, summing, totalization, etc., shall be Moore Industries, AGM, RIS, or equal.

3. Transient/Lightning Suppressors:

a. Device Locations: As a minimum, provide surge protection devices at the following locations:

1) At any connections between ac power and electrical and electronic equipment,

including panels, assemblies, and field mounted analog transmitters.

2) At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.

3) At both ends of all copper-based communications cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.

4) On all external telephone communications lines.

b. Surge protection device assemblies for connections to AC power supply circuits shall:

1) Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.

2) Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.

3) Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events, and shall have status indication lights.

4) Comply with all requirements of UL 1449, Latest edition.

5) Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.

6) Have the following characteristics:

a) Maximum Continuous Operating Voltage: 150VAC
b) Maximum Operating Current: 20 amps
c) Ambient Temperature Range: -20 degrees C to +65 degrees C
d) Response Time: 5 nanoseconds

c. Surge protection device assemblies for analog signal circuits shall:

1) Have four lead devices with a threaded mounting/grounding stud or DIN Rail mounting.

2) Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.

3) Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.

4) Comply with all requirements of UL 497B.

5) Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.

6) Limit line-to-line voltage to 40 volts on 24VDC circuits.

7) Have the following characteristics:

a) Maximum Continuous Operating Voltage: 28VDC
b) Ambient Temperature Range: -20 degrees C to +65 degrees C
c) Response Time (Line-to-Line): 5 ns

d. Acceptable manufacturers shall be Phoenix Contact, Weidmuller, Transtector, or equal.

4. Altitude and Pressure Gauges:

a. All indicating gauges are pipe mounted with male and brass threaded pipe connections. Gauges shall be 4 1/2 inch liquid filled for maximum vibration and corrosion protection. Gauges shall have phosphor bronze Bourdon tubes, white laminated phenol dials. Gauges shall have micrometer adjustment of pointers and black phenol, black cast iron, brass, or aluminum case and ring, original rotary gear design, corrosion resistant, stainless steel movement, blowout protection, and bronze socket with wrench flats. Accuracy shall be within 1/2 of 1 percent of the scale range. They shall be as manufactured by Helicoid Gage Division, “410"; Ashcroft; U.S. Gauge; Wika; or equal.

b. All gauges shall be piped with provisions for venting pressure to allow calibration (zero) checks. Valves for gauge shutoff and zeroing shall be 1/4 turn ball valves with lever handle, corrosion-resistant.

c. Liquid filled diaphragm seals shall be installed on all gauges as indicated in the Gauge Schedule in Section 17480 of the Specifications. Diaphragm seals shall be of the continuous duty type, 3 piece construction with 1/4 inch flushing connection, 1/4 inch fill connection, 316 stainless steel lower housing and diaphragm material 1/4 inch gauge connection and 1/2 inch lower connection. Housing bolts shall also be stainless steel. Acceptable models are Marsh 42-01, Helicoid 100H, Ashcroft, or equal. Viton diaphragms are required on low range pressure applications (less than 15 psig). To prevent accidental loss of fluid, diaphragm seals shall be permanently attached to gauges by installation of a lead sealed wire connecting the two. Fill fluid shall be factory installed silicone. All gauges shall be pre-calibrated, as an assembly, with the seal.

5. Magnetic Flowmeter

a. Meter sizes larger than 4 inch shall be obstructionless, short form, characterized coil design, and the output signal produced shall be directly proportional to the liquid flow rate. The metering tube shall be steel with 150 pound ANSI flanged end connections. Liner shall be polyurethane or rubber. The electrodes shall be bullet nosed 316 stainless steel or Hastelloy C, and shall be field replaceable. The coils which generate the field shall be inside the pipe wall and shall be encapsulated in epoxy plastic and encased within the flow meter lining material. Laying length shall not exceed 1 ½ times the meter size. The meter shall have complete zero stability.

b. The temperature of the process will not exceed 135 degrees Fahrenheit. The meter primary shall be suitable for submersion in 33 ft. of water for 48 hours.

c. The signal converter (transmitter) shall be designed for use in connection with the magnetic flowmeter primary devices supplied and shall receive its signal from the primary device and convert it to a corresponding pulse and current signal. A linear output meter and 8 digit non-reset register shall be provided on the converter. Indication, totalization and output signal shall be for either forward or reverse flow, with flow direction indicated by contact closure. Signal converter shall be powered by 120 VAC, single phase.

d. The meter shall provide a constant zero output during conditions of false flow signals are possible. An empty pipe detection feature shall drive the output signals to zero or 130% of range when electrodes become uncovered.

e. The signal converter shall have a NEMA 4X enclosure. The enclosure shall have a gasketed cover with window for reading the horizontal output meter and 8 digit non-reset flow register. The converter shall have solid state, printed circuit construction with a continuously adjustable range from 0-3 to 0-30 ft./sec., requiring no zero adjustment. The transmitter shall utilize a pulsed DC technique to drive the flux producing coils of the primary, converting the low level, high impedance pulsed DC signal to a 4-20 mADC current output directly proportional to flow rate. Where indicated, provide RS-232 or RS-484 serial interface connection. The output shall be provided with HART™ digital communications, which provides a digital process variable superimposed on the 4-20 mADC signal, with protocol based on Bell 202 FSK standard.

f. Liner voltage and frequency variations of 10% shall have no effect on instrument calibration.

g. The scaled pulse output signal shall be inhibited when the flow rate is 2 percent or less of the maximum flow setting.

h. The accuracy, including the primary, shall be <0.25% ofr rate or <5% of full scale for a span setting of 0.53-30 ft/sec.

i. All magnetic flow meters shall be provided with type 316 stainless steel grounding rings. All interconnecting signal cable between the magnetic flowmeter and signal converter shall be provided by the meter manufacturer and be of sufficient length as required for the installation shown on the Drawings. Provide all special cable terminations/fittings to replace the meter body should removal be necessary.

j. The flowtube shall be suitable for use in Class I, Division 2, Group D hazardous locations, unless otherwise noted on drawings.

k. The flowmeter shall be 3000 or 3000G, COPA-X series as manufactured by ABB, or equal.

6. Submersible Pressure Transducer

a. The submersible pressure transducer shall be a continuous level measuring device that converts the measured pressure to a level reading and provides a continuous 4-20 mADC output.

b. The sensor shall be constructed of titanium and shall be suitable for installation in a well, tank, pipe, etc. Wetted materials shall be suitable for installation in nearly all fluids, including wastewater. The sensor cable shall contain a vent tube to reference the measured pressure to atmosphere.

c. The cable shall be constructed of tefzel, and shall be integrally connected at the sensor with internal potting to prevent ingress of fluid back into the transmitter. Length of the cable shall be as required for the installation shown.

d. The sensor shall contain an internal lightning arrestor and voltage spike protection.

e. Operating temperature range shall be -4 to 140° F. The sensor shall be furnished and calibrated for the operating pressures encountered for the application, and the sensor shall be capable of four times the rated pressure without damage to the sensor.

f. The sensor/cable assembly shall be rated NEMA 4X, NEMA 6P, and NEMA 7 for Class

I, Division 1 hazardous locations.

g. The submersible pressure transmitter shall be Druck PTX 1835 series, or equal.

7. Eccentric Weight Float Type Level Sensors

a. The level monitor shall be the integral eccentric weight non-mercury float switch type, Flygt Model ENM-10, or approved equal.

8. Parshall Flume Liner

a. The primary element shall be a fiberglass reinforced polyester Parshall flume liner, with 2 inch flanges on the ends and top or other size are required by the manufacturer for the flume size and installation conditions shown and heavy angle bracing across the top flanges, completely self-supporting. A head gage shall be molded into the side of the flume opposite the probe mounting, so as to retain a smooth surface on the sidewall, engraved in inches and fractions thereof. Throat size shall be as shown on the loop diagram or as otherwise scheduled.

b. Materials: Fiberglass reinforced polyester

1) Tensile strength (ASTM D 638): 14,000 psi

2) Flexural strength (ASTM D 790): 25,000 psi

3) Flexural modulus (ASTM D 790): 0.90 x 106 psi

4) Barcol hardness (resin-rich surface) (ASTM D 2583): 30, minimum

5) Chemical resistance: Comply with ANSI/AWWA F101, Type II classification.

c. Construction: full length, molded fiberglass reinforced polyester laminated in one piece.

1) For flumes to be embedded in concrete, provide temporary internal bracing.

2) Flume Size(s): As indicated on the Drawings and/or schedule.

3) The interior surface of the flume shall have a 10 to 15 mil white gelcoat backed by a resin-rich layer of resin and chopped glass forming a water and chemical resistant surface. The remainder of the laminate shall be fiberglass reinforced polyester containing not less than 30% glass content by weight.

4) The thickness of the walls and floor shall be ¼-inch minimum.

5) Flumes shall be reinforced with box section stiffeners down the sides and across the bottom for flumes with a throat size 3 inches or greater. Stiffeners shall be joined together at the knee to form a rigid dimensionally stable flume.

6) Provide inlet and/or outlet adapter to provide transition between a pipe and the flume.

7) Provide inlet and/or outlet bulkheads or wingwalls to transition flow between the flume and channel.

8) Provide locking clips that shall be fastened along the side of the flume and shall be used for anchorage into the concrete. Locking clips shall be so designed to be an integral part of the liner and of sufficient number to insure permanent alignment.

Temporary bracing shall be provided to assure maintenance of dimensions during shipment and installation.

9) Flume dimensions shall be within ± 1/16th inch for flumes 12-inch and smaller, ± 3/32nd inch in the throat and ± 1/8th inch elsewhere for flumes 18-inch to 24-inch, and ± 1/8th inch in the throat and ± 1/4th inch elsewhere for flumes 30-inch to 60-inch.

d. Furnish a curve of head in inches and fractions thereof versus flow through the flume, which shall be used to verify calibration and to make manual flow measurements.

e. Provide stainless steel or FRP level sensor mounting bracket for upstream side of flume at the proper distance from the throat for accurate level measurement.

f. Parshall flume shall be installed in accordance with manufacturer's published instructions. Minimum requirements shall be as listed hereinafter:

1) Ensure that the Parshall flume is installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer and as indicated in the Contract documents.

2) Set flume at proper elevation in accordance with the Drawings.

3) Flume shall be installed level end-to-end and side-to-side by using a level on the floor.

4) Fasten flume securely to prevent flotation or twisting during placement of concrete.

5) Place concrete along sides and bottom of flume to ensure complete filling without voids and displacement of flume. Stage placement in alternating lifts; 1/3 of the height on each side of flume.

6) Flumes with bolt on adapters, caulking collars or transition sections shall be sealed between joints. At a minimum, apply one or two continuous bead(s) of silicone on all seating surfaces between flanged joints before bolting together.

7) The inlet of the flume shall be set at the same elevation or higher elevation than the inlet pipe or channel. The inlet pipe or channel shall never be set higher than the inlet floor of the flume.

8) Level sensor for Parshall fume shall be programmed with the correct formulas to convert level measurement to flow rate and configured to output flow signal in mgd.

g. Liners shall be as manufactured by Plasti-Fab, Warminster Fiberglass, TraCom, or equal.

10. Pump Controller

a. Description: Microprocessor based, intelligent pump controller with built-in pump control logic, liquid level sensing inputs and pump fault inputs. The controller shall be specifically configured for VFD control as indicated in this specification. The Pump Control Equipment shall be Multitrode Model MT2PC-VFD or devices of equal functionality and operation.

b. VFD Functions: The pump controller shall have the following functions for VFD control:

1) VFD Equalization: The pump control unit shall be capable of regulating the speed of individual pumps and fine tune the transition stage of hydraulic flow when more than one pump is running. A single 4-20ma analog output from the pump controller

shall be used to control multiple VFD drives. As multiple pumps are activated, the analog output signal shall be recalculated so that the net flow through the discharge piping is averaged over the activated pumps and the controlling signal shall be adjusted such that all of the pumps are running at the same speed to produce the required flow.

2) VFD Equalization Programming: The VFD pump control unit shall be programmed with the following pump settings:

a) Start and Stop level %

b) Start Speed %

c) Maximum speed level %. (20ma point)

3) VFD Advanced Modes: The VFD pump control unit shall be programmed with the following advanced modes of operation:

a) Multi-Pump Mode – Allows control of up to nine VFD drives when the pump control is networked with two other VFD controllers.

b) Mimic Mode – The analog output shall be the same across any networked controllers.

c) Multi-Well Mode – Up to three wells shall be able to be controlled as follows:

(1) The VFD algorithm will run on each controller in the network (3 maximum).

(2) The networked arrangement shall allow VFD's in each well to be properly cycled across the wells.

(3) Each VFD pump controller will generate its own output signal to the VFD drives associated with its own well according to the level in that particular well.

c. Communication and Interface:

1) A user-friendly interface shall be provided via the front keypad to access and display all programming functions without the need for an external programming device.

2) The pump controller firmware shall be programmable and upgradeable with a laptop computer using a built-in RJ-45 communications port.

3) The built-in RJ-45 communications port shall be capable of receiving data connection from a dial-up modem for remote status reporting, changing of control settings and display of pump information on a remote computer using control and monitoring software.

d. Indication Characteristics: An LED based front panel/keypad shall display the following information:

1) Pump status for each pump including:

a) Pump running

b) Pump is in the HAND position

c) Pump is in the OFF position.

d) Pump is in the AUTOMATIC position

e) Pump is available to run

f) Pump fault (Auto Reset)

g) Pump lockout (Manual Reset)

h) Motor overtemp (thermal) fault

i) Motor seal failure fault

2) Two (2) liquid level alarm indicators

3) Pump alternation active indicator

4) Alternation sequence indicator

5) Current liquid level

e. Level Sensing: The control unit shall be capable of accepting a level input signal from the following sources:

1) Multi-stage conductive sensor probe compatible with the pump control equipment.

2) Analog input signal from a 4-20ma level sensing device. When an analog 4-20ma signal is used for primary level measurement, the control unit shall have the ability to toggle between input sources (switch to a multi-stage probe) in the event that the primary analog input fails. This toggle function shall be automatic.

f. Pump Alternation: The control unit shall have the ability to automatically alternate between pump activation outputs or select a fixed lead-lag pattern according to user requirements. The unit shall be field programmable to allocate pumps into separate groups and thereby select alternation patterns between groups of pumps. The unit shall capable of setting any group of pumps to alternate automatically or operate in a fixed lead arrangement. The control unit shall also be capable of alternating some or all of the pumps.

g. Time Delay Functions: The control unit shall provide the following time delay functions for pump activation and deactivation:

1) Pump Start and Stop: The control unit shall provide programmable pump activation and deactivation delays that are selectable from the front keypad.

2) Inter Pump Delays: A programmable inter pump time delay shall be provided for non-coincidental starting or stopping of pumps which shall provide a smooth transition of pump activation and deactivation without harmful cycling.

3) Maximum Pump Off Time: The control unit shall be capable of automatically activating a pump if a programmable maximum pump off time is reached. This function shall allow pumps to be exercised when required. If a pump is activated using the maximum pump off time function, then the pump shall run only if there is sufficient liquid level to allow for pump activation. When the liquid level reaches the “off” point of the pump, the pump shall be deactivated.

4) Maximum Pump On Time: The control unit shall be capable of deactivating a pump after a specified time interval of continuous pump operation and thereby force the running cycle to sequence between other pumps. This function shall induce alternation where there has not been sufficient liquid level change to alternate pumps

regularly.

h. Fault Monitoring: The control unit display panel shall have features which clearly identify faults and clearly indicate the status of conditions, such as lockouts and level alarms. The control unit shall provide the following user configurable fault monitoring capability:

1) Critical Faults: A fault condition that locks out a pump and prevents the pump from operating until the fault is cleared and the fault is manually reset on the control unit keypad.

2) Non-Critical Faults: A fault condition that will temporarily disable a pump until the fault condition is cleared.

3) Pump Seal Failure Detection: Adjustable pump seal detection shall be provided to indicate a pump inner seal failure and disable a pump when a seal fault is present.The seal fault function shall be user selectable to assign a seal leakage condition to a display only fault, critical (lockout) fault or non-critical (auto reset) fault.

4) Motor Overtemp Fault: Adjustable pump thermal detection shall be provided to indicate a motor over temperature (thermal) condition and disable a pump when the thermal condition is present. The motor overtemp function shall be user selectable to assign a motor overtemp (thermal) condition to a display only fault, critical (lockout) fault or non-critical (auto reset) fault.

i. Programming Features: The control unit shall have the following additional features and functions:

1) Pump Start/Stop Setpoints: The pump activation and deactivation points for each pump shall be user selectable from the front keypad of the control unit.

2) Pump Alternation: All lead select and pump alternation settings shall be programmable from the front keypad of the control unit.

3) Fail Safe Hand Override: If a pump is set to the HAND mode on the control unit, the unit shall activate the designated pump and allow the pump to run only until the off setpoint of the pump is reached. This function prevents a pump from running if there is no liquid level present in the tank or sump.

4) Lead Pump Lockout: The pump control unit shall be capable of recording the amount of lag pump starts and stops while the lead pump continues to run. If the programmed number of lag starts is exceeded while the lead pump is running, the control unit shall be able to lockout the lead pump for occurrences of impeller wear or pump blockage.

5) Maximum Starts per Hour: The pump control unit shall be capable of programming the number of pump starts per hour on any pump.

6) Maximum Pumps Running: The pump control unit shall be capable of programming the maximum number of pumps to run simultaneously.

7) Mounting and Wiring: The control unit shall have the ability to be DIN rail mounted or panel mounted. The front keypad display of the control unit shall be capable of being remotely mounted or attached directly to the control housing. For ease of removal, wiring terminations at the control unit shall be made with plug-in terminal connectors.

8) Minimum of two (2) configurable relay alarm contacts for monitoring by SCADA system.

j. Multi-Pump Control Interfacing: The monitoring unit shall be capable of being networked with other monitoring units and pump controllers using an available RS485 connection between units. This connection shall be able to create a Local Area Network (LAN) to allow the interconnection of up to three (3) monitoring units and three (3) pump controllers. The LAN connected equipment shall be able to control and monitor up to nine (9) individual pumps and report pump status information to a telemetry system using a single two-way radio or a dial-up modem.

k. The pump controller(s) shall be the Multitrode Model MT2PC, or equal.

12. Non-Contact Radar Type

a. Where non-contact level measurement is indicated, the system shall consist of an integral sensor/transmitter assembly complete with housing, transmitter, microwave module and Wave-Guide (antenna). The radar assembly will transmit energy in the form of microwave pulses, target the microwave pulses returning to the antenna, measure the transit time of the microwave pulses and calculate the distance to the target. The radar assembly shall have the following features: remote level indicator and adjustment module for field calibration and display of process variable: 3”-10” ANSI 150# 316SS process connection with 316SS cone antenna 4-Wire Universal power supply (24VDC or 120VAC) with 4-20 mA HART output; programmable electronics shall provide linear 4-20mA output signal proportional to level or flow. The housing shall be a dual chamber aluminum style rated Class I, Division I Explosion proof.

b. Non-contact radar level measuring systems shall be Ohmart VegaPuls WL 61series and cable up to 100 feet in length depending on location. Unit shall be submersible to 2 bar.

c. Provide remote VEGADIS 82 transmitter with HART communication.

d. Provide interface connector VEGACONNECT 4 PACTware and VEGA-DTM.

13. Single Station Smoke Detectors

a. The detector shall be photo-electric type with 2.5% normal sensitivity.

b. The alarm shall utilize an infrared LED sensing circuit which pulses in 4 to 5 second intervals; when subjected to smoke the pulse rate shall increase 8 times. After 2 consecutive pulses in smoke, the detector will alarm.

c. The alarm shall provide minimum 5-to-1 signal-to-noise ratio in the optics frame to assure stability of operation in environments of high RF and transient conditions.

d. The sensing chamber shall be fully protected to prevent entrance of small insects, thus reducing the probability of false alarms.

e. A solid state piezo alarm rated at 90dBA at 10ft.

f. A visual LED monitor (condition indicator) will pulse in normal operation and will remain solid in alarm.

g. An easily accessible test knob shall be provided. The test knob in the TEST position will simulate an actual smoke condition of approximately 3.4% causing the detector to alarm within 20-36 seconds. It will also have the capability of testing to 0.85% as a required minimum. A magnetic switch closure or other switch closure, or smoke generating equipment which does not scatter the light beam or test sensitivity is not sufficient.

h. The alarm shall have a tandem interconnect capability of up to 12 units or 6 units with relay.

i. The manufacturer shall provide other compatible alarm models with the following optional features: 1) auxiliary Form A/Form C relay contacts for the initiating remote functions and annunciation; 2) relay option that is capable of activation by tandem interconnect wire. Thermal sensor shall be self-restoring.

j. Unit must be UL 217 listed for both wall and ceiling mount.

k. All equipment shall be completely factory assembled, wired and tested, and the contractor shall be prepared to submit a certified letter testifying to this condition.

l. The Photoelectric Smoke Alarm shall be a Gentex Model 7100F, or equal.

14. Temperature Switch

a. Provide a temperature switch for monitoring high temperature in the Electrical Building.

b. Switch shall be United Electric 100 Series, 0-225 degrees Fahrenheit (or approved equal), set at 120 degrees.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 17430 - BOXES, PANELS, AND CONTROL CENTERS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish and install all boxes, panels and control centers and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 – PLC Hardware and Software
Section 17410 – Basic Measurement and Control Instrumentation Materials and Methods
Section 17420 – Instruments
Section 17480 – Instrument Lists and Reports
Section 17490 – Measurement and Control Commissioning
Section 16900 – Controls

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

PART 2 - PRODUCTS

2.01 FABRICATION

A. Instrument Panels

1. Furnish and install the following instrument panels:

   a. WWS Control Panel
   b. IPS Pump Station Control Panel
   c. Recycle Pump Station Control Panel
   d. Grit System Control Panel
   e. Bar Screen/Screening Compactor Control Panel(s)
   f. Screw Conveyor Control Panel(s)
   g. Recycle Pump Station Control Panel

   The instrument panels shall be similar in design to that shown on the Drawings or as specified herein. The panels shall be of all-welded Type 316 stainless steel construction, shall be rated NEMA 4X, and shall have a continuous drip lip over the door(s). Panels shall be suitable for surface wall mounting, unless indicated as freestanding.

2. The panel shall have double doors if wider than 36”. Doors shall have a triple latch with continuous hinge with chrome plated handle and lock. The top of the panel shall be covered. Panels wider than 36” shall mount on the floor and be anchored down, similar to the way Motor Control Centers are anchored.

3. Panels shall contain an interior light with switch by the door inside, and an interior GFCI duplex receptacle. The duplex receptacle shall be powered upstream of the UPS.

4. The panels shall be sized to provide heat dissipation such that the maximum operating temperature for the lowest rated component is not exceeded with an ambient temperature of 100 deg F. Calculation shall include direct mid-summer sun exposure for exterior-mounted panels.

5. Provide thermostatically-controlled panel heater to maintain an interior panel temperature of not less than 50 degrees F with an ambient temperature of -20 deg F. Panel heater shall not be powered from the UPS.

6. All conductors running from the field to the panels shall be a single, continuous length, without splices, except at accepted junction boxes. Junction boxes shall have terminal blocks with 20 percent spares in addition to terminals for all wires including spare wires. Special care shall be exercised to carry grounding lines through such junction boxes with the least possible resistance.

7. All panel equipment shall be mounted and wired on or within the cabinet. Wiring shall comply with the latest National Electrical Code. All wiring within the panel shall be grouped together with harnesses or ducts and secured to the structure. All wiring shall be numbered in accordance with the numbering system used on the wiring/connection diagrams. Power wiring shall be routed in separate wireways from low voltage DC signal wiring. Where crossing power and low voltage DC wiring is necessary, crossing shall be at right angles. Parallel troughs for different voltages shall be separated by a minimum of 12 inches. Power wire shall be 12 AWG type THWN stranded, insulated for not less than 600 volts, unless specified otherwise. Signal wire shall be 16 AWG, THW stranded, insulated for not less than 600 volts.

8. Wire color shall be as follows:

    a. Line Power – Black

    b. Neutral or common – White

    c. AC Control – Red

    d. DC Control – Blue

    e. Equipment or Chassis Ground – Green

    f. Externally powered circuits - Yellow

9. Wiring and connection diagrams shall conform to ISA S5.4 Instrument Loop Diagrams and shall be submitted by the manufacturer as part of the shop drawings for review by the Engineer.

10. All wiring in the panels shall terminate in terminal blocks. Terminal blocks shall have a minimum of 25 percent spares of each type. Terminal blocks shall be arranged in vertical rows and separated into groups (Power, AC control, DC signal, alarm). Terminal blocks shall be barrier type with the appropriate voltage rating (600 volts minimum). They shall be the raised channel mounted type. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. The sidewalls shall be open top type to permit wire changing without disconnecting. Wire connectors shall be the hook fork type with non-insulated barrel for crimp type compression connection to the wire. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers. Terminal strips shall be provided for the purpose of connecting all control and signal wiring. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6 inches of

the side panel or adjacent terminal. Wiring troughs shall not be filled to more than 60 percent visible fill. Wiring trough covers shall be match marked to identify placement. If component identification is shown on covers for visibility, the ID shall also appear on the mounting sub-panel.

11. All wiring to hand switches and devices which are live circuits independent of the panel's normal circuit breaker protection shall be clearly identified as such.

12. Nameplates shall be provided for all flush mounted equipment. The nameplates shall be approximately 1 inch by 3 inch constructed of black and white laminated, phenolic material having engraved letters approximately 1/4 inch high, extending through the white face into the black layer. Nameplates may be omitted if a nameplate of approximately the same dimension is more conveniently and suitably located on the instrument door or face. Nameplates shall be attached to panels by self-tapping screws.

13. Print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold all of the prints required to service the equipment.

14. The instrument panel shall be factory-tested prior to shipment. Field installation by the Subcontractor shall consist only of setting the panel in place and making necessary electrical connections.

15. All components shall be mounted in a manner that shall permit servicing adjustment, testing and removal without disconnecting, moving or removing any other component. All gages, meters, receivers, switches, pushbuttons and accessories shall be flush mounted.

16. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices. All internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with Drawings, Specifications, and Supplier's data.

17. Pushbuttons shall be heavy-duty, oil tight, 30.5 mm, with momentary contacts. Switches shall be supplied with the number of poles required for the application, an escutcheon plate, and contacts rated for 10 amperes at 120 volts AC.

18. Relays shall be double pole, double throw, octal plug-in type with a transparent dust cover. The relay shall be equipped with an indicating light to indicate when its coil is energized. The relays shall have contacts rated for 10 amperes at 120-volts AC. The mechanical life of the relay shall be 10,000,000 operations minimum (ampere rating shall be increased as necessary for load handling capacity where needed.)

19. Timing relays shall be solid-state plug-in type with a dust and moisture resistant case. The timers shall be of the multi-range/analog or digital type with selectable ranges, between 1 second and 10 hours full scale. The output contacts shall be rated at 2.5 amperes minimum at 120 volts AC. The timing relay shall have a "timing in progress" indication. The mechanical life shall be 10,000,000 operations minimum.

20. Selector switches shall be heavy-duty 30.5 mm, oil tight. Switches shall be supplied with the number of poles required for the application, an escutcheon plate, and contacts rated for 10 amperes at 120 volts AC.

21. General layout of instruments and controls are shown on the Drawings. Minor deviations from the layout may be allowed after review by the Engineer.

22. The instrument panels shall be furnished by the instrumentation and control system

supplier. Complete shop drawings, including wiring diagrams and panel structural drawings, shall be required for review prior to shipment.

23. Furnish Oxidation Inhibitors and install one in each panel at time of start-up.

24. Instrument panel power supply shall wire to a cord end inside the panel. A properly sized UPS system as specified elsewhere shall sit inside the enclosure and be plugged into the receptacle. UPS output shall power the instrument panel.

25. Loop isolators called out or intrinsic safety barriers shall mount inside the instrument panels.

26. An uninterruptible power supply, manufactured by APC, or owner approved equal shall be provided for power to all PLC equipment for a minimum of 8 hours, as well as field instruments. Provide alarm relay card.

27. Provide a 4 port Modbus Gateway for interface with valve and gate actuators; Prosoft or equal. Provide all configuration software and the software development kit.

28. The main Ethernet switch in PLC-WWS shall be an Allen Bradley Stratix 8300 or equal, Layer 3 managed switch. Provide the base switch with ten copper ports and two additional 10-port copper expansion modules, for a total of 30 copper ports. Provide redundancy module and redundant 24-volt power supplies. Two fiber optic ports shall be provided to operate in a redundant ring topology.

29. The Contractor shall provide a fiber cross connect cabinet to be bracket-mounted in PLC enclosure as shown on the Network Block Diagram. The Contractor shall provide fiber optic patch cables which meet the performance characteristics of the primary plant network fiber optic cabling. Fiber patch cables shall be obtained from the primary fiber optic cable manufacturer. The Contractor shall provide all appurtenances necessary to complete a functional fiber run to the fiber transceivers via the fiber cross connect cabinet. The fiber cross connect cabinet shall be as manufactured by Fiber Optic X or Black Box.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 17431 – OPERATOR INTERFACE TERMINAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. References:

1. NFPA 70 (NEC)
2. UL508
3. EN61131-2
4. IEC 61000-6-2
5. FCC (Class A)
6. UL 1604
7. CSA C22-2 #14
8. ANSI/NEMA ICS 6
9. API RP550
10. ISA S5.4
11. IAS S20
12. ISA S50.1
13. ISA S51.1

1.02 SUMMARY

A. This Section includes Human Machine Interface Terminals and associated configuration software for control and visualization of process equipment, process-oriented machinery, and process systems.

1.03 DEFINITIONS

A. AI: Analog Input

B. AO: Analog Output

C. Control Panel Designer: A firm or individual that is responsible for designing the layout of control panels. This entity will choose the devices to be included in the panel, and will decide on the actual layout.

D. CPU: Central Processing Unit

E. DI: Digital Input

F. DO: Digital Output

G. HMI: Human-Machine Interface

H. I/O Input and/or Output

I. Node: A network connection point. Examples include a PLC, PC, Operator Interface Terminal, Switch, Server, etc.

J. OIT: Operator Interface Terminal: A terminal usually embedded in a control panel that allows the operator to view and modify control system parameters. Operator Interface Terminals are not capable of running commercially available software.

K. Operator Workstation Terminal: A terminal that runs a commercially available operating system such as Windows or Linux. An Operator Station will usually execute the SCADA software. Operator Stations are usually desktop mounted personal computers. However, they may be computers that are designed to be embedded in the doors of control panels and motor control centers (MCC)

L. PID: Control action, proportional plus integral plus derivative.

M. PLC: Programmable Logic Controller.

N. SCADA: Supervisory Control and Data Acquisition. A SCADA System is a computer (typically a personnel computer), or a group of computers and servers running a software dedicated for SCADA purposes. This SCADA software can exchange over industrial networks, with PLC's, VFD's, and other industrial devices. Typically, the SCADA software will allow for trending, graphic display, alarm tracking, and reporting of data.

O. SCADA System Supplier: A company that takes a commercially available SCADA software package, and then develops a project-specific application. This company will typically supply hardware to run the SCADA software and project-specific application.

1.04 SUBMITTALS

A. Product Data:

B. For each type of Operator Interface Terminal include dimensions, mounting arrangements, and weights. Also include manufacturer's technical data on features, performance, electrical ratings, characteristics, terminal connections, and finishes.

C. Each Operator Interface Terminal type shall have a separate check sheet. This check sheet shall be an acknowledgement of all criteria in this specification. The check sheet will consist of three columns. The leftmost column will indicate the referenced section of the specification. The middle column will indicate whether the indicated specification criteria are met, not met, or has a variance. The rightmost column will be used to describe reasons for variances or for not meeting the specified criteria. Each row on the check sheet will be for a dedicated specification section or sub-section. Each organization delineation will have its own dedicated row. For instance, you cannot accept section 1.5B and its corresponding subparagraphs in a single row. You must accept 1.5B in a row, and 1.5B1 in another row.

D. Operator Interface Terminal supplier shall be responsible for providing accurate and complete submittals in a timely fashion so as to not cause delay to the project schedule.

E. Once submitted, Operator Interface Terminal suppliers shall not proceed with their associated work until the reception of submittals marked as “Approved” or “Approved as noted”.

F. Operation and Maintenance Data: Provide for each Operator Interface Terminal component literature detailing routine maintenance requirements (if any).

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer shall have, within 200 miles of Project site, a facility, system integrator, or panel shop capable of providing training, parts, and coordination of emergency maintenance and repairs.

B. Source Limitations:

1. All Operator Interface Terminals shall be from a single manufacturer.

2. Operator Interface Terminals shall be from the same manufacturer of the PLC SCADA, and power distribution equipment.

3. To prevent possible collusion, the Operator Interface Terminals shall not be shall not be manufactured by the same company that manufacturers water process equipment specified in this project.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for Operator Interface Terminals, minimum clearances between Operator Interface Terminals, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances, or with Operator Interface Terminal vendors required distances if they are greater than the distances indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver Operator Interface Terminals in packaging designed to prevent damage from static electricity, and physical damage.

B. Store Operator Interface Terminals according to manufacturers’ requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect Operator Interface Terminals from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the Operator Interface Terminals from all forms of electrical and magnetic energy that could reasonably cause damage.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 50 deg C.

2. Humidity: Less than 85 percent (non-condensing).

3. Altitude: Not exceeding 2000 meters (6500 feet).

B. Control panel designer supply independent line fuses or circuit breakers, per the manufacturers' recommendation, for each Operator Interface Terminal.

C. Control panel designer shall insure that communication signals are properly conditioned for the Operator Interface Terminal and protected from all sources of radiated energy or harmonics.

1.08 SPARE PARTS

A. Furnish spare parts as described below for each type of Operator Interface Terminal. Material shall be packaged for long term storage and identified with labels describing contents. Coordinate with each Operator Interface Terminal based control panel vendor to optimize the amount of spares provided.

1. Provide a spare memory card for each Operator Interface Terminal.

2. Provide Five (5) spare fuses for each type of Operator Interface Terminal

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. SQ-D/Group Schneider
2. Samsung
3. Equal by others

B. Qualified Manufacturers:

1. Only manufacturers that have been selling Operator Interface Terminals for a minimum of **10 ten** years will be considered acceptable.

C. Basis-of-Design Product: Schneider Electric; Magelis Operator Interface Terminals, Samsung BN68-01570A-00 Operator Workstation Terminals.

2.02 TRADITIONAL OPERATOR INTERFACE TERMINALS

A. GENERAL:

1. All of the Operator Interface Terminals shall comply with the following general requirements as a minimum.

a. Certifications: The Operator Interface Terminal will have certifications by CE, CSA, UL Class 1 Division 2 T4A or T5 (UL and CSA), and C-Tick

b. Power Supply: The Operator Interface terminal will have a nominal voltage of 24VDC with a range of 19.2-28.8Volts DC. The power supply will have a voltage cut of </= 10milliseconds maximum and an Inrush current of </= 50A Maximum. Connection of power will be via a 3

terminal screw terminal block. This block will be pitched at least 5mm, and will have a tightening torque of 0.5Nm.

c. Real-time Clock: All Operator Interface Terminals shall have a built-in real-time clock.

d. Visual Diagnostics: Visual diagnostics shall comply with the following.

1) For screens smaller then 6 inch, screen status shall be displayed on the LCD display.

2) For screens larger the 6"A single LED visible from the front panel, without the need to open the control panel door, will be used to indicate status of the terminal. The LED will be green during normal operation, orange if the back-lighting is faulty, and red under various fault conditions.

3) Units using multiple LEDs, or LED's visible from the back of the unit will not be acceptable.

e. To protect the municipality's ability to competitively bid future projects, the Operator Terminal shall utilize Ethernet networks that are available for multiple vendors. Ethernet protocols shall either use Port 502 or be supported by the Open Device Net Vendors Association (ODVA). Conversion equipment to convert a non compliant Ethernet protocol will not be accepted.

B. ENVIRONMENTAL REQUIREMENTS:

1. All of the Operator Interface Terminals shall be capable of withstanding the following criteria as a minimum.

a. Temperature: The Operator Interface Terminal shall be rated to operate in a range of 0-50º C. (32-122 º F.). The unit shall be able to withstand a range of -20-60º C. (-4-140 º F.) while in storage.

b. Relative Humidity: The Operator Interface Terminal shall be capable of handling a minimum of non-condensation humidity of 0-85%.

c. Altitude: The Operator Interface Terminal shall be designed to operate between 0-6500 feet above sea level minimum without derating.

d. Degree of Protection: The Operator Interface Terminal shall have a front panel rating of IP 65 and conform to IEC 60529. This rating shall be a NEMA 4X rating suitable for indoor use only. The back panel rating shall be IP 20 and conform to IEC60529.

e. Shock Resistance: The Operator Interface Terminal shall conform to one of the following:

1) IEC 60068-2-27; Semi-sinusoidal Pulse for 11ms, and 15gn on 3 axes.

2) IEC 61131-3; 15gn 11ms

f. Vibration: The operator Interface Terminal shall conform to one of the following

1) IEC 60068-2-6. The Terminal shall be capable of 5-9Hz at 3.5 mm, and 9-150Hz at 1g.

2) IEC 61131-3; 1gn 5Hz to 150Hz (maximum 3.5 mm (0.13 in.))

g. Electrostatic Discharge: The Operator Interface Terminal shall conform to one of the following

1) IEC61000-4-2, level 3.

2) 6 kV direct contact, or 8Kv air contact

h. Electromagnetic Interference: The Operator Interface Terminal shall conform to one of the following

1) IEC 61000-4-3, 10 V/m.

2) 10 V/m / 80 MHz to 2.7GHz Sinus amplitude modulated 80 % 1 kHz + Internal clock frequency

i. A color STN screen with 4096 solid colors. The screen shall have a 640x480 pixel (VGA) resolution, with a backlighting service life of 50,000 hours of continual usage. There shall be an embedded analog touch sensitive zone with a resolution of 1024x1024. The screen shall have eight (8) levels of brightness, and eight (8) levels of contrast via tactile feedback.

j. A color TFT screen with 65,536 solid colors, or 16,384 colors if flashing. The screen shall have a 640x480 pixel (VGA) resolution, with a backlighting service life of 50,000 hours of continual usage. There shall be an embedded analog touch sensitive zone with a resolution of 1024x1024. The screen shall have eight (8) levels of brightness, and eight (8) levels of contrast via tactile feedback.

2. The Operator Interface Terminal shall have a video and audio input jacks for connection to a video camera. The Operator Interface Terminal shall also have audio output jacks.

3. Primary Memory: The Operator Interface Terminals shall have a 32Mb flash EPROM memory, and a Compact Flash expansion memory slot. The Compact Flash slot shall be capable of handling cards up to 1GB.

4. RAM: The Operator Terminal shall be supplied with lithium batteries to back up 512Kb

5. Communication Protocols. The Operator Interface shall be supplied with Modbus, Modbus TCP/IP. **B**asis of Design: The basis of design is the Schneider Electric Magelis XBT-GT terminal series for OIT's.

C. LARGE OPERATOR INTERFACE TERMINAL

1. Samsung BN68-01570A-00 for Operator Workstations.

2. The Operator Interface Terminal shall have video and audio input jacks for connection to a video camera. The Operator Interface Terminal shall also have audio output jacks.

3. Communication Protocols. The Operator workstation shall be supplied with **Modbus, Modbus TCP/IP.**

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive Operator Interface Terminals for compliance with requirements, installation tolerances, <**Insert Project-specific conditions,**> and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Select Operator Interface Terminals based upon I/O, memory, communication, expansion, and other criteria. If multiple Operator Interface Terminal-based control panels will be supplied from different vendors, coordinate with other vendors to insure that Operator Interface Terminals are of identical brand and are equipped to utilize identical communication networks.

3.03 INSTALLATION

A. Anchor Operator Interface Terminals within enclosures as recommended by the Operator Interface Terminal manufacturer.

B. Provide spacing around Operator Interface Terminals as required by the Operator Interface Terminals manufacturer to insure adequate cooling. Insure that the air surrounding and penetrating the rear and sides of the Operator Interface Terminal has been ambiently conditioned to maintain the required temperature and humidity range of the Operator Interface Terminal.

C. Wires entering and exiting Operator Interface Terminals shall be sized to comply with the manufacturers requirements.

D. During installation, upper ventilation slots shall be covered to prevent accidental debris entry. However, during normal operation ventilation slots shall not be blocked, or obstructed by any means.

3.04 IDENTIFICATION

A. Identify Operator Interface Terminal components, and wiring according to all applicable codes, standards and contract document sections.

3.05 FIELD QUALITY CONTROL

A. Field Service: The Operator Interface Terminal-based control panel supplier shall provide a qualified service representative to perform the following:

1. Inspect Operator Interface Terminal, wiring, components, connections, and equipment installation.

2. Assist in field testing of equipment

3. Report results in writing.

B. Training

1. Control panel supplier shall provide a qualified service representative to train Owner's maintenance personnel to adjust, operate, and maintain Operator Interface Terminals. The training under this section is included in the thirty-two (32) hours of training required by Section 17311.

END OF SECTION

SECTION 17480 - INSTRUMENT LISTS AND REPORTS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish and install all instrumentation equipment and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 – Plc Hardware and Software
Section 17410 - Basic Measurement and Control Instrumentation Materials and Methods
Section 17420 - Instruments
Section 17430 - Boxes, Panels and Control Centers
Section 17490 - Measurement and Control Commissioning

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

1.03 LOOP DESCRIPTIONS

A. Loop 100 - Miscellaneous Alarms and Status

The high wetwell level float switches shall be connected directly to a digital input in the WWS Control Panel. A power failure output shall be provided from the phase volt monitor located in the MCC. Generator running status shall be provided from the automatic transfer switch. Both of these alarm contacts shall be wired directly to digital inputs in the WWS Control Panel.

Bar screen running status and overtorque alarm shall be provided from the motor control center. Both of these alarm contacts shall be wired directly to digital inputs in the RTU.

B. Loop 200 – Influent Flow

Gravity flow to the station shall be measured via VEGA radar mounted over a parshall flume. The level shall be converted to flow, and the measured value shall be displayed at the transmitter, and a 4-20 mADC output sent to the WWS Control Panel (CP-100), where the flow shall be recorded and totalized.

C. Loop 300 – Pump Station Discharge Flow

The primary force main for the station is 30.” An alternate 24” force main is also available for use either separately or simultaneously with the 30.” Both force mains shall include line size magnetic flowmeters to monitor flow. Measured flow for each shall be displayed at the respective transmitter, and a 4-20 mADC output sent to the WWS Control Panel (CP-100), where the flow shall be recorded and totalized.

D. Loop 400 – Wetwell Level

1. Each wetwell level shall be measured with a radar level sensor. A 4-20 mADC output from each level sensor shall be sent to the WWS Control Panel (CP-100).

2. Common (Combined) Tank Mode: When the slide gate between Wetwell A and Wetwell B is open, the two tanks will combine to form one common liquid level. The operation of the pumps when in Common Mode shall be as follows:

   a. All pumps shall be set to alternate. Whichever pump has the lead position will start running when the liquid level in either tank has reached the lead "ON" start point for the common well. If the lead pump cannot maintain the desired liquid level in the tank, then the first lag pump will start once on the "ON" set point is reached for lag pump #1. When two or more pumps are running, VFD speed equalization shall occur and the pumps shall run at the same speed while maintaining the desired liquid level in the tank. If the lead pump and lag pump #1 cannot maintain the desired liquid level in the tank, then lag pump #2 shall start once on the "ON" set point is reached for lag pump #2. If the lead pump, lag pump #1 and lag pump #2 cannot maintain the desired liquid level in the tank, then lag pump #3 shall start once the "ON" set point is reached for lag pump #3. If the lead pump, lag pump #1, lag pump #2 and lag pump #3 cannot maintain the desired liquid level in the tank, then lag pump #4 shall start once the "ON" set point is reached for lag pump #4. When an energized "running" pump reaches the liquid level "OFF" set point in the lead/lag sequence, the pump shall be turned "OFF" until it is called for again based on the level in the common tank.

   b. All pumps shall be able to be grouped into different operational sequences if required.

   c. Rising Water Level: As the level in the wetwell rises, the lead pump stop level is reached. As the wetwell continues to rise, the lead pump start level is reached, and the lead pump starts. The 4-20 mADC speed reference output from the controller to the VFD shall be adjusted based on the measured level, to try to match incoming flow. If level continues to rise, the speed output shall continue to increase until the pump is operating at full speed. If the level continues to rise, the lag pump start level is reached, and the lag pump shall start. The lead and lag pump speed outputs shall be adjusted based on the measured level, to try to match incoming flow. If the level continues to rise, the speed output shall continue to increase until the pumps are operating at full speed. If the level continues to rise, the lag-lag pump start level is reached, and the lag-lag pump shall start. Speed outputs shall be adjusted based on the measured level, to try to match incoming flow. If the level continues to rise, the speed output shall continue to increase until all pumps are operating at full speed. The station is not designed for simultaneous operation of all four pumps; therefore, the backup pump is not part of the sequence.

   d. Falling Water Level: If all pumps are operating at full speed, and the wetwell level begins to fall, all pumps shall continue to operate at full speed until the lead pump stop level is reached. If one or more pumps is operating at reduced speed, and the wetwell level begins to fall, the pump which is operating at reduced speed shall stop when its respective stop level has been reached. Any remaining pumps operating at full speed shall continue to operate at full speed until the lead pump stop level is reached.

3. Isolated (Individual) Tank Mode: When the slide gate between Wetwell A and Wetwell B is closed, the two tanks will be isolated from each other and each tank will function with a separate set of pumps and controls. The operation of the pumps when the tanks are in isolated tank mode shall be as follows:

   a. All pumps for each individual well shall be set to alternate. Whichever pump has the lead position will start running when the liquid level in the tank has reached the lead "ON" start point for the individual well. If the lead pump cannot maintain the desired

liquid level in the tank, then the first lag pump will start once the "ON" set point is reached for lag pump #1. When two or more pumps are running, VFD speed equalization shall occur and the pumps shall run at the same speed while maintaining the desired liquid level in the tank. If the lead pump and lag pump #1 cannot maintain the desired liquid level in the tank, then lag pump #2 shall start once the "ON" set point is reached for lag pump #2. When an energized "running" pump reaches the liquid level "OFF" set point in the lead/lag sequence, the pump shall be turned "OFF" until it is called for again based on the level in the individual tank.

b. All pumps in each individual well shall be able to be grouped into different operational sequences if required.

4. Disabled Tank Mode: If Tank A or Tank B should need to be out of operation, a selector switch shall be used to select the desired tank to be disabled and thereby shutdown the associated Triplex Pump Controller until needed. The pump controls shall automatically adjust to control the remaining active tank as determined by the position of the selector switch.

5. Failsafe Operation: The pump controls shall be able to be configured for failsafe operation if liquid level is not detected in the wet well (low level fault). Each set of pump controls for Tank A and Tank B shall be protected against a low level condition, such that the pumps will not be permitted to run while a low liquid level condition exists.

E. Loop 500 – Submersible Pump Control

The pump controller(s) shall include outputs for on/off control for each pump, as well as 4-20 mADC speed output. On/off and speed control shall be as described in Loop 400 above.
A status output is provided from each VFD to the controller(s). A fail output is also provided from each VFD to the controller(s)

F. Loop 600 – Bar Screen Level Control

The bar screen control panels from the vendor will have Local-Off-Remote capability. Radar detectors provided by the integrator will provide 4-20mADC to CP-100 for processing. CP-100 will determine if the bar screens are to operate in low or high speed and provide discrete contacts to each bar screen control panel. Fail, In Remote and On Feedbacks shall be provided from each bar screen control panel to CP-100.

1.04 GAUGE SCHEDULE

Location Required	Range					Accessories
	Combination			Compound		
	Size	PSI	Feet	Vacuum (ft)	Altitude (ft)	

Pressure Gauge Accessory Code:

A - Gauge Liquid Filled
B - Diaphragm Seal, Liquid Filled
C - Ball Valves for Shutoff and Vent
* - Viton Diaphragm

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 17490 - MEASUREMENT AND CONTROL COMMISSIONING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish and install all instrumentation equipment and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

A. The following Sections of this Specification Division contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project):

Section 17311 - PLC Hardware and Software
Section 17410 - Basic Measurement and Control Instrumentation Materials and Methods
Section 17420 - Instruments
Section 17430 - Boxes, Panels and Control Centers
Section 17480 - Instrument Lists and Reports

B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

Division 1 - General Requirements
Division 11 - Equipment
Division 16 - Electrical

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SEQUENCE OF CONSTRUCTION

A. Installation and startup of the new Wet Weather Storage Facility shall be coordinated with the Owner, as the equipment will communicate over fiber optic cable to existing WTP SCADA System.

B. Delivery, startup, and programming of new equipment furnished under this Division shall be coordinated with process equipment installation. A qualified technician shall be present on site during pump startup.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Engineer during construction. Obtain in the field all information relevant to the placing of process control work, proceed as directed by the manufacturer and furnish all labor and materials necessary to complete the work in an acceptable manner.

B. The instrumentation installation details on the Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the

Drawings, the manufacturer's recommended practice shall be followed.

C. All work shall be executed in full accordance with codes. Should any work be performed contrary to said codes and/or regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising therefrom. All equipment used in areas designated as hazardous shall be designed for the Class, Division, and Group as required on the Drawings for the locations.

D. Unless specifically shown in the Contract Documents, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves.

E. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors, and shut-off valves.

F. Field instruments requiring power supplies shall be provided with local electrical shut-offs and fuses as required.

G. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

H. The system supplier shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the system supplier shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The system supplier shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).

I. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground point be employed for each shield.

J. Lifting rings shall be removed from cabinets/assemblies. Hole plugs shall be provided for the holes of the same color as the cabinet.

K. The system supplier, acting through the Contractor, shall coordinate the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's acceptance. He shall be responsible to ensure that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to ensure a satisfactory functioning installation. The Contractor hereunder shall schedule and coordinate his work under this Section with that of the electrical work specified under applicable Sections of Division 16.

3.03 FIELD QUALITY CONTROL

A. After equipment and materials have been shipped to the job site, the Supplier shall furnish the services of a factory-trained service technician or engineer to assist and advise the Contractor during installation and to provide programming/calibration/ adjustment at initial startup. A minimum period of two (2) days at eight (8) person hours a day on the job site is required, with a minimum of a one (1) calendar day follow up two (2) weeks after the original training and expenses associated with additional days necessary shall be at no cost to the Owner.

B. Following installation, checkout, and final adjustment of all panels, instruments, meters, monitoring, and control devices, the Contractor shall schedule a performance test in the presence of the Engineer on all equipment. The Contractor shall furnish the services of the system supplier's servicemen, all special tools, calibration equipment, and labor to perform the tests.

C. Meters shall be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of scale, if possible. All status and alarm switches as well as all monitoring and control functions shall also be checked, including logging at printers and change of state on graphics. Testing shall be done from the signal source to the final element or device including all field wiring. Results of all testing shall be submitted to the Engineer in writing.

D. As much as possible, points shall be checked “end-to-end”. For example, valve status inputs shall be checked by stroking the valve, and a pump start output shall be checked by using it to start to start the pump. Simulated testing shall be allowed only when no practical alternative exists. Workstation displays shall be verified for correctness at the same time. An I/O checklist shall be used to record test results and a copy provided to the Engineer upon completion. During system testing, the Contractor shall have a representative onsite continuously who is capable of troubleshooting and modifying system configuration programming.

E. If, during running of the tests, one or more points appear to be out by more than the system accuracy statement, or fails to perform in accordance with agreed strategies, the system supplier’s servicemen shall make such adjustment or alterations as are necessary to bring equipment/programming up to specification performance. Following such adjustment, the tests shall be repeated for all specified points to ensure compliance.

3.04 PERFORMANCE TEST

A. Subsequent to the full system implementation, the Contractor shall conduct a successful 30 day final acceptance test for the system furnished and installed under this Contract. In this test, the entire system must operate continuously for 24 hours per day, 7 days per week during the test period, with zero downtime resulting from system failures. If a system failure occurs, the 30-day test period will be repeated, starting over at time zero, from the time that the system failure is repaired. The Contractor shall repeat the test until it is satisfactorily completed. The system will only be acceptable to the Owner after all equipment and software has satisfied the performance test requirements.

B. The Contractor shall submit a final acceptance test completion report which shall state that all Contract requirements have been met and which shall include a summary of maintenance/repair efforts that were required during the test period. Final acceptance of the system by the Owner until this has occurred.

3.05 ADJUSTING AND CLEANING

A. All equipment furnished under this Section of the Specifications shall be adjusted/calibrated as defined elsewhere this Section/Division.

B. All instruments and equipment shall be left free from shipping stickers, paint splatter, dirt, grease, etc., and shall be clean and in like new condition at final acceptance. Touch-up paint shall be furnished as needed to repair blemishes and scratches in finish paint on panels and enclosures, which shall be corrected by the Contractor.

3.06 EXTRA STOCK/SPARE PARTS

A. The following supplies and spare parts shall be furnished:

1. Ten fuses for each type/size in the system.

2. Four Cutler-Hammer C799L2 oxidation inhibitors; install one in each cabinet.

3. One 100-count box of recording charts for each recorder in the system (4-100 count boxes for 24 hour charts).

4. One year supply of fiber tipped pens for each installed chart recorder pen.

5. One relay of every size and type provided in the project.

6. One pump control module (Section 17420).

B. Other spare parts are listed in specific instrument technical specifications in the appropriate Division 17 Specification Section herein. All spare parts shall be packaged in an acceptable manner for long-term storage and adequately protected against corrosion, humidity and temperature extremes. All items shall be tagged externally with what they are; both a written description and a manufacturer brand/part number.

END OF SECTION