

SECTION 406000 - PROCESS CONTROL SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. PLC-based Process Control System (PCS) for monitoring and control of process equipment related plant process system(s), plant alarming, and monitoring miscellaneous plant support systems. Process Control System shall be complete to meet the performance as described in this specification and related information on the project Contract Drawings and other specifications as noted below.
2. Work to connect the PCS furnished under this project into the City's SCADA network interface point at City Hall. Contractor shall coordinate with the SCADA network administrator and City Hall's IT department to provide all equipment, programming, network configuration, and all other services necessary to ensure secure and functional integration of the PCS with the City's SCADA network.
3. Field instruments for monitoring and control of plant processes:
 - a. Pressure Instruments
 - b. Temperature Instruments
 - c. Flow Instruments
 - d. Level Instruments
 - e. Chlorine Analyzers
 - f. Position Limit Switches
 - g. Actuated Valves
4. See attachments for additional performance requirements:
 - a. Attachment A: Control Narrative
 - b. Attachment B: I/O List

B. Related requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for instrumentation cable, control cable and control circuit conductors.
2. Section 260529 "Hangers and Supports for Electrical Systems" for support requirements.
3. Section 260533.13 "Conduits for Electrical Systems" for raceways for low-voltage control cable.
4. Section 260533.16 "Boxes and Covers for Electrical Systems" for boxes and covers for low-voltage control cable.
5. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for construction of underground control cable raceways.
6. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling" for sleeves and sleeve seals for control raceways.

7. Section 260553 "Identification for Electrical Systems" for general raceway and wire identification.
8. Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cabling.
9. Section 271513 "Communications Copper Horizontal Cabling" for balanced twisted pair communications cable.
10. Section 400551 "Plant Valves" for electrically actuated valves used for process control.
11. Section 407113 "Magnetic Flow Meter" for electromagnetic flow meters.
12. Section 407521 "Chlorine Analyzer" for chlorine analyzers.

1.02 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- E. COV: Changes of value.
- F. E/P: Voltage to pneumatic.
- G. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- H. HLC: Heavy load conditions.
- I. KVM: Keyboard, video, mouse.
- J. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- K. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- L. Modbus TCP/IP: An open protocol for exchange of process data.
- M. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- N. MTBF: Mean time between failures.

- O. PCS: Process control system.
- P. PLC: Programmable logic controller.
- Q. PLC System Provider: Authorized representative of, and trained by, PLC system manufacturer and responsible for execution of PLC system Work indicated.
- R. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- S. I/P: Current to pneumatic.
- T. LAN: Local area network.
- U. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- V. POT: Portable operator's terminal.
- W. RAM: Random access memory.
- X. Router: Device connecting two or more networks at network layer.
- Y. SCADA: Supervisory Controls and Data Acquisition.
- Z. Server: Computer used to maintain system configuration, historical and programming database.
- AA. TCP/IP: Transport control protocol/Internet protocol.
- BB. UPS: Uninterruptible power supply.
- CC. USB: Universal Serial Bus.
- DD. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

1.03 BUY AMERICAN REQUIREMENTS

- A. Provide certificates to show that all products meet the following requirements.
 - 1. American Iron and Steel (AIS)
 - 2. Build America, Buy America Act
- B. See Supplementary Conditions for details.

1.04 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors affecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
 - a. PLC controllers and I/O modules.
 - b. Operator interface terminals.
 - c. Gateways.
 - d. Routers.
 - e. Enclosures.
 - f. Electrical power devices.
 - g. UPS units.
 - h. Instruments.
 - i. Control valves and actuators
 - j. Accessories.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, and PLC controller.
2. Description and technical data of all software provided and cross-referenced to products in which software will be installed.

3. Operating system software, operator interface and programming software, color graphic software, PLC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. Shop drawings shall be stamped by a Certified Automation Professional or registered Alaska Professional Engineer in either Control Systems or Electrical discipline.
2. General Requirements:
 - a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
 - c. Drawings Size: 11 inches x 17 inches.
3. Include plans, elevations, sections, and mounting details where applicable.
4. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
5. Detail means of vibration isolation and show attachments to rotating equipment.
6. Control panel drawings indicating the following:
 - a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
 - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
 - c. Front, rear, and side elevations and nameplate legend.
 - d. Unique drawing for each panel.
7. PCS system electrical power riser diagram indicating the following:
 - a. Each point of connection to field power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
 - b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
 - c. Each product requiring power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
 - d. Power wiring type and size, race type, and size for each.
8. Monitoring and control signal diagrams indicating the following:
 - a. Control signal cable and wiring between controllers and I/O.

- b. Point-to-point schematic wiring diagrams for each product.
 - 9. Color graphics for HMI screens indicating the following:
 - a. Itemized list of HMI color graphic displays to be provided.
 - b. For each HMI display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
 - c. Intended operator access between related hierarchical display screens.
- E. System Description:
 - 1. Full description of PCS system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
 - 2. Complete listing and description of each report, log and trend for format and timing, and events that initiate generation.
 - 3. System and product operation under each potential failure condition including, but not limited to, the following:
 - a. Loss of power.
 - b. Loss of network communication signal.
 - c. Loss of controller signals to inputs and outpoints.
 - d. Server failure.
 - e. Network failure.
 - f. Controller failure.
 - g. Instrument failure.
 - h. Control valve actuator failure.
 - 4. Complete bibliography of documentation and media to be delivered to Owner.
 - 5. Description of testing plans and procedures.
 - 6. Description of Owner training.
- F. Delegated Design Submittals: For PCS products and installation indicated as being delegated.
 - 1. Supporting documentation showing PCS design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
 - 2. Schedule and design calculations for control valves and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Pressure-differential drop across valve at Project design flow condition.
 - c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
 - d. Design and minimum control valve coefficient with corresponding valve position.
 - e. Maximum close-off pressure.
 - f. Leakage flow at maximum system pressure differential.
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.
 - i. Actuator signal to control damper (on, close or modulate).
 - j. Actuator position on loss of power.
 - k. Actuator position on loss of control signal.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Statements:

1. Systems Provider's Qualification Data:

- a. Resume of project manager assigned to Project.
- b. Resumes of application engineering staff assigned to Project.
- c. Resumes of installation and programming technicians assigned to Project.
- d. Resumes of service technicians assigned to Project.
- e. Brief description of past project including physical address and building's primary function.
- f. Description of past project PCS system, noting similarities to Project scope and complexity indicated.
- g. Names of staff assigned to past project that will also be assigned to execute work of this Project.

2. Manufacturer's qualification data.
3. Testing agency's qualification data.

C. Source Quality-Control Submittals:

1. Source quality-control reports.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

E. Sample warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For PCS system.

1. Include the following:

- a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
- b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
- c. As-built versions of submittal Product Data.
- d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for PCS system and products.

- e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
- f. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- g. Backup copy of graphic files, programs, and databases supplied on electronic media.
- h. List of recommended spare parts with part numbers and suppliers.
- i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- k. Licenses, guarantees, and warranty documents.
- l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- m. Owner training materials.

B. Licensing

- 1. Licensing for Owner. Entity name to receive the following licenses will be obtained from the Owner.
- 2. PLC software licensing shall be provided to the Owner for all PLC systems.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials and parts to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list to be indicated for each year.
- C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.
- D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
 - 1. PLC Controller: One.
 - 2. I/O Card: One of each type.
 - 3. General-Purpose Relay: Two.
 - 4. Multifunction Time-Delay Relays: Two.
 - 5. DC Power Supply: One.

1.08 QUALITY ASSURANCE

A. PCS System Manufacturer Qualifications:

1. Rockwell Automation, no substitutions allowed.
2. Nationally recognized manufacturer of process control systems and products.
3. Process control systems with similar requirements to those indicated for a continuous period of 10 years within time of bid.
4. Process control systems and products that have been successfully tested and in use on at least three past projects.
5. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
6. Having full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing, and quality control.
 - d. Technical support for process control system installation training, commissioning, and troubleshooting of installations.
 - e. Owner operator training.

B. PCS System Provider Qualifications:

1. Authorized representative of, and trained by, PCS system manufacturer.
2. PCS system provider shall maintain a UL 508A certified panel shop or engage the services of a UL 508A certified panel shop for the fabrication of all process control system panels.
3. Demonstrate past experience with installation of process control system products being installed for period within five consecutive years before time of bid.
4. Demonstrate past experience on five projects of similar complexity, scope, and value.
5. Demonstrate past experience of each person assigned to Project.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support ongoing PCS system operation for a period of not less than five years after Substantial Completion.
9. PCS system manufacturer's backing to take over execution of the Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.09 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

- a. Install updates only after receiving Owner's written authorization.
- 3. Warranty service shall commence within 16 hours of Owner's warranty service request.
- 4. Warranty Period: Two year(s) from date of Substantial Completion.
- B. PCS System Maintenance: Provide quarterly maintenance to verify system operations for a period of 1 year. Software upgrades to maintain licensing where not required to address warranty items shall be scheduled with owner written authorization at these times.

PART 2 - PRODUCTS

2.01 PCS/PLC SYSTEM MANUFACTURERS

- A. Allen Bradley/Rockwell Automation, no substitutions, including the following base modules:
 - 1. Platform: CompactLogix Platform
 - 2. Processor Module: 1769-L33ER (or current compatible model) with Ethernet communications.
 - 3. Discrete Isolated Input Modules: 1769 class for operation at 24 V dc.
 - 4. Discrete Output Modules: 1769 class or operation at 24 V dc.
 - 5. Analog Input Modules: 1769-IF HART family.
 - 6. Analog Output Modules 1769-OF HART family.
 - 7. Power Supplies: 1769 class for operation at 24 V dc.
- B. Size and selection of PCS PLC modules shall allow for expansion within the enclosures.
- C. PCS PLC control panel/cabinet shall be certified to UL 508A.

2.02 WEB ACCESS

- A. Access to PCS to be web compatible.
 - 1. Web-Compatible Access to PCS System:
 - a. Workstation to perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
 - b. PCS system to support web browser access to process data. Operator using a standard web browser is able to access control graphics and change adjustable set points.
 - c. Password-protected web access.

2.03 PERFORMANCE REQUIREMENTS

- A. Delegated Design, Qualified Professional: Engage a qualified professional to design PCS system to satisfy requirements indicated.
 - 1. System Performance Objectives:

- a. PCS system manages all unit process operations involved with the pump house process, water storage tank monitoring, and pump house balance of plant support systems.
- b. PCS system responds to power failures, process equipment failures, and adverse and emergency conditions encountered through connected I/O points.
- c. PCS system operates while unattended by an operator and through operator interaction.
- d. PCS system records trends and transactions of events and produces report information such as performance, production records, and equipment operation.

B. PCS System Data Storage:

1. Include capability to archive not less than 12 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends, and other information indicated.
2. Local Storage:
 - a. Provide with data storage indicated. Server(s) to use IT industry standard database platforms and be capable of functions described in "PCS Data Access" Paragraph.

C. PCS Data Access:

1. When logged into the system, operator shall be able to also interact with any PLC controllers connected to PCS system as required for functional operation of PCS system.
2. Use for application configuration; for archiving, reporting, and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

D. Future Expandability:

1. PCS system size is expandable to an ultimate capacity of at least 1.35 times total I/O points indicated.
2. Design and install system networks to achieve ultimate capacity with only addition of I/O modules and associated wiring and cable. Design and install initial network infrastructure to support ultimate capacity without having to remove and replace portions of network installation.
3. Operator interfaces installed initially do not require hardware and software additions and revisions for system when operating at ultimate capacity.

E. Environmental Conditions for Controllers and Switches:

1. Products to operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.
 - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.

2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:
 - a. Outdoors: Type 4X.
 - b. Indoors, Heated: Type 12.
 - c. Localized Areas Exposed to Washdown: Type 4.
 - d. Chlorine Room: Type 4X.
- F. Environmental Conditions for Instruments and Actuators:
1. Instruments and actuators to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure is internally insulated, electrically heated, and ventilated as required by instrument and application.
 2. Protect instruments, actuators, and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House instruments and actuators not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location is to dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors: Type 4X.
 - b. Indoors, Heated: Type 4X.
 - c. Localized Areas Exposed to Washdown: Type 4.
 - d. Chlorine Room: Type 4X.
- G. Electric Power Quality:
1. Power-Line Surges:
 - a. Protect PCS system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
 - b. Do not use fuses for surge protection.
 - c. Test protection in the normal mode and in the common mode, using the following two waveforms:
 - 1) 8-by-20-microsecond waveform with a peak voltage of 1000 V and a peak current of 500 A.
 2. Power Conditioning:
 - a. Protect PCS system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner are as follows:

- 1) At 85 percent load, output voltage to not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
 - 2) During load changes from zero to full load, output voltage to not deviate by more than 3 percent of nominal.
 - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
 - 4) Total harmonic distortion to not exceed 3 percent at full load.
3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products to not fail due to ground fault condition.

H. UPS:

1. PCS system products powered by UPS units are to include the following:
 - a. PLC controllers and I/O modules.
 - b. PCS communications modules.
 - c. PCS operator interface terminals.
 - d. PCS network switches.
 - e. Panel-mounted lights and sounders.
 - f. Instruments and field devices connected to I/O modules.

I. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems are to automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.04 PCS SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator able to access entire PCS system through any of multiple means including, but not limited to, the following:
1. HMI touchscreen display mounted on front of PCS PLC enclosure.
 2. Portable operator terminal with hardwired connection through LAN port.
 3. Remote connection through remote access.
- B. Make access to system, regardless of operator means used, transparent to operator.
- C. Network Ports: For hardwired connection of portable workstation. Network port easily accessible, properly protected, clearly labeled, and installed at the following locations:
1. Inside PLC Panel PLC-001.

2.05 NETWORKS

A. Acceptable networks for connecting workstations and PLC controllers include the following:

1. IP.
2. ISO/IEC/IEEE 8802-3, Ethernet.

2.06 PCS OPERATOR INTERFACE TERMINAL

A. Description: A touchscreen HMI display mounted to enclosure doors.

B. Basis of Design: Allen Bradley PanelView Plus 7.

C. Requirements:

1. Display: Minimum 10-inch TFT color touchscreen display capable of displaying SVGA screen resolution (800x600) minimum.
2. Nonvolatile Memory: 512 MB.
3. Type: Rated NEMA 250 Type 4/4X for indoor use.
4. Network Interface: Built-in 10-100-1000 Base TX Ethernet with RJ-45 connector port.
5. USB: USB port for external USB drive.
6. CF Card: CF card slot for data logging.

2.07 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Operator interface software to include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
2. Scheduling software to schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Make operator sign-off a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Make automatic sign-off period programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Security Access:
 - a. Use password control for operator access to PCS system.
 - b. Assign an alphanumeric password (field assignable) to each operator.
 - c. Grant operators access to PCS system by entry of proper password.

- d. Use same operator password regardless of which computer or other operator interface means are used.
 - e. Automatically update additions or changes made to passwords.
 - f. Assign each operator an access level to restrict access to data and functions the operator is capable of performing.
 - g. Provide software with at least five access levels.
 - h. Assign each menu item an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
 - i. Display menu items to operator with those capable of access highlighted. Make menu and operator access level assignments online programmable and under password control.
6. Operators able to perform commands including, but not limited to, the following:
- a. Start or stop selected equipment.
 - b. Adjust set points.
 - c. Add, modify, and delete time programming.
 - d. Enable and disable process execution.
 - e. Lock and unlock alarm reporting for each point.
 - f. Enable and disable totalization for each point.
 - g. Enable and disable trending for each point.
 - h. Override control loop set points.
 - i. Enter temporary override schedules.
 - j. Enter and modify analog alarm limits.
 - k. Enter and modify analog warning limits.
7. Reporting:
- a. Generated manually.
 - b. Sent to displays and disc files.
 - c. Types of Reporting:
 - 1) General listing of points.
 - 2) List points currently in alarm.
 - 3) List of off-line points.
 - 4) List points currently in override status.
 - 5) List of disabled points.
 - 6) List points currently locked out.
8. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.
- C. Graphic Interface Software:
- 1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
 - 2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface is

- to use pull-down or penetrating menus, color, and animation to facilitate operator understanding of system.
3. Make descriptors for graphics, points, alarms, and such modifiable through operator's workstation under password control.
 4. Make graphic displays online user definable and modifiable using the hardware and software provided.
 5. Make data displayed within a graphic assignable regardless of physical hardware address, communication, or point type.
 6. Make graphics online programmable and under password control.
 7. Make points assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
 8. Graphics to also contain software points.
 9. Penetration within a graphic hierarchy is to display each graphic name as graphics are selected to facilitate operator understanding.
 10. Display operator accessed data on the monitor.
 11. Provide operator with ability to select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Display defined and linked graphic below that selection.
 12. Include operator with means to directly access graphics without going through penetration path.
 13. Make dynamic data assignable to graphics.
 14. Display points (physical and software) with dynamic data provided by PCS system with appropriate text descriptors, status or value, and engineering unit.
 15. Use color, rotation, or other highly visible means, to denote status and alarm states. Make colors variable for each class of points, as chosen by operator.
 16. For operators with appropriate privilege, command points directly from display using pointing device.
 - a. For an analog command point such as set point, display current conditions and limits so operator can position new set point using pointing device.
 - b. For a digital command point such as valve position, show valve in current state such as open or closed so operator could select alternative position using pointing device.
 - c. Include a keyboard equivalent for those operators with that preference.
 17. Provide graphic generation software to allow operator ability to add, modify, or delete system graphic displays.
- D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
1. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication.
 2. Graphic display for each piece of equipment connected to PCS system through a data communications link. Include dynamic indication of all points associated with equipment.
- E. Alarm Handling Software:
1. Include alarm handling software to report all alarm conditions monitored and transmitted through PCS controllers.

2. Include first in, first out handling of alarms in accordance with alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Make alarm handling active at all times to ensure that alarms are processed even if an operator is not currently signed on to PCS system.
4. Alarms display is to include the following:
 - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
 - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Fuel Blend Tank T-1 High High Level."
 - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
 - d. Include extended message capability to allow assignment and printing of extended action messages. Capability is to be operator programmable and assignable on a per point basis.
5. Direct alarms to appropriate operator interface terminals and individual operators by privilege level and segregation assignments.
6. Send text and voice messages to designated operators for critical alarms.
7. Process and categorize alarms by class as described in Attachment A "Control Narrative."
 - a. Class 1:
 - 1) Associated with fire, security, and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
 - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
 - 3) All conditions make an audible alarm sound and require individual acknowledgment to silence audible sound.
 - b. Class 2:
 - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
 - 2) Acknowledgement may be through a multiple alarm acknowledgment.
 - c. Class 3:
 - 1) General alarms; printed, displayed, and placed in unacknowledged alarm buffer queues.
 - 2) Configure so each new alarm received makes an audible alarm sound that are silenced by "acknowledging" alarm or by pressing a "silence" key.
 - 3) Make acknowledgement of queued alarms either on an individual basis or through a multiple alarm acknowledgement.
 - 4) Print alarms returning to normal condition without an audible alarm sound or require acknowledgment.
 - d. Class 4:

- 1) Routine maintenance or other types of warning alarms.
 - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
 8. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key.
- F. Reports and Logs:
1. Include reporting software package that allows operator to select, modify, or create reports using PCS system I/O point data available.
 2. Setup each report so data content, format, interval, and date are operator definable.
 3. Sample and store report data on PCS controller, within storage limits of PCS controller, and then uploaded to archive on server for historical reporting.
 4. Make it possible for operators to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
 5. Store reports and logs on server hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
- G. Standard Reports: Provide standard PCS system reports with operator ability to customize reports later.
1. All I/O: With current status and values.
 2. Alarm: All current alarms, except those in alarm lockout.
 3. Disabled I/O: All I/O points that are disabled.
 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
 5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
 6. Logs:
 - a. Alarm history.
 - b. System messages.
 - c. System events.
 - d. Trends.
- H. Custom Reports: Operator able to easily define and prepare any system data into a daily, weekly, monthly, annual, or other historical report. Reports to include a title with time and date stamp.
- I. Standard Trends:
1. Trend all I/O point present values, set points, and other parameters indicated for trending.
 2. Preset trend intervals for each I/O point after review with Owner.
 3. Make trend intervals operator selectable from 1 second up to 60 minutes. Make minimum number of consecutive trend values stored at one time 100 per variable.
 4. When drive storage memory is full, overwrite oldest data with most recent data.
 5. Make archived and real-time trend data available for viewing numerically and graphically by operators.
 6. Make exporting of reports to Microsoft Excel or Word as standard features.

2.08 ENCLOSURES

A. General:

1. House each controller and associated control accessories in single enclosure. Enclosure is to serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies, and transformers.
2. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
3. Freestanding enclosures maximum of 48 inches wide and 72 inches high.
4. Supply each enclosure with complete set of as-built schematics, tubing, and wiring diagrams and product literature located in pocket on inside of door.

B. Internal Arrangement:

1. Arrange internal layout of enclosure to group and protect electric, and electronic components associated with controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling, and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 20 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install maximum of two wires on each side of terminal.
9. Include enclosure field electric power supply with toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with line-voltage nominal 20 A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with 5 A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). Nameplates are to have at least 1/4-inch-high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with continuous removable cover.
14. Label each end of cable, wire, and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction, and wind) on enclosure.

3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Freestanding, NEMA 250, Type 12:

1. NRTL listed in accordance with UL 508A.
2. Seams and joints are continuously welded and ground smooth.
3. Modular single or double door floor standing enclosure.
4. Externally formed body flange around perimeter of enclosure face.
5. Type 12 Enclosure Sizes:
 - a. Single-door modular enclosure sizes up to 72 inches tall by 36 inches wide.
 - b. Double-door modular enclosure sizes up to 72 inches tall by 48 inches wide.
6. Frames are roll-formed, welded design made of 12 gauge steel with sold steel, fully welded corners.
7. Frames accommodate the 25-mm DIN standard and include rectangular holes for clip nuts and through holes for use with thread-forming screws.
8. External sides, covers and door constructed of 16 or 14 gauge steel.
9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior Color: Gray.
 - b. Interior Color: Gray.
10. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
11. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty, oiltight handle with integral locking mechanism.
12. Removable internal panel, 0.093 inch thick, with white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
14. Grounding stud on enclosure body.
15. Thermoplastic pocket on inside of door for record Drawings and Product Data.
16. Equip top of enclosure with no fewer than two lifting eyes.
17. Internal rack-mount shelves and angles, as required by application.

E. Accessories:

1. Ventilation Fans, Filtered Intake, and Exhaust Grilles:

- a. Number and size of fans, filters, and grilles, as required by application.
- b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
- c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
- d. Thermostatic control with adjustable set point from 32 to 140 deg F.
- e. Airflow Capacity at Zero Pressure:
 - 1) 4-Inch (100-mm) Fan: 100 cfm.
 - 2) 6-Inch (150-mm) Fan: 240 cfm.
 - 3) 10-Inch (250-mm) Fan: 560 cfm.
- f. Maximum operating temperature of 158 deg F.
- g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
- h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
- i. Dynamically balanced impellers molded from polycarbonate material.
- j. Fan furnished with power cord and polarized plug for power connection.
- k. Fan brackets, finger guards, and mounting hardware provided with fans to complete installation.
- l. Removable Intake and Exhaust Grilles: ABS plastic, of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
- m. Filters for NEMA 250, Type 12 Enclosures: Disposable, of size to match intake grille.

2.09 RELAYS

A. General-Purpose Relays:

- 1. NRTL listed.
- 2. Heavy-duty, electromechanical type; rated for at least 10 A at 30 V dc and at 240 V ac and 60 Hz.
- 3. SPDT, DPDT, or three-pole double-throw, as required by control application.
- 4. Plug-in-style relay with 8-pin octal or multiblade plug for DPDT relays and 11-pin octal or multiblade plug for three-pole double-throw relays.
- 5. Construct contacts of silver, silver alloy, or gold.
- 6. Enclose relay in a clear transparent polycarbonate dust-tight cover.
- 7. Include LED indication.
- 8. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 15 ms or less.
 - d. Dropout Time: 10 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.
 - g. Power Consumption: 5 VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F

9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

B. Multifunction Time-Delay Relays:

1. NRTL listed.
2. Continuous-duty type, rated for at least 10 A at 24 V dc and at 240 V ac and 60 Hz.
3. Relay with up to 8 programmable functions to provide on/off delay, interval, one-shot interval, and recycle timing functions.
4. Plug-in-style relay with either multi-pin or blade plug.
5. Construct contacts of silver, silver alloy, or gold.
6. Enclose relay in a dust-tight cover.
7. Include knob and dial scale for alternative digital interface for setting delay time.
8. Visual Status Indication: Power "On" and Output "On" status.
9. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
 - d. Repeatability: Within 2 percent.
 - e. Recycle Time: 45 ms.
 - f. Minimum Pulse-Width Control: 50 ms.
 - g. Power Consumption: 5 VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
10. Equip relays with transient suppression to limit transients to non-damaging levels.
11. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
12. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

C. Latching Relays:

1. NRTL listed.
2. Continuous-duty type, rated for at least 10 A at 30 V dc and at 250 V ac and 60 Hz.
3. SPDT, DPDT, or three-pole double-throw, as required by control application.
4. Plug-in-style relay with either multi-pin or blade plug.
5. Construct contacts of silver, silver alloy, or gold.
6. Enclose relay in a clear transparent polycarbonate dust-tight cover.
7. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 15 ms or less.
 - d. Dropout Time: 10 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.

- g. Power Consumption: 5 VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
- 8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
 - 9. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
 - 10. Relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

2.10 ELECTRICAL POWER DEVICES

A. DC Power Supplies:

- 1. Description: Linear or switched, regulated power supplies with ac input to one or multiple dc output(s).
 - a. Include both line and load regulation to ensure stable output.
 - b. To protect both power supply and load, include power supply with an automatic current limiting circuit.
- 2. Features:
 - a. Housing: Enclose circuitry in a housing.
 - b. Local Adjustment: Include screw adjustment on exterior of housing for dc voltage output.
 - c. Mounting: DIN rail.
 - d. Visual status indicator.
- 3. Performance:
 - a. Input Voltage: Nominally 120 V ac, 60 Hz.
 - b. Output Voltage: Nominally 24 V dc with plus or minus 1 V dc adjustment.
 - c. Output Current: Minimum 5 A.
 - d. Load Regulation: Within 0.1 percent.
 - e. Line Regulation: Within 0.05 percent.
 - f. Stability: Within 0.1 percent of rated volts after warmup period.
 - g. Ripple: 1 mV rms.

2.11 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

A. Furnish local UPS units, of type indicated, installed with PCS system.

B. DIN Rail Mounted UPS:

- 1. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.
- 2. Performance:

- a. Capacity: Load not to exceed 75 percent of rated capacity.
 - b. Efficiency: Minimum 94 percent.
 - c. Input Voltage: Single phase, 120 V ac, compatible with field power source.
 - d. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
 - e. Output Voltage: 101 to 132 V ac, while input voltage varies between 89 and 152 V ac.
 - f. On Battery Output Voltage: Sine wave.
 - g. Inverter Overload Capacity: Minimum 150 percent for 30 seconds.
 - h. Battery Backup: 15 minutes of operation at full load with battery power.
 - i. Battery Recharge Time: Maximum of six hours to 90 percent capacity after full discharge.
 - j. Transfer Time: 6 ms.
 - k. Surge Voltage Withstand Capacity: IEEE C62.41.1 and IEEE C62.41.2, Categories A and B.
3. Automatic bypass operation during fault or overload conditions.
 4. Integral line-interactive, power condition topology to eliminate all power contaminants.
 5. Include power switch and visual indication of power, battery, fault.
 6. Include audible alarm of faults with silence feature.
 7. Include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure). Points shall be connected to the PCS.
 8. Batteries: Sealed; maintenance free; replacement without dropping load.

2.12 NETWORK EQUIPMENT

- A. Industrial network switches shall have copper (RJ45) ports required for interconnection of the PCS system. Switches shall include a minimum of 2 unallocated copper 100-BaseT ports for temporary maintenance and future equipment access.
- B. PLC mounted equipment shall be Allen-Bradley/Rockwell Automation Stratix 5800 series.
- C. Hardware firewall shall be Ubiquiti Unifi USG Security Gateway.

2.13 PRESSURE INSTRUMENTS

A. Pressure Transmitters

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Endress+Hauser.
 - b. Rosemount.
 - c. Or approved equal.
2. Source Limitations: Obtain pressure transmitters from single manufacturer.
3. Performance:
 - a. Accuracy: Plus or minus 0.05 percent.

- b. Input/Outputs: One (1) analog output (4-20 mA).
 - c. Registration: Pounds per square inch.
 - d. Display: Integral digital readout.
 - e. Ambient Temperature: Minus 40 to 185 deg F.
- 4. Construction:
 - a. Body: Stainless steel or aluminum, NEMA 4X, IP66 rated.
 - b. Housing: Two chamber stainless steel or aluminum.
 - c. Sensor range: 0 to 270 psig.
 - d. Rating: NSF 61 compliant wetted components via EPDM isolation diaphragm.

2.14 TEMPERATURE INSTRUMENTS

A. Space Air Temperature Sensors

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Moore Industries.
 - b. Or approved equal.
- 2. Platinum RTD:
 - a. 1000-ohm platinum RTD at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
 - b. Two wire, PTFE-insulated, 22-gauge stranded copper leads.
- 3. Performance:
 - a. Range: Minus 40 to 140 deg F.
 - b. Input/Output: One analog output (4-20 mA).
 - c. Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
 - d. Repeatability: Within 0.5 deg F.
 - e. Self-heating: Negligible.
- 4. Temperature Transmitter Requirements:
 - a. Mating transmitter required.
- 5. Space Air Temperature Sensor Accessories:
 - a. Insulating Bases: For room temperature sensors located on exterior walls.
 - b. Thermostat Guards: Locking transparent plastic mounted on separate base.

2.15 FLOW INSTRUMENTS

- A. Comply with requirements in Section 407113 "Magnetic Flow Meter" for electromagnetic flowmeters.

2.16 LEVEL INSTRUMENTS

A. Hydrostatic Level Sensor

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Endress+Hauser.
 - b. Or approved equal.
2. Description: Loop-powered, submersible transducer and transmitter with support cord, interconnecting cable with cable shield, and vent tube for atmospheric reference.
3. The vent tube shall be provided with a replaceable moisture barrier.
4. Installation shall allow easy removal of the transducer and cable assembly for maintenance.
5. The electronic signal transmitter shall be incorporated in the transducer and shall produce a 4-20 mA dc signal linearly proportional to the operating pressure range.
6. A weatherproof enclosure housing the vent tube moisture barrier shall be furnished with the sensor.
7. Sensor probe shall be no more 12 inches long and 1.5 inches in diameter.
8. The measurement system shall be supplied with integral water density compensation via integral temperature sensor.
9. Performance:
 - a. Range: Span shall be 0 – 30 feet full scale with minimum sensor extension cable length of 40 feet, with cable suspension mounting fixture and weight.
 - b. Input/Output: One analog output (4-20 mA).
 - c. Submersible transducer shall be suitable for sensing pressure equivalent to liquid level ranged indicated at the specific water depth.
 - d. Sensor extension cable shall have a pull strength of 200 pounds, be factory attached to the transducer, and shall be terminated in a furnished weatherproof enclosure.
 - e. Ambient Temperature:
 - 1) Transducer: 14 to 158 deg F.
 - 2) Sensor Cable: Minus 22 to 158 deg F.
 - 3) Weatherproof enclosure: Minus 40 to 176 deg F.
10. Construction:
 - a. Sensor Probe: 316L stainless steel probe with 316L stainless steel isolating diaphragm and EPDM seal.
 - b. Sensor Extension Cable: Abrasion-resistant cable; twisted copper wires; aluminum shield; TPE insulation; pressure compensation tube with Teflon filter.
 - c. All wetted parts shall be NSF-61 certified for potable water.
 - d. Enclosure: Polycarbonate or aluminum housing.
 - e. Enclosure Rating: NEMA 4X or IP66/67.

B. Float Level Switches

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. SJE Rhomus.
 - b. Or approved equal.
2. Mounting: Suitable for application; horizontal or vertical.
3. Performance:
 - a. Level Actuation and De-Actuation Deadband: 3.0 inches.
 - b. Electrical Rating: 0.1 A at 30 V dc.
4. Wetted Parts Construction:
 - a. Float: Polypropylene.
 - b. Cable: High-impact, corrosion resistance CPE.
 - c. All wetted parts shall be NSF-61 certified for potable water.
 - d. Switch Type: Mercury-free snap switch.

2.17 CHLORINE ANALYZERS

- A. Comply with requirements in Section 407521 "Chlorine Analyzers" for chlorine analyzers.

2.18 POSITION LIMIT SWITCHES

- A. Source Limitations: Obtain position limit switches from single manufacturer.
- B. Description: Select type of actuating head (plunger, roller lever, or rod) to suit application.
- C. Performance:
1. Life Expectancy: Not less than 5 million mechanical operations and 50,000 electrical operations.
 2. Voltage: 125, 250, 480, and 600 V ac or 8, 12, 14, 24, 30, 48, 125, and 250 V dc, as required by application.
 3. Current Rating: As required by application.
 4. Temperature Rise: 90 deg F.
 5. Ambient Temperature: Minus 20 to 185 deg F.
- D. Construction:
1. Enclosure Material: Metal with corrosion-resistant finish.
 2. NEMA 250, Type 4X, as required by application
 3. Switch Type: SPDT or DPDT, as required by application.
 4. Electrical Connection: Screw or plug-in terminals.
 5. Conduit Connection: 1/2 inch NPT.

2.19 ACTUATED VALVES

- A. Comply with requirements in Section 400551 "Plant Valves" for control valves used in process controls.

2.20 CONTROL WIRE AND CABLE

- A. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables" for instrumentation and control circuit cables and conductors.

2.21 RACEWAYS

- A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for low-voltage control raceways.
- B. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for boxes and covers for low-voltage control boxes.

2.22 PROCESS TUBING

- A. Products in this article are intended for signals to instruments connected to process piping.
- B. Stainless Steel Tubing (for Process Tubing):
 - 1. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, and free from scale.
 - 2. Chemical and physical properties in accordance with ASTM A269/A269M.
 - 3. Diameter, as required by application, of not less than nominal 3/8 inch.
 - 4. Wall thickness, as required by application, but not less than 0.035 inch.
 - 5. Furnish stainless steel tubing in 20 ft. straight random lengths.
- C. Stainless Steel Tubing Connectors and Fittings (for Process Tubing) - Stainless Steel, Compression Type:
 - 1. Connectors and fittings constructed from Type 316 stainless steel, with collets, flareless type.
 - 2. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.
 - 3. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on other end.

2.23 SOURCE QUALITY CONTROL

- A. Product(s) and material(s) will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
 - 1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
 - 2. Examine roughing-in for control valves installed in piping to verify actual locations of piping connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, control valve assemblies, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic event, wind, impact, or other forces common to the application.
- D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- F. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- G. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."
- H. Welding Requirements:

1. Restrict welding and burning to supports and bracing.
2. No equipment is cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, is to be by inert-gas electric arc process and is to be performed by qualified welders in accordance with applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

I. Fastening Hardware:

1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

J. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. When conduit is located in a corrosive environment (including all process areas), use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems."
3. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.03 INSTALLATION OF ENCLOSURES

A. Install the following items in enclosures, to comply with indicated requirements:

1. PLC control systems.
2. Industrial network switches.
3. Network equipment.
4. Electrical power devices.
5. UPS units.
6. Relays.
7. Accessories.
8. Actuators.
9. Instrument terminal boxes.

B. Align top of adjacent enclosures of like size.

C. Install floor-mounted enclosures located on concrete housekeeping pads. Attach enclosure legs using galvanized-steel or stainless steel anchors.

- D. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireways used for application are to have protection equal to NEMA 250 rating of connected enclosures.

3.04 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to PCS system products requiring electrical power connections.
- B. Design of electrical power to products not indicated with electric power is delegated to PCS system provider and installing trade to provide a fully functioning PCS system. Work is to comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.
- E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems for electrical power raceways.
- F. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power boxes.

3.05 INSTALLATION OF IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.
- B. Install laminated acrylic or melamine plastic signs with unique identification on face for each of the following:
 - 1. PLC equipment.
 - 2. Enclosure.
 - 3. Electrical power device.
 - 4. UPS unit.
 - 5. Accessory.
- C. Install stainless steel instrumentation identification tags (metal tags) for each instrument or field device connected to PCS.
- D. Install stainless steel instrumentation identification tags (metal tags) for each control valve actuator connected to PCS controller.
- E. Warning Labels and Signs:
 - 1. Permanently attach to equipment that can be automatically started by PCS system.

2. Locate where highly visible near power service entry points.

3.06 INSTALLATION OF NETWORKS

- A. Install balanced twisted pair cables when connecting between the following network devices to interconnect all PLC and PCS components together in accordance with requirements of Sections 271513 "Communications Copper Horizontal Cabling."

3.07 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.08 PRESSURE INSTRUMENTS INSTALLATION

- A. Installation of pressure transmitters shall comply with instrument manufacturer's written instructions.

3.09 TEMPERATURE INSTRUMENTS INSTALLATION

- A. Mount air temperature transmitters on wall. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- B. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation not located in finished space, conceal insulating barrier in a cover matching the instrument cover.
- C. Mounting Height:
 1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
- D. Installation of Space Temperature Sensor:
 1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
 2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
 3. In finished areas, recess electrical box within wall.
 4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
 5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

3.10 INSTALLATION OF FLOW INSTRUMENTS

- A. Comply with requirements in Section 407113 “Magnetic Flow Meter.”

3.11 INSTALLATION OF LEVEL INSTRUMENTS

- A. Hydrostatic Level Sensors:

1. Installation of hydrostatic level sensors shall comply with instrument manufacturer’s written instructions.
2. Suspend level sensor using manufacturer supplied suspension clamp. Follow manufacturer’s written instructions when attaching suspension clamp and inserting level sensor extension cable through suspension clamp.
3. Connect level sensor extension cable to manufacturer supplied weatherproof terminal box as directed in the manufacturer’s written instructions. Connect control circuit from terminal box to the process control system.

- B. Float Level Switches:

1. Installation of float level switches shall comply with instrument manufacturer’s written instructions.

3.12 INSTALLATION CHLORINE ANALYZERS

- A. Comply with requirements in Section 407521 “Chlorine Analyzers.”

3.13 INSTALLATION OF POSITION LIMIT SWITCHES

- A. Mounting Location:

1. Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, and conduit to final location.
2. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

3.14 ACTUATED VALVES

- A. Comply with requirements in Section 400551 “Plant Valves.”

3.15 INSTALLATION OF PROCESS TUBING

- A. Install process tubing for signal to instruments in liquid and steam systems. Instruments include, but are not limited to, the following:
 1. Sensors.
 2. Transmitters.

- B. Support tubing in accordance with MSS SP-58, but at intervals no more than 60 inches apart.
- C. Install minimum NPS 1/2 process tubing for industrial-grade sensors, transmitters, and switches. Install bushings where required.
- D. Make smooth tubing bends with a bending tool. Flattened or wrinkled bends are unacceptable.
- E. Support tubing independent of other trades.
- F. Route tubing parallel to and at right angles to building construction.
- G. Install tubing concealed in areas with ceilings.
- H. Install dirt leg with an isolation valve and threaded plug in drain valve at each connection to a transmitter and switch.
- I. Insulate process piping and tubing connected to process systems for personnel protection if surface temperature exceeds 120 deg F. Only insulate piping and tubing within maintenance personnel reach from floor, platform, or catwalk.
- J. Wrap pipe threads of fitting in process tubing with service temperatures below 350 deg F with single wrap of PTFE tape.
- K. Coat pipe threads of fittings on process tubing in services with temperatures exceeding 350 deg F with pipe compound before being made up to reduce possibility of galling.
- L. Do not make tubing connections to a fitting before completing makeup of connection.
- M. Check tubing for correct diameter and wall thickness. Cut the tube ends square and deburred. Exercise care during cutting to keep tubing round.
- N. Do not install fittings close to a bend. Straight length of tubing, not deformed by bending, is required for proper connection.
- O. Align tubing with fitting when installed. Avoid springing tube into position.
- P. Install tubing with extreme care to keep foreign matter out of system. Plug open tubing ends to keep out dust, dirt, and moisture.
- Q. Do not attach tubing to equipment that may be removed frequently for maintenance or may impart vibration and expansion from temperature change.
- R. Protect exposed tubing in mechanical equipment rooms from inadvertent mechanical damage within 76 inches above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
- S. Identify above-grade process tubing as follows:
 - 1. Every 50 ft. of straight run.
 - 2. At least once for each branch within 36 inches of main tee.
 - 3. Near each change in direction.

4. Within 36 inches of each ceiling, floor, roof, and wall penetration.
5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
6. Near each isolation valve.
7. Mark each instrument tube connection with a number-coded identification. Each unique tube is to have same unique number at instrument connection and termination at opposite end of tube.

T. Process Tubing Isolation Valves Installation:

1. Install valves full size of piping and tubing.
2. Install isolation valves at the following locations:
 - a. Process connection.
 - b. Inlet to each instrument including, sensors, transmitters, switches, gauges, and other control devices.
3. Locate valves to be readily accessible from floor.
4. Install needle valves for isolation and throttling applications. Option to install ball valves in lieu of needle valves for isolation only applications.

3.16 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
2. Comply with installation requirements in Section 271513 "Communications Copper Horizontal Cabling."
3. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
4. Terminate wiring in a junction box.
 - a. Clamp cable over jacket in a junction box.
 - b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.
5. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
6. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
7. Use shielded cable to transmitters.

8. Use shielded cable to temperature sensors.
9. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section 260533.13 "Conduits for Electrical Systems" for control-voltage conductors.
2. Comply with Section 260533.16 "Boxes and Covers for Electrical Systems" for control-voltage conductors.
3. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling.

3.17 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.
- B. Tests and Inspections: Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.18 PCS SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
- E. Control Valve Checkout:
 1. Verify that control valves are installed correctly for flow direction.
 2. Verify that valve body attachment is properly secured and sealed.
 3. Verify that valve actuator and linkage attachment are secure.
 4. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 5. Verify that valve ball, disc, or plug travel is unobstructed.
 6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.
- F. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments, verify the following:
 - a. Sensing element type and proper material.
 - b. Length and insertion.

3.19 PCS SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
 1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.
- F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.
- G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.
- H. Test all I/O channels not connected to field instruments, control valves, or other process field devices.
- I. Analog Signals:
 1. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 2. Check resistance signals for temperature sensors at zero, zero, 50, and 100 percent of operating span using a precision-resistant source.

J. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Check and document open and close cycle times for applications with cycle time less than 30 seconds.
3. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Meters: Check meters at zero, 50, and 100 percent of Project design values.

M. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

N. Switches: Calibrate switches to make or break contact at set points indicated.

O. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.20 PCS SYSTEM CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to backup power source.
6. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.21 PCS SYSTEM I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to PCS controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.

2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify that operation is stable and accurate.
4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
 - a. Upper quarter of range.
 - b. Lower quarter of range.
 - c. At midpoint of range.
8. Exercise each digital point.
9. For every I/O point in PCS system, read and record each value at operator workstation, at operator interface terminal, at PCS controller, and at field instrument simultaneously. Value displayed at operator workstation, at operator interface terminal, at PCS controller, and at field instrument must match.
10. Prepare and submit report documenting results for each I/O point in PCS system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

3.22 PCS SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed Pretest Checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
 1. Detailed explanation for any items that are not completed or verified.
 2. Required mechanical installation work is successfully completed and equipment is working correctly.
 3. Process equipment motors operate below full-load amperage ratings.
 4. Required PCS system components, wiring, and accessories are installed.
 5. Installed PCS system architecture matches approved Drawings.
 6. Control electric power circuits operate at proper voltage and are free from faults.
 7. Required surge protection is installed.
 8. PCS system network communications function properly, including uploading and downloading programming changes.
 9. Each controller's programming is backed up.
 10. Equipment, products, tubing, wiring cable, and conduits are properly labeled.
 11. All I/O points are programmed into controllers.
 12. Valves and actuators zero and span adjustments are set properly.

13. Each control valve and actuator goes to failed position on loss of power and loss of signal.
14. Meter, sensor, and transmitter readings are accurate and calibrated.
15. Control loops are tuned for smooth and stable operation.
16. View trend data where applicable.
17. Each controller works properly in standalone mode.
18. Safety controls and devices function properly.
19. Electrical interlocks function properly.
20. Operator interface terminals and other interfaces are delivered, all system and database software is installed, and graphics are created.
21. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit validation Test Plan including test procedures for performance validation tests.
2. Address all specified functions of PCS system and control sequences as outlined in Attachment A: Control Narrative in Test Plan.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include Test Checklist to be used to check and initial that each test step has been successfully completed.
6. Submit Test Plan documentation 10 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in PCS system.
 - a. Verify analog I/O points at operating value.
 - b. Make adjustments to out-of-tolerance I/O points.
 - 1) Identify I/O points for future reference.
 - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
 - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of PCS system to establish desired conditions.
4. 24 hours after initial validation test, do as follows:
 - a. Re-check I/O points that required corrections during initial test.
 - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. 24 Hours after second validation test, do as follows:

- a. Re-check I/O points that required corrections during second test.
 - b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that PCS system performs according to requirements indicated.
 7. After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

3.23 FINAL REVIEW

- A. Submit written request to Owner when PCS system is ready for final review. State the following:
 1. PCS system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
 2. PCS system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
 3. PCS system monitoring and control of process systems results in operation according to control sequences indicated in Attachment A "Control Narrative".
 4. PCS system is complete and ready for final review.
- B. Upon receipt of written request for final review, Owner will start review within 10 business days and upon completion issue field report(s) documenting observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Compensation for Subsequent Reviews: Should more than two reviews be required, PCS system manufacturer and Installer shall compensate entity/entities performing reviews for total costs (labor and expenses) associated with subsequent reviews. Estimated cost of each subsequent review to be submitted and approved by PCS system manufacturer and Installer before review.
- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. Part of PCS system final review to include demonstration to parties participating in final review.
 1. Provide staff familiar with PCS system installed to demonstrate operation of PCS system during final review.
 2. Provide testing equipment to demonstrate accuracy and other performance requirements of PCS system that is requested by reviewers during final review.
 3. Demonstration to include, but not be limited to, the following:
 - a. Accuracy and calibration of 20 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by

- reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
- b. Demonstrate all validation tests with the Owner's Representative present as a witness. Demonstration shall be carried out as described under "Validation Test."
 - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored.
 - d. Reporting of alarm conditions for randomly selected alarms to ensure that alarms are properly received by operators and operator workstations.
 - e. Trends, summaries, logs, and reports set up for Project.
 - f. Software's ability to communicate with controllers, operator workstations, and uploading and downloading of control programs.
 - g. Software's ability to edit control programs offline.
 - h. Data entry to show Project-specific customizing capability including parameter changes.
 - i. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
 - j. Execution of digital and analog commands in graphic mode.
 - k. System speed of response compared to requirements indicated.
 - l. For Each PCS Controller:
 - 1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation are not to be lost during power failure.
 - 2) Operator Interface: Ability to connect directly to each type of digital controller with portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
 - 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
 - 4) Electric Power: Ability to disconnect any controller safely from its power source.
 - 5) Wiring Labels: Match control drawings.
 - 6) Network Communication: Ability to locate controller's location on network and communication architecture matches Shop Drawings.
 - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.
 - m. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management.
 - 1) Data Presentation: On each operator interface terminal, demonstrate graphic display capabilities.
 - 2) Set-Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
 - 3) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.

- 4) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.

3.24 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, verify that maintenance service includes 12 months' full maintenance by PCS system manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration, and adjusting as required for proper operation. Use only manufacturer's authorized replacement parts and supplies.

3.25 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, verify that service agreement includes software support for two year(s).

3.26 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain PCS system.
- B. Extent of Training:
 1. Base extent of training on scope and complexity of PCS system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
 3. Minimum Training Requirements:
 - a. Provide not less than two days of training total.
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training to occur before end of warranty period.
 - c. Break down total days of training into not more than two separate training classes.
 - d. Schedule training so each training class is not less than two consecutive day(s).
- C. Training Schedule:
 1. Schedule training with Owner 20 business days before expected Substantial Completion.
 2. Schedule training to provide Owner with at least 10 business days of notice in advance of training.
 3. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session to be split in half with 15-minute break between sessions. Morning

and afternoon sessions to be separated by 60-minute lunch period. Training, including breaks and excluding lunch period, are not to exceed eight hours per day.

4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number, and email address.
2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session. Indicate which attendees, if any, joined for only part of training sessions.

E. Training Attendee Headcount:

1. Plan in advance of training for two five Insert number attendees.
2. Make allowance for Owner to add up to two attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:

1. High school education and degree.
2. Basic user knowledge of computers and office applications.
3. Basic knowledge of PCS systems.
4. Basic knowledge of PCS system and products installed.

G. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.

H. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
 - a. Daily operators.
 - b. Advanced operators.
 - c. System managers and administrators.

2. Plan and organize training sessions to group training content to protect PCS system security. Some attendees may be restricted to some training sessions to ensure PCS system security.

I. Training Outline:

1. Submit training outline for Owner review at least 10 business day(s) before scheduling training.
2. Include in outline a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session, and synopses for each lesson planned.

J. On-Site Training:

1. Provide as much of training located on-site as deemed feasible and practical by Owner.
2. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.

K. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding PCS system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by PCS system including sequences of operation, each unique control algorithm, and each unique optimization routine.
5. Logging on and off system.
6. Accessing graphics, reports, and alarms.
7. Adjusting and changing set points and time schedules.
8. Recognizing PCS system malfunctions.
9. Understanding content of operation and maintenance manuals including control drawings.
10. Understanding physical location and placement of PCS controllers and I/O hardware.
11. Accessing data from PCS controllers.
12. Running each specified report and log.
13. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
14. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
15. Executing digital and analog commands in graphic mode.
16. Demonstrating the following for process systems and equipment controlled by PCS system:
 - a. Operation of process equipment in normal-off, normal-on, and failed conditions while observing individual equipment and valves for correct position under each condition.
 - b. For process equipment with factory-installed software, show that integration into PCS system is able to communicate with PCS controller.

- c. Hardware interlocks and safeties function properly and PCS system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
 - d. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
 - e. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
- L. Training Content for Advanced Operators:
 - 1. Creating, deleting, and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
 - 2. Creating, deleting, and modifying reports.
 - 3. Creating, deleting, and modifying points.
 - 4. Performing PCS system checkout and diagnostic procedures.
 - 5. Performing PLC controller operation and maintenance procedures.
 - 6. Performing operator workstation operation and maintenance procedures.
 - 7. Maintaining, calibrating, troubleshooting, diagnosing, and repairing hardware.
 - 8. Adjusting, calibrating, and replacing PCS system components.
- M. Training Content for System Managers and Administrators:
 - 1. PCS system software maintenance and backups.
 - 2. Uploading, downloading, and offline archiving of all PCS system software and databases.
 - 3. Interface with Project-specific, third-party operator software.
 - 4. Understanding password and security procedures.
 - 5. Adding new operators and making modifications to existing operators.
 - 6. Operator password assignments and modification.
 - 7. Operator authority assignment and modification.
 - 8. Workstation data segregation and modification.

END OF SECTION

SECTION 406000 - ATTACHMENT B- I/O LIST

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Project:	City & Borough of Yakutat Airport Water System Extension
Project #:	I0297.24002
Title:	Section 406000 Attachment B - I/O List
Design:	NK
Drawn:	REM
Checked:	KHD
Date:	4/16/2025

TAG	DESCRIPTION	I/O ADDRESS	I/O TYPE	SIGNAL TYPE	CONFIGURED RANGE/SETPOINT	UNITS	REMARKS
XS-010A	BOOSTER PUMP BP-01 RUN STATUS CONTACT	S01CH00	DI	24 VDC	N/A	N/A	
XS-010B	BOOSTER PUMP BP-01 FAULT ALARM CONTACT	S01CH01	DI	24 VDC	N/A	N/A	
XS-012A	BOOSTER PUMP BP-03 RUN STATUS CONTACT	S01CH02	DI	24 VDC	N/A	N/A	
XS-012B	BOOSTER PUMP BP-03 FAULT ALARM CONTACT	S01CH03	DI	24 VDC	N/A	N/A	
XS-013A	RE-CIRCULATION PUMP (RC-01) RUN STATUS CONTACT	S01CH04	DI	24 VDC	N/A	N/A	
XS-013B	RE-CIRCULATION PUMP (RC-01) FAULT ALARM CONTACT	S01CH05	DI	24 VDC	N/A	N/A	
XS-014A	CHLORINE DOSING PUMP CP-01 RUN STATUS CONTACT	S01CH06	DI	24 VDC	N/A	N/A	
XS-014B	CHLORINE DOSING PUMP CP-01 FAULT ALARM CONTACT	S01CH07	DI	24 VDC	N/A	N/A	
ASH-020	CHLORINE ROOM GAS DETECTOR PANEL ALARM CONTACT	S01CH08	DI	24 VDC	0.5	PPM	SETPOINT CONFIGURED AT CHLORINE ROOM GAS DETECTOR PANEL
XS-300A	PLC UPS ON BATTERY STATUS CONTACT	S01CH09	DI	24 VDC	N/A	N/A	
XS-300B	PLC UPS LOW BATTERY ALARM CONTACT	S01CH10	DI	24 VDC	N/A	N/A	
XS-102A	ATS CONNECTED TO UTILITY POWER DRY CONTACT	S01CH11	DI	24 VDC	N/A	N/A	
XS-102B	ATS CONNECTED TO GEN POWER DRY CONTACT	S01CH12	DI	24 VDC	N/A	N/A	
XS-102C	ATS UTILITY POWER FAILURE ALARM CONTACT	S01CH13	DI	24 VDC	N/A	N/A	
XS-102D	ATS FAILURE TO SWITCH TO GENERATOR ALARM CONTACT	S01CH14	DI	24 VDC	N/A	N/A	
SPARE	SPARE I/O POINT FOR FUTURE USE	S01CH15	DI	24 VDC	N/A	N/A	
XS-011A	BOOSTER PUMP BP-02 RUN STATUS CONTACT	S02CH00	DI	24 VDC	N/A	N/A	
XS-011B	BOOSTER PUMP BP-02 FAULT ALARM CONTACT	S02CH01	DI	24 VDC	N/A	N/A	
XS-103A	GENERATOR AUTO/HAND STATUS CONTACT	S02CH02	DI	24 VDC	N/A	N/A	
XS-103B	GENERATOR RUN STATUS CONTACT	S02CH03	DI	24 VDC	N/A	N/A	
XS-103C	GENERATOR FAULT ALARM CONTACT	S02CH04	DI	24 VDC	N/A	N/A	
LSL-101	DAY TANK LOW LEVEL ALARM CONTACT	S02CH05	DI	24 VDC	N/A	N/A	
LSH-101	DAY TANK HIGH LEVEL ALARM CONTACT	S02CH06	DI	24 VDC	N/A	N/A	
XS-204A	CATHODIC PROTECTION SYSTEM STATUS CONTACT	S02CH07	DI	24 VDC	N/A	N/A	
XS-204B	CATHODIC PROTECTION SYSTEM TROUBLE ALARM CONTACT	S02CH08	DI	24 VDC	N/A	N/A	
ZSC-202	WATER STORAGE TANK HATCH INTRUSION SWITCH	S02CH09	DI	24 VDC	N/A	N/A	
LSHH-201	WATER STORAGE TANK HIGH-HIGH LEVEL SWITCH	S02CH10	DI	24 VDC	284	INCHES	FLOAT LEVEL SWITCH MOUNTED AT ELEVATION OF 23 FEET 8 INCHES.
LSLL-201	WATER STORAGE TANK LOW-LOW LEVEL SWITCH	S02CH11	DI	24 VDC	42	INCHES	FLOAT LEVEL SWITCH MOUNTED AT ELEVATION OF 3 FEET 6 INCHES.
XS-203A	WATER STORAGE TANK MIXER RUN STATUS CONTACT	S02CH12	DI	24 VDC	N/A	N/A	
XS-203B	WATER STORAGE TANK MIXER ALARM CONTACT	S02CH13	DI	24 VDC	N/A	N/A	
ST-014	CHLORINE DOSING PUMP SPEED FEEDBACK	S02CH14	DI	PULSE	0-100	%	PROVIDE INTERFACE CIRCUIT BETWEEN THIS INPUT POINT AND CHLORINE DOSING PUMP SPEED PULSE OUTPUT POINT.
SPARE	SPARE I/O POINT FOR FUTURE USE	S02CH15	DI	24 VDC	--	--	
RESERVED	RESERVED FOR FUTURE WELL PUMP CONTROLS	S03CH00	DI	24 VDC	--	--	
RESERVED	RESERVED FOR FUTURE WELL PUMP CONTROLS	S03CH01	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH02	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH03	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH04	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH05	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH06	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH07	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH08	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH09	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH10	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH11	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH12	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH13	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH14	DI	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S03CH15	DI	24 VDC	--	--	
XY-010	BOOSTER PUMP BP-01 START/STOP COMMAND	S04CH00	DO	24 VDC	N/A	N/A	
XY-011	BOOSTER PUMP BP-02 START/STOP COMMAND	S04CH01	DO	24 VDC	N/A	N/A	
XY-012	BOOSTER PUMP BP-03 START/STOP COMMAND	S04CH02	DO	24 VDC	N/A	N/A	
XY-013	RE-CIRCULATION PUMP (RC-01) START/STOP COMMAND	S04CH03	DO	24 VDC	N/A	N/A	
XY-014	CHLORINE DOSING PUMP CP-01 START/STOP COMMAND	S04CH04	DO	24 VDC	N/A	N/A	
XY-203	WATER STORAGE TANK MIXER MXR-01 START/STOP COMMAND	S04CH05	DO	24 VDC	N/A	N/A	
RESERVED	RESERVED FOR FUTURE WELL PUMP CONTROLS	S04CH06	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH07	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH08	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH09	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH10	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH11	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH12	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH13	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH14	DO	24 VDC	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S04CH15	DO	24 VDC	--	--	
FIT-001	WATER TANK FILL LINE FLOWMETER	S05CH00	AI	4-20 MA	0-400	GPM	
FIT-005	CBY INTERTIE LINE FLOWMETER	S05CH01	AI	4-20 MA	0-800	GPM	
FIT-006	AIRPORT SUPPLY LINE FLOWMETER	S05CH02	AI	4-20 MA	0-800	GPM	
FIT-008	RE-CIRCULATION LINE FLOWMETER	S05CH03	AI	4-20 MA	0-40	GPM	
PIT-003	BOOSTER PUMP SUCTION WATER PRESSURE TRANSMITTER	S05CH04	AI	4-20 MA	0-100	PSIG	
PIT-004	BOOSTER PUMP DISCHARGE WATER PRESSURE TRANSMITTER	S05CH05	AI	4-20 MA	0-100	PSIG	
AIT-007	FREE CHLORINE CONCENTRATION TRANSMITTER	S05CH06	AI	4-20 MA	0-10	PPM	



Project:	City & Borough of Yakutat Airport Water System Extension
Project #:	I0297.24002
Title:	Section 406000 Attachment B - I/O List
Design:	NK
Drawn:	REM
Checked:	KHD
Date:	4/16/2025

TAG	DESCRIPTION	I/O ADDRESS	I/O TYPE	SIGNAL TYPE	CONFIGURED RANGE/SETPOINT	UNITS	REMARKS
ST-011	BOOSTER PUMP BP-02 SPEED FEEDBACK	S05CH07	AI	4-20 MA	0-60	HZ	
ST-010	BOOSTER PUMP BP-01 SPEED FEEDBACK	S06CH00	AI	4-20 MA	0-60	HZ	
ST-012	BOOSTER PUMP BP-03 SPEED FEEDBACK	S06CH01	AI	4-20 MA	0-60	HZ	
ZT-002	WATER STORAGE TANK LEVEL CONTROL VALVE POSITION FEEDBACK	S06CH02	AI	4-20 MA	0-100	% OPEN	
TT-021	PUMP ROOM AMBIENT TEMPERATURE TRANSMITTER	S06CH03	AI	4-20 MA	0-120	DEG F	
LT-200	WATER STORAGE TANK LEVEL SENSOR	S06CH04	AI	4-20 MA	360	INCHES	
ST-013	RE-CIRCULATION PUMP (RC-01) SPEED FEEDBACK	S06CH05	AI	4-20 MA	--	--	
RESERVED	RESERVED FOR FUTURE WELL PUMP CONTROLS	S06CH06	AI	4-20 MA	--	--	
RESERVED	RESERVED FOR FUTURE WELL PUMP CONTROLS	S06CH07	AI	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S07CH00	AI	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S07CH01	AI	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S07CH02	AI	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S07CH03	AI	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S07CH04	AI	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S07CH05	AI	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S07CH06	AI	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S07CH07	AI	4-20 MA	--	--	
SY-010	BOOSTER PUMP BP-01 VFD SPEED CONTROL	S08CH00	AO	4-20 MA	0-60	HZ	
SY-012	BOOSTER PUMP BP-03 VFD SPEED CONTROL	S08CH01	AO	4-20 MA	0-60	HZ	
LV-002	WATER STORAGE TANK LEVEL CONTROL VALVE	S08CH02	AO	4-20 MA	0-100	% OPEN	
SY-014	CHLORINE DOSING PUMP CP-01 SPEED CONTROL	S08CH03	AO	4-20 MA	0-60	HZ	
SY-013	RE-CIRCULATION PUMP (RC-01) VFD SPEED CONTROL	S08CH04	AO	4-20 MA	--	--	
RESERVED	RESERVED FOR FUTURE WELL PUMP CONTROLS	S08CH05	AO	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S08CH06	AO	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S08CH07	AO	4-20 MA	--	--	
SY-011	BOOSTER PUMP BP-02 VFD SPEED CONTROL	S09CH00	AO	4-20 MA	0-60	Hz	
SPARE	SPARE I/O POINT FOR FUTURE USE	S09CH01	AO	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S09CH02	AO	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S09CH03	AO	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S09CH04	AO	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S09CH05	AO	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S09CH06	AO	4-20 MA	--	--	
SPARE	SPARE I/O POINT FOR FUTURE USE	S09CH07	AO	4-20 MA	--	--	