SECTION 17000

general requirements for instrumentation   
& control (I&C) system

# GENERAL

## DESCRIPTION

### This section identifies general requirements for the Contractor’s Process Instrumentation and Control Integrator (PICI) and the District’s Process Control and Instrumentation System (PCIS) supplier. The Telemetry Control Panels (TCP), wireless communications equipment, Applications Software and the SCADA control of the facility/plant is provided by the District’s PCIS supplier. The PICI is responsible for implementation of the Contractor’s work described within this Section and to ensure that all of the integration work required to make all of the various electrical, mechanical and control elements operate correctly.

## RELATED WORK SPECIFIED UNDER OTHER SECTIONS

### The requirements of the following sections and divisions apply to the Work of this section. Other sections and divisions, not referenced below, shall also apply to the extent required for proper performance of this Work.

#### Section 01300 – Contractor Submittals

#### Section 01700 – Project Closeout

#### Section 01810 – Start-Up, Testing and Commissioning

#### Section 17100 – Input/Output Signals List

#### Section 17200 – Field Mounted Instruments

#### Section 17300 – Remote Terminal Unit (RTU/TCP)

#### Section 17400 – Control Narrative

[Note to Engineer – Adjust the related sections as appropriate to the specific project sections.]

## DEFINITIONS

### **PICI:** A member of the Contractor’s team or a Sub-Contractor thereof.

### **PCIS Supplier:** The District’s supplier of the PCIS system.

### **Commissioning Coordinator:** A member of the Contractor’s team. The Commissioning Coordinator shall lead all pre-commissioning and commissioning efforts and utilize representatives of the CONTRACTOR’s mechanical, electrical and instrumentation Subcontractors, and others as appropriate for Pre‑commissioning and Commissioning activities and testing.

## REFERENCE STANDARDS

### American Society for Testing and Materials (ASTM):

#### ASTM A269 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

### International Society of Automation (ISA):

#### ISA S5.2 – Binary Logic Diagrams for Process Operations.

#### ISA S5.3 – Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.

#### ISA S5.4 – Standard Instrument Loop Diagrams.

### American National Standards Institute (ANSI):

#### ANSI X3.5 – Flowchart Symbols and Their Usage in Information Processing.

### National Electrical Manufacturers Association (NEMA).

### Underwriter Laboratories (UL)

### National Fire Protection Association (NFPA)

### Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

## PICI SCOPE

### PICI responsibilities includes:

#### Development of the wiring drawing packages for all interconnects for all equipment.

#### Providing all of the information necessary for the PCIS supplier to correctly identify all of the I/O that is to be connected to the control system.

#### Assign all field wiring numbers.

#### Develop and execute Loop drawings for all real and virtual loops (Virtual loops are defined as analog values provided using some sort of communications method rather than a hardwired signal).

#### Prepare testing documents for the PICI portion of the Startup-Up, Testing and Commissioning Plan. Prepare Pre-Commissioning and Commissioning testing documents and provide to the Commissioning Coordinator for integration into the facility Commissioning Plan.

#### Preform, document and submit results of all unwitnessed field testing of all of the loops (Real and Virtual).

#### Coordinate memory map with the PCIS for vendor supplied PLC Panels.

#### Coordinate with the PCIS supplier to validate all I/O real and virtual prior to executing SAT-2.

#### Develop the Site Acceptance Plan for approval by the District.

#### The PICI shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the Electrical Contractor and to the PICI furnishing the equipment under this Division.

#### The PICI shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.

[Note to Engineer – Identify all required virtual signals on the P&ID’s and in the Control Strategies.]

### Prior to performing any work, the PICI shall meet the Design Engineer and the District’s representative to confirm work requirements and to follow District standards. The PICI shall provide all components, system installation services, as well as, all required and specified ancillary services including all materials, labor, tools, fees, charges and documentation required to furnish, install, program (programming for items other than PCIS system programming provided by District’s PCIS supplier), test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified in the contract drawings. The system shall include all measuring elements, signal converters, transmitters, control panels, cabinets signal and data transmission systems, interconnecting wiring, brackets, supports, piping, tubing, valves, mounting hardware, and such accessories as shown, specified, and/or required to provide the functions indicated and a complete working system in place. In addition, the PICI shall provide Loop sheets for all mechanical, electrical and virtual data points from all equipment. In particular loop drawings shall be provided for every virtual electrical points provided over either Ethernet or serial communications. At a minimum, the following data points shall be provided:

#### Volts, amps, device status, obtain IP address, Ethernet /IP or Modbus address from the District, scaling of all analog values

##### Motor protection device; remote reset, fault status

##### Soft Starter; last 5 faults, address of output to reset soft Starter fault

##### Power monitoring; Watts, power factor, current

### The scope of the work to be performed includes, but is not limited to, the following:

#### The PICI shall retain overall responsibility for the instrumentation and non- PCIS products and services, as specified herein and shown on P&IDs, I/O lists, Alarm Lists and Control Narrative.

#### The PICI shall furnish all services and equipment defined herein and in other Specification sections as listed below under related work.

#### Furnish and install process instrumentation and associated taps, nipples, valves, tubing, embedded supports, instrument stands, brackets, mounting hardware and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.

#### Final termination and testing of all instrumentation and control system signal wiring and power supply wiring at equipment furnished under this Division at the TCP panels. Wire terminations may be performed by the Electrical Contractor.

#### Furnish and install surge protective device systems for all digital equipment, data communications equipment, local control panels, and field instruments provided under this Division, including connections to grounding system(s) provided under Division 16.

#### Coordinate grounding requirements with the Electrical Contractor for all digital equipment, local control panels, and field instrumentation provided under this Division. Terminate grounding system cables at all equipment provided under this Division. Each control panel shall be provided with a ground lug.

#### Provide to the PCIS supplier the loop diagrams for all points including ranging and alarm point settings for each point (both virtual and real).

#### PICI to develop and execute the end-to-end point by point test plan for both Virtual and real I/O points. Coordinate testing process with PCIS supplier and arrange with the PCIS supplier to execute the test plan to verify that the field data is received into the TCP.

#### Provide system testing, calibration, and startup services as specified herein and as required to make all systems fully operational.

#### Furnish operator training services as described herein. Coordinate with the District for the number of training classes required and times.

### Instrument and control systems furnished by the PICI shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications:

#### Verify following work not by PICI is provided:

##### Correct type, size, and number of signal wires with their raceways including grounding systems, special cables, and Ethernet cables.

##### Correct electrical power circuits and raceways.

##### Correct size, type, and number of I&C related pipes, valves, fittings, and tubes. Correct size, type, materials, and connection of process mechanical piping for in-line primary elements.

##### Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, A.C. power supplies for all equipment, control panels and accessories furnished under Division 17. All control panels with analog instrument inputs are to have an isolated ground.

##### Conduit and raceways for all instrumentation and control system signal wiring.

##### Installation of (pull in conduit system) copper and fiber optic data communications cables.

##### Installation of grounding systems for all digital equipment, local control panels, and field instrumentation provided under Division 16 Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the PICI.

##### Termination of all instrumentation and control system grounding, signal and data communications cables, wiring and surge suppression devices at the equipment end of all equipment furnished under other divisions of the Specifications. Wiring systems shall be complete to the equipment provided under Division 16, ready for termination by the PICI.

#### For equipment not provided under PICI, but directly connected to equipment required by PICI:

##### Obtain from Contractor, manufacturer’s information on installation, interface, function, and adjustment.

##### Coordinate with Contractor to allow required interface and operation with I&C System.

##### For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed with manufacturer’s recommendations.

##### Test to demonstrate required interface and operation.

##### Examples of items in this category, but not limited to the following:

###### Valve operators, position switches, and controls.

###### Variable frequency drives.

###### Motor control centers.

###### Packaged subcontrol (Vendor) systems.

### It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein or shown on the design drawings.

## PCIS SCOPE

### The Process Control and Instrumentation System (PCIS) is the method by which the overall collection, local control, HMI and historical data collection and display are provided. The District’s PCIS supplier is to utilize the project documents as the functional design criteria for the operation of the Process Control and Instrumentation System. In general, the PCIS supplier is to ensure that the PCIS functions correctly for the specific requirements of the project facility. The District has one SCADA based PCIS supplier and one DCS based PCIS supplier that are qualified to create the PCIS for a specific project. Prior to performing any work, the District’s PCIS supplier shall meet with the District and District’s Representatives to confirm project requirements.

### The PCIS supplier shall utilize the Contract documents as the basic criteria for the design of the project’s PCIS to develop and implement PCIS software programs, alarms, and screen implementation. Contract documents include the P&IDs, I/O lists, Alarm Lists (including high / low alarm limits and action to be taken – action taken can be defined in Control Narrative) and Control Narrative. The output product of the PCIS supplier is to deliver a working automated control system which will be integrated into the District’s existing automated control systems.

### The PCIS supplier shall ensure that the commissioned PCIS system meets the project’s operational requirements and to provide an integrated control, monitoring and alarm reporting system while maintaining District standards. The function of the PCIS system is to monitor, control, report, safeguard and notify operators of any abnormal system conditions. The PCIS supplier provides all the SCADA Central control room and field HMI digital access via the required wireless data links as well as the full implementation of the automated controls as defined by the Contract documents. The SCADA PCIS typically performs testing activities remotely with the assistance of the District Operations on-site.

## GENERAL INFORMATION AND DESCRIPTION

### The Contractor shall provide all materials, equipment, labor, and services required to ensure that all of the field controls and status information is correctly received by the TCP. The PCIS supplier shall be responsible for ensuring that the full automated control of the system is accomplished per the P&ID of the design drawings and control narratives provided by the Engineer. The PICI shall provide final design and coordinate the instrument and control equipment to ensure proper manual operation of all field equipment and materials furnished by other suppliers under other sections of these Specifications and with related existing plant equipment.

### Auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with equipment provided by other suppliers under other Sections of these Specifications, shall be included whether they are shown on the design drawings or not.

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

### Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with detailed drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer as approved by the District.

### To facilitate the District's future operation and maintenance, products shall be of the same major instrumentation manufacturer, with panel mounted devices of the same type and model to the greatest extent possible.

### All equipment shall be listed and labeled as defined in Article 100 of National Electrical Code, and shall satisfy applicable Federal, State and local codes.

### All installations shall be per National Electrical Code, and shall satisfy applicable Federal, State and local codes.

### Supplementing this Section, the Drawings and the related Specification sections provide additional details showing panel elevations, instrument device schedules, functional requirements of the system and interaction with other equipment.

### Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings. All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of Shop Drawings, unless otherwise specified to match existing equipment. All technical data publications included with submittals shall be the most recent issue.

### In order to centralize responsibility, it is required that all equipment (including field instrumentation and non-PCIS hardware and software) offered under this Division shall be furnished and installed by the Contractor, or under the supervision of the PICI, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating all signals, and furnishing all appurtenant equipment.

### The PICI shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and non-PCIS related control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment and/or systems ..

### The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field-mounted equipment provided by others. The PICI shall examine the mechanical, process, and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The PICI shall inspect all equipment, panels, instrumentation, controls, and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the control and information system. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished. The PICI shall review and approve the size and routing of all instrumentation and control cable and conduit systems furnished by the Electrical Contractor for suitability for use with the associated cable system.

### The PICI shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the Electrical Contractor and to the PICI furnishing the equipment under this Division.

### The PICI shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.

### The District shall have the right of access to the PICI facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The PICI and his equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

### The terms "Instrumentation", "Instrumentation and non-PCIS Control System", and "Instrumentation, non-PCIS Control and Monitoring System" shall hereinafter be defined as all equipment, labor, services and documents necessary to meet the intent of the Specifications.

### Signal Characteristics:

#### Signals shall be electrical, as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted. Electrical signals outside control panel(s) shall be 4 to 20 milliamperes DC, except as noted. Signals within enclosures may be 0-32 volts DC.

### Matching Style Appearance and Type:

#### All instruments to be panel mounted at the control panels shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be of 1 manufacturer.

### Accuracy and Repeatability:

#### The overall accuracy of each instrumentation system or loop shall be as prescribed in the Specifications for that system or loop and shall be shown on each loop drawing. Each system's accuracy shall be determined as a probable maximum error; this shall be the square-root of the sum of the squares of certified "accuracy s" of certain designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual electronic instrument shall have a minimum accuracy of +/-0.7 percent of full scale and a minimum repeatability of +/-0.4 percent of full scale unless otherwise specified. Instruments which do not conform to or improve upon these criteria are not acceptable. Accuracy requirements apply to both hardwired signals and virtual (soft/IO) signals via communications connectivity.

### Alternative Equipment or Methods:

#### Equipment or methods requiring redesign of any project details are not acceptable without prior approval of the District . Any changes inherent to a proposal alternative shall be at no additional cost to the District. The required approval shall be obtained in writing by the PICI through the Contractor prior to submittal of Shop Drawings and data. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage, and maintenance enhancement over the equipment or method specified, or shall include evidence that a specified component is not available. Otherwise, alternative equipment (other than direct, equivalent substitutions) and alternative methods shall not be proposed.

## PICI RELATED WORK

### Instrument and control systems furnished by the PICI shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications:

#### Verify following work not by PICI is provided:

##### Correct type, size, and number of signal wires with their raceways including grounding systems, special cables, and Ethernet cables.

##### Correct electrical power circuits and raceways.

##### Correct size, type, and number of I&C related pipes, valves, fittings, and tubes. Correct size, type, materials, and connection of process mechanical piping for in-line primary elements.

##### Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, A.C. power supplies for all equipment, control panels and accessories furnished under Division 17. All control panels with analog instrument inputs are to have an isolated ground.

##### Conduit and raceways for all instrumentation and control system signal wiring.

##### Installation of (pull in conduit system) copper and fiber optic data communications cables.

##### Installation of grounding systems for all digital equipment, local control panels, and field instrumentation provided under Division 16 Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the PICI.

##### Termination of all instrumentation and control system grounding, signal and data communications cables, wiring and surge suppression devices at the equipment end of all equipment furnished under other divisions of the Specifications. Wiring systems shall be complete to the equipment provided under Division 16, ready for termination by the PICI.

#### For equipment not provided under PICI, but directly connected to equipment required by PICI:

##### Obtain from Contractor, manufacturer’s information on installation, interface, function, and adjustment.

##### Coordinate with Contractor to allow required interface and operation with I&C System.

##### For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed with manufacturer’s recommendations.

##### Test to demonstrate required interface and operation.

##### Examples of items in this category, but not limited to the following:

###### Valve operators, position switches, and controls.

###### Variable frequency drives.

###### Motor control centers.

###### Packaged subcontrol (Vendor) systems.

## QUALITY ASSURANCE

### The Contractor shall provide qualifications, details and a description of the proposed PICI and how he/she proposes to fulfill the requirements set forth in this Specification. The PICI shall present the information in sufficient detail so that proper evaluation regarding the experience and capabilities of the PICI can be performed:

#### The information shall contain evidence that the proposed PICI has sufficient financial and labor resources to meet the obligations incident to the performance of the work including available bonding. (This requirement may be provided in the form of a verifiable or certified financial report for the company’s latest fiscal year).

#### The information shall contain a list of personnel available for assignment to the responsible positions of Project Manager, Project Engineer, Installation Supervisor, and Area Service Representative. Also include a concise resume of each individual’s education, work experience, and accomplishments.

##### The information shall contain the following specific information:

##### Maintenance services available, hardware and software: Evaluation will be based on the PICI’s capability to provide the required routine and emergency services locally (within 180 miles of job site). The PICI’s proposal is to describe the capabilities and location of his/her nearest (to job-site) service organization.

##### Technical validation examples of recently completed, and similar scope projects: the PICI is to provide information regarding type, size, complexity, and performance of five systems recently completed, along with names, addresses, telephone numbers of persons qualified to verify PIC’s statements approximate cost of the instrumentation system supplied, project completion date and description. Evaluation will be based on the similarity of system requirements PICI’s performance.

##### A description of how the PICI plans to execute the various functions and locations where the various portions of the work will be performed, coordinated and managed (e.g., design, engineering, manufacturing, programming, testing and scheduling).The vendor is required to state in his/her proposal those functions which he/she intends to subcontract to other organizations and include the name, address and capabilities of these organizations.

#### The PICI shall be required to demonstrate a minimum of five years recent, past experience in the design, manufacture and commissioning of instrumentation and control systems of comparable size, type and complexity to the proposed project. The PICI shall be required to have his/her own in-house capability to handle complete system engineering, fabrication, and testing.

#### The PICI shall have a UL approved shop and shall build all panels according to UL 508A and 698A where applicable.

#### Coordination, drafting, procurement and expediting, scheduling, construction, testing, inspection, installation, training start-up service for calibration and commissioning and warranty compliance for the period specified.

## PICI SUBMITTALS

### The PICI shall be responsible to comply to all below listed submittals requirements for all the work and material provided in the project scope. The PICI shall disregard the requirements not applicable in the project.

### Submit shop drawings in accordance with Section 01300 - Submittals and Record Drawings. These shop Drawings shall fully demonstrate that the equipment and services to be furnished will comply with the provisions of these specifications and shall provide a true and complete record of the equipment as manufactured and delivered. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all Drawings reduced to a maximum size of 11-inch by 17-inch for inclusion within the binder. Separate submittals shall be made as follows:

#### Section 17000 – General Requirements for I&C System

#### Section 17200 – Field Mounted Instruments

[Note to Engineer: Identify other Sections above related to PICI submittals as applicable to the specific project.]

### Project Plan:

#### PICI shall provide an overview of the proposed system including system architecture diagrams, the proposed work schedule indicating milestones and potential meetings (costs for potential meetings with various Contractor’s subcontractors shall be borne by the Contractor), project personnel and organization, details of factory testing and field testing, details of training programs and a paragraph-by-paragraph review of the specifications indicating any proposed deviations. The schedule shall illustrate all major project milestones including the following:

##### Schedule for all subsequent project submittals.

##### Tentative dates for all project design review meetings.

##### Schedule of manufacture and staging of all instrumentation and control system equipment.

##### Schedule for shipment of all instruments and control system equipment all peripheral devices.

##### Schedule for factory tests (FAT-1 and FAT-2).

##### Schedule for equipment start up.

##### Schedule for SAT-1, SAT-2, RAT, and 30-day Continuous Plant Operation tests.

##### Schedule for all training.

##### The project plan must be submitted and approved before any future submittals are made. PICI to provide appropriate project plan documents to the Contractor’s Commissioning Coordinator for incorporation into the overall Commissioning Plan.

### Testing Related Submittals:

#### Test Procedures: Submit the procedures proposed to be followed during the test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests:

##### Preliminary test procedure submittals: Prior to the preparation of the detailed test procedures, submit outlines of the specific proposed tests. Submittals shall include examples of the proposed forms, checklists, and layout of testing equipment and wiring diagrams.

##### Test Procedure Submittals: After the preliminary test procedure submittals have been reviewed by the District and returned stamped either "approved" or "approved as noted, confirm" submit the proposed detailed test procedures via the Commissioning Coordinator for incorporation into the overall Commissioning Plan. Following approval of the overall Commissioning Plan, the tests may be started.

#### Test Documentation: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures via the Commissioning Coordinator.

### District Training Plan - Submittals:

#### Preliminary training plan submittal:

##### Within 60 days of contract award to the Contractor, submit an overview of the proposed training plan. This overview shall include, for each course proposed:

###### An overview of the training plan explaining why specific courses are proposed.

###### Course title and objectives.

###### Prerequisite training and experience of attendees.

###### Recommended types of attendees.

###### Course Content: A topical outline.

###### Course Duration.

###### Course Location: Factory training facility, on-site and/or off-site classroom.

###### Course Format: Lecture, laboratory demonstration, etc.

###### Qualifications and experience of individual(s) providing training.

##### The District will review the preliminary training plan submittal.

#### **Training Plan Submittal:** Upon receipt of the District's comments on the preliminary training plan, submit the specific proposed training plan via the Commissioning Coordinator for incorporation into the overall Commissioning Plan. The training plan shall include:

##### Definitions of each course.

##### Specific course attendance.

##### Schedule of training courses including dates, duration, and locations of each class.

##### Resumes of the instructors who will actually implement the plan.

#### A minimum of 14 days prior to beginning each training course, submit documentation for use by the District's personnel during training. The training documentation shall be specific to the particular course, and shall include the following:

##### A listing of all subjects to be covered.

##### Course schedule.

##### Documentation/lesson plans covering all subjects to be covered during the course instruction. Information shall be in a "how to" format, with sufficient background documentation and references to manufacturer literature to provide a thorough and clear understanding of the materials to be covered.

### Spares, Expendables, and Test Equipment Lists Submittal:

#### This submittal shall include for each Subsystem:

##### A list of, and descriptive literature for, spares, expendables, and test equipment as specified –in this section.

##### A separate list of, and descriptive literature for, additional spares, expendables and test equipment recommended by the System Supplier.

##### Unit and total costs for the additional spare items recommended for each subsystem.

##### Provide storage instructions for all spare parts.

### Instrumentation:

#### This submittal shall provide complete documentation of all field instruments and other instrument and control equipment not specified to be submitted elsewhere:

##### Provide data sheets for each component listing all model numbers, optional and ancillary devices that are being provided. The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

###### Project Equipment Number and tag number per the Contract Drawings.

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

###### Manufacturer's complete model number.

###### Location of the device.

###### Input - output characteristics.

###### Range, size, and graduations.

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

###### Materials of construction of all components.

###### Instrument or control device sizing calculations where applicable.

###### Certified calibration data on all flow metering devices.

##### Provide equipment specification sheets which shall fully describe the device, the intended function, how it operates, and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross references to equipment identification tags. As a minimum the specification sheets shall include the following:

###### Dimension, rigid-clearances for maintenance and calibration.

###### Mounting or installation details.

###### Connection.

###### Electrical power or air requirements.

###### Materials of construction.

###### Environmental characteristics.

###### Performance characteristics.

### Loop Drawings:

#### **Project-Wide Loop Drawing Submittal:** Furnish a Project-wide Loop Drawing Submittal that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop associated with equipment provided under the instrumentation sections, equipment provided under sections in other Divisions, existing, and PCIS equipment that is to be incorporated into the I&C. The Project-wide Loop Drawing Submittal shall be a singular complete bound package electronically drafted in the latest version of AutoCAD. The Loop Drawings are to be per ISA S5.4 expanded format.

#### In addition, the PICI shall provide Loop sheets for all mechanical, electrical and virtual data points from all equipment. In particular loop drawings shall be provided for every virtual electrical points provided over either Ethernet or serial communications. At a minimum, the following data points shall be provided:

##### Volts, amps, device status, obtain IP address, Ethernet /IP or Modbus address from the District, scaling of all analog values

##### Motor protection device; remote reset, fault status

##### Soft Starter; last 5 faults, address of output to reset soft Starter fault

##### Power monitoring; Watts, power factor, current

## PICI SEQUENCING AND SCHEDULING

### Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

#### Submittal Reviews by District:

##### Prerequisite: District acceptance of Instrumentation Control and Monitoring Schedule of Values and Progress Schedule.

##### Schedule: submit within 90 days after award of contract:

###### This section 17000 General Requirements for I&C System (including project plan, testing related subjects, District training plan, spares, expendable and test equipment)

[Note to Engineer: Identify other Sections above related to PICI Sequence and Scheduling as applicable to the specific project.]

#### Hardware Purchasing, Fabrication, and Assembly:

##### Prerequisite: Associated Shop Drawing Submittals completed.

#### Preliminary design review meeting with the District.

## DELIVERY, STORAGE, AND HANDLING

### Shipping Precautions:

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

#### Special instructions for proper field handling, storage and installation required by the manufacturer for proper protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in re-sealable plastic bags or other acceptable means of protection.

#### All equipment supplied under Section 17000 and Section 17200 shall be shipped to the job site.

[Note to Engineer: Identify other Sections above related to PICI Delivery, Storage, and Handling as applicable to the specific project.]

### Identification:

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

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

### Storage:

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

## PICI WARRANTY

### The PICI shall provide a 1-year warranty to the District for on-site warranty services. The warranty shall include all labor, parts, and emergency calls providing initial phone response within 2 hours and on-site response within 24 hours, to provide complete system maintenance and troubleshooting for a warranty period of 1 year after the date of final acceptance of the system. The warranty shall apply to all hardware and software components furnished, installed, programmed, and calibrated by the instrumentation and control systems integrator.

### The warranty contract shall also include a minimum of 2 (semi-annual) preventive maintenance visits by a qualified serviceman of the PICI who is familiar with the type of equipment and software provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning and lubrication of system equipment and verification of correct software operation.

### During the one-year warranty period, observation of maintenance operations by District's personnel and the instruction of said personnel in the details of the maintenance work being performed, shall be provided. At the end of the warranty contract period, the PICI shall replenish the spare parts supply to the original status of component parts and physical condition.

## ENVIRONMENTAL CONDITIONS

### Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.

### Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 5 to 40 degrees Celsius; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

### Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees Celsius with relative humidity between 40 and 95 percent non-condensing humidity.

### Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from - 20 to 60 degrees Celsius and relative humidity from 10 to 100 percent. All supports, brackets, and interconnecting hardware shall be Type 316 stainless steel as shown on the installation detail drawings. For equipment installed outside that is not protected by sun shades, sun shielding shall be added to the 5 sides of the panel to ensure that the temperature inside the enclosure doesn’t exceed 55 degrees Celsius.

## FINAL SYSTEM DOCUMENTATION

### Prior to final acceptance of the system and District training, operating and maintenance manuals covering instruction and maintenance on each type of equipment shall be furnished in accordance with the District General Conditions.

### The PICI's final documentation shall be new documentation written specifically for this project but may include standard and modified standard documentation. Modifications to existing hardware or software manuals shall be made on the respective pages or inserted adjacent to the modified pages. All standard documentation furnished shall have all portions that apply clearly indicated. All portions that do not apply shall be lined out.

### The manuals shall contain all illustrations, detailed drawings, wiring diagrams and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

### If the PICI transmits any documentation or other technical information which he/she considers proprietary, such information shall be designated. Documentation or technical information which is designated as being proprietary will be used only for the design, construction, operation, or maintenance of the system and, to the extent permitted by law, will not be published or otherwise disclosed.

### The requirements for the PICI's final documentation are as follows:

#### As built documentation shall include all previous submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.

#### The Hardware Maintenance Documentation shall describe the detailed preventive and corrective procedures required to keep the system in good operating condition. Within the complete Hardware Maintenance Documentation, all hardware maintenance manuals shall make reference to appropriate diagnostics, where applicable, and all necessary timing diagrams shall be included. A maintenance manual or a set of manuals shall be furnished for all delivered hardware, including peripherals. The Hardware Maintenance Documentation shall include, as a minimum, the following information:

##### Operation Information -This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

##### Preventative-Maintenance Instructions -These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.

##### Corrective-Maintenance Instructions -These instructions shall include guides for locating malfunctions down to the card-replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.

##### Parts Information -This information shall include the identification of each replaceable or field-repairable module. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references PIC's part number and manufacturer's part numbers shall be provided.

# PRODUCTS

## SYSTEM DESCRIPTION

### Contractor shall refer to this section Scope for detail sequence of construction and schedule and shall coordinate his/her work accordingly.

## PICI NAMEPLATES

### All items of equipment listed in the instrument schedule, control panels, and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the District's approval.

### Nameplates shall be made of 1/16-inch-thick machine engraved laminated 3-ply phenolic plastic having white numbers and letters not less than 1/4-inch high on a black background. The manufacturer agrees that nameplate wording may be changed without additional cost or time if changes are made prior to commencement of engraving.

### Nameplates shall be attached to metal equipment by self-tapping Type 316 stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless-steel wire.

### Nameplates shall identify tag number of instruments inside cabinet and identify all other internal cabinet component. Devices shown on shop drawings shall be labeled with the name and tag that appears on the diagram. Prior to mounting adhesive nameplate, the intended surface shall be cleaned with an alcohol or lacquer thinner. Nameplates shall be attached to panel surfaces, not to instruments.

## SIGNAL COORDINATION REQUIREMENTS

### The PICI shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, the HVAC subcontractor, the Security / access control subcontractor, and the PCIS supplier. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLCs and TCP’s.

### Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLC's, the TCP’s, etc.

### Analog Signal Transmission:

#### Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 24 volts D.C. @ 100 ohm impedance maximum.

#### Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.

#### All cable shields shall be grounded at one end only, at the control panel, with Terminals bonded to the panel isolated ground bus.

#### Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.

#### Non-standard transmission systems such as pulse duration, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 milliampere signal.

### Discrete Inputs:

#### All discrete inputs to equipment and PCIS TCPs, from field devices, starters, panels, etc., shall be dry contacts in the field device or equipment, powered from the TCPs, unless specified otherwise.

#### Sensing power (wetting voltage) supplied by the TCP shall be 24 VDC.

### Discrete Outputs:

#### All discrete outputs from local control panels and TCPs to field devices, starters, panels, etc., shall be dry contact closures with isolation relay outputs. A minimum of 2 amp @120VAC relay contacts shall be provided.

#### Outputs to solenoid valves for non-TCP panels shall be fused 24 VDC or 120VAC as appropriate, powered from the control panel via output relays. Each output shall be fused using blown fuse indicating fuse holders and a protecting diode. Outputs for solenoid valves controlled by the TCP shall be dry contacts powered externally.

### Other Discrete Signals:

#### Discrete signals between starters, panels, etc. may be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.

#### Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.

#### Output contacts in the starter, panel, etc. which are powered from other locations shall be provided with special tags and/or color coding. Disconnecting Telemetry strips shall be provided for such contacts.

#### The above requirements shall apply to all starters and panels, regardless of supplier.

## PCIS SCADA SYSTEM CONFIGURATION REQUIREMENTS

### Status-to-Command Disagreement (STCD): Provide a STCD alarm for all equipment controlled with the control system. The STCD alarm shall be initiated if a piece of equipment is commanded to start/stop or open/close by the TCP control logic and the appropriate run or position status is not reported back within a predetermined adjustable time interval.

### Provide high-high, high, low, low-low, rate of change and instrument fail alarms: For all analog points including virtual analog points in the TCP system. If an alarm is used by TCP, that alarm shall be implemented at the TCP level.

### All software control/alarm switches shall be implemented with associated time delays before any control or alarm action is taken. No time delay value shall be configured, unless specified otherwise.

### All flow values and elapsed running time of motors shall be totalized and stored at the TCP and either uploaded or queued and uploaded later if the communications infrastructure is down. In any case totalization data shall not be lost because of a communication failure. Two levels of totalization shall be provided: (1) Keep a running total at the inception/activation of the signal. (2) 2nd totalization of the same signal that is resettable.

### If a field instrument is provided with an analog output and an additional discrete alarm (dry contact) outputs, at least one of the alarm discrete outputs shall be considered a common alarm and be interfaced with the field control system to send an advisory alarm through the TCP to the operator.

### Scaling of analog signals shall be implemented in the field control system. Each local TCP shall interface with a Human Machine Interface (HMI) and with the Process Control network using data in engineering units.

### The Process Control System (PCIS) shall monitor communication with each TCP. If a communication failure with a TCP is detected, alarms shall be generated and logged.

### Where packaged systems are being utilized to control various processes, the packaged systems will interface with the PCIS as described in section 2.06 below.

### All the above control, monitoring, trending and recording features are required and shall be provided for all of the I/O points identified on the design drawings or P&ID drawings developed by the Engineer.

### Requirements for Trending

#### In general, the PCIS SCADA Historian shall be configured to process all SCADA data which includes the followings:

##### All physical I/O: Analog Inputs (Al), Analog Outputs (AO), Digital Inputs (Dl), Digital Outputs (DO).

##### All measured process variable values from networked field devices such as power system meters, analyzers, and networked instruments.

##### All operator-entered values including setpoints, calculation constants, and manually entered process variables.

##### All calculated values used for direct control of the process.

##### All alarms and events.

#### The District's PCIS SCADA system collects data using Exception-Transmission-Rule Blocks (ETRs) and or History Blocks (Polled). SCADA Trending shall follow the following requirements:

##### Every Digital Input, Digital Output, Analog Input, Analog Output will have its 'OUTPUT' attribute trend-able and polled at least once per day on an ETR trend.

##### Every Equipment block will have its 'OUTPUT' attribute trend-able on an ETR trend.

##### Every Analog Output & Analog Input will have a fifteen minute, daily and monthly History trend for MIN, MAX, AVERAGE and TOTALIZER (Flows).

##### Every Digital Input Run signal will have two ETRs configured

##### One to track life-time pump run hours and pump run count. Not resettable by operator.

##### One to track life-time pump run hours and pump run count. Resettable by operator.

##### Every Digital Input Run signal will have a History block to track Daily pump run time totals and daily pump run count totals.

##### Every input source dead-band in an ETR block will be zero unless otherwise required to properly track exception events.

##### Every Analog Input will have its 'Exception Dead-band' set to 0.5% of full span.

##### Every Analog Input and Output will have its 'Live Zero' set to 1.0% of full span.

##### Every Analog Input will have its 'Filter Method' set to 'Driver Defined' and its 'Filter Value' set to '80'.

##### Every Analog Input and Output will have 'Engineering Units' set.

##### Every Call block will have its 'STATUS' & 'OUTPUT\_A' through 'OUTPUT\_F' attributes trend-able.

##### Every MUX block will have its 'OUTPUT' attribute trend-able.

##### Every Timer block will have its 'OUTPUT' & 'ENABLED' attribute trend-able.

##### Every Peer-to-Peer block will have its 'TRANSFER RATE' set to '10' seconds.

##### Every block with a configured attribute alarm level greater than '5' (Log Only) will have the alarm attribute trend-able on an ETR trend.

##### Any additional trending requirements the District determines necessary to meet their operational needs.

### Requirements for Events Logging

#### Events are established, such as equipment status, local/remote switch setting changes and setpoint or parameter adjustments. Event logging shall follow the following requirements:

##### Every Digital Input block will have its 'STATE HIGH' or 'STATE LOW' (determined by which state is abnormal or active) attribute configured as 'LOG Only' alarm level. If the alarm list dictates a higher alarm level, then the higher alarm level will be configured.

##### Every Analog Input and Analog Output block will have its 'INVALID' attribute configured as 'ALARM\_10\_30\_0' alarm level and its 'IGNORE' attribute set to '60'. If the alarm list dictates a different alarm level or ignore value, then the alarm list alarm level/value will be configured.

##### Every EQUIPMENT block will have its 'OUTPUT\_A', 'OUTPUT\_B', 'SUSPEND', 'LOCKOUT', 'MODE', 'HEALTH', 'STATUS' attributes configured as 'LOG Only' alarm level. In special cases where additional 'OUTPUT\_XX' attributes are used in the control strategy, those attributes will also be configured as 'LOG Only' alarm level. If the alarm list dictates a different alarm level, then the alternate alarm level will be configured.

##### Every EXPRESSION block will have its 'INACTIVE' and 'STATE HIGH' attributes configured as 'LOG Only' alarm level. If the alarm list dictates a higher alarm level, then the higher alarm level will be configured.

##### All changes made through the operator workstation will be logged in the 'Log Viewer' and in the 'Audit Trail'. Ex. Setpoint changes, Mode changes, Parameter changes, Reset triggers, etc.

##### All block 'Instruction' changes will be logged in the 'Log Viewer' and in the 'Audit Trail'.

##### All operator setpoints and parameter changes will have bounds checking to insure settings are only allowed within a defined acceptable range.

##### Any additional logging requirements the District determines necessary to meet their operational needs.

## PCIS INTERFACING WITH VENDOR PACKAGED CONTROL SYSTEMS

[Note to Engineer: Suggest removing the following requirements if Vendor Packaged Control Systems do not apply to the specific project.]

### Where, packaged systems are being utilized to control various District processes (e.g., chemical feed, UV, blower, etc.) the packaged systems are required to interface with the District’s PCIS. The packaged systems shall be required to utilize programmable logic controller technology for control and monitoring purposes. Additionally, the PLCs shall be provided with Ethernet communications ports to interface with the District’s PCIS. Depending on the packaged system’s control strategy design requirements, the interfacing implementation can differ from system to system.

### The District identifies vendor supplied packaged systems as:

#### Completely Independent

#### Partially Dependent

#### Dependent

### **Completely Independent Systems:** If the vendor’s packaged system operates “Completely Independent” from a control strategy standpoint, then the interface to the District’s PCIS is implemented via a monitor only digital link. The PCIS will have mostly a ‘monitor only’ interface with the option to modify settings/set points through the PCIS. In this completely independent configuration, hardwired or network provided I/O signals shall be required to properly operate the vendor’s system. The vendor’s equipment and shall not rely on the PCIS to communicate start/stop commands I/O status or values for proper operation using either a network connection or hardwired I/O. The vendor’s system will make its own determination as to when it turns on and when it turns off and will not rely on outside control system triggers to start and stop including any field sensors required to support this independent system operation requirement.

### **Partially Dependent Systems:** If the vendor’s packaged system operates “Partially Dependent” from a control strategy standpoint, meaning that the vendor’s system requires a start/stop trigger from the District’s PCIS, (or some other type of handshaking) then the triggering interface with the District’s PCIS will be implemented via hardwired dry contacts and/or hardwired 4-20mA signals from District’s PCIS to the vendor’s packaged system. District’s PCIS shall be given enough feedback from the packaged system to understand the state of the vendor’s system without relying on an Ethernet link. All monitoring, not related to controls, may or may not be done via hardwired interface. It is assumed that an Ethernet data link will be required to pick up the bulk of the non-control related status information from the vendor’s system (the only network interfaces that will be supported are Ethernet based using either Modicon TCP/IP or Ethernet/IP protocols except as explicitly identified in the drawings. The PCIS will also have the option to modify settings/set points from the PCIS through the Ethernet data link.

### **Dependent System:** If the vendor’s packaged system operates “dependent” from a control strategy standpoint, meaning that the vendor’s system requires multiple start/stop triggers from the District’s PCIS and the PCIS is the main driver of the implemented control strategy; then all start/stop interfaces to the District’s PCIS are implemented via hardwired dry contact closures. Other hardwired analog signals will have to be added to ensure the District’s PCIS has enough feedback to understand the state of the vendor’s packaged system and subsystems. Digital inputs will be implemented via hardwired dry contact connections. Analog inputs and outputs will be implemented via hardwired 4-20 mA signals. All monitoring and control will be accomplished via hardwired interface modules. An Ethernet data link will also be required to connect to any Ethernet capable equipment. This addition will allow for remote monitoring and management of the vendors packaged system by District’s PCIS. For this type of system, the Vendor shall also be required to provide a control write up addressing what happens when various PCIS inputs into the Vendor’s packaged system fail.

## GENERAL REQUIREMENTS – VENDOR PACKAGED PLC SYSTEMS

[Note to Engineer: Suggest removing the following requirements if Vendor Packaged PLC Systems and/or Contractor/PICI PLC Systems do not apply to the specific project.]

### **General:** The following requirements for Vendor Packaged PLC Systems apply to Vendor supplied PLC’s and any other Contractor/PICI PLC’s provided for the project.

### **Voltage Requirements:** 24 vdc power with 24 vdc battery backup power or 120 vac supply power with 120 vac UPS backup power with a minimum of 1 hour or twice the generator start time whichever is greater.

### **District Standard PLC:** Vendor packaged PLC systems will be supplied with the District’s standard PLC. The current standard PLCs used throughout the District are Allen Bradley Compact Logix family platform. Vendors shall coordinate the exact PLC platform to be provided during the project submittal phase.

### The District requires that any vendor packaged PLCs or HMIs installed in the District can be serviced and maintained by District staff. District staff shall be provided the ability to upload/download, maintain, program and replace any PLC or HMI. It is understood by the District that vendor supplied packaged systems with vendor programmed PLCs/HMIs remain in their commissioned as-built form. However, when the PLCs or HMI’s fail these systems must be recoverable by District staff. Specifically, the District IT-SCADA group has this sole responsibility to support all PLC/HMI based systems. To this end, the Vendor provided packages shall provide copies of all PLC and HMI files required for the ability to use locally purchased replacement hardware and upload with PLC programs provided using District or contract personnel. All PLC programs shall be provided in a form to allow the District the ability, if the PLC were to be obsoleted, to modify the PLC program to use the currently available hardware. With respect to the local HMI, the package supplier shall provide all programming software required to support the HMI. At a minimum 5 software licenses shall be required.

### Vendor Start-up Services: Vendor startup services shall include fully testing vendor packaged system’s including hardware and software and the interface to the District’s PCIS.

### Vendor Packaged System Features: Vendor systems shall provide:

#### Ethernet link’s interfacing with the District’s PCIS.

#### Local HMI panel with settings changeable from the District’s PCIS or local HMI panel.

#### Backup of as-built PLC program applications and IP address in a format that can be downloaded into the PLC. 5 licenses shall be provided for any software that is required to download the software into the PLC (if not already owned by the District).

#### Backup of as-built HMI screen applications in a format that can be downloaded into the HMI. 5 licenses shall be provided for any software that is required to download the software into the HMI (if not already owned by the District).

#### Written procedure for recovering from a PLC hardware failure.

#### Written procedure for recovering from a HMI hardware failure.

#### After hours and weekend technical support.

#### As-built drawings and O&M Manuals for the vendor’s electrical and controls systems.

# EXECUTION

## CLEANING

### The Contractor shall thoroughly clean all soiled surfaces of installed equipment and materials.

### Upon completion of the instrumentation and control work, the Contractor shall remove all surplus materials, rubbish, and debris that have accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the District.

## FINAL ACCEPTANCE

### Final acceptance of the PICI and PCIS will be determined complete by the District, and shall be based upon the following:

#### Receipt of acceptable start up Gate Reports for Pre-Commissioning, Commissioning Phase I, Commissioning Phase II, and other documentation as required by the Contract Documents.

#### Completion of the Reliability Acceptance Test (RAT) and 30-Day Continuous Plant Operation test.

#### Completion of all punch-list items.

## GENERAL INSTALLATION

### Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms, and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the District during construction. Obtain in the field all information relevant to the placing of process control work and in case of any interference with other work, proceed as directed by the District, and furnish all labor and materials necessary to complete the work in an approved manner. All instruments shall be mounted as to allow access for service without the use of portable ladders.

### The PICI Loop Drawings indicate the intent of the interconnection between the individual instruments. Any exceptions should be noted. Two complete sets of approved shop drawings and Loop Drawings shall be kept at the job site during all on-site construction. Both sets shall be identically marked up to reflect any modifications made during field installation or start-up.

#### Following completion of installation and SAT-1, one set of the marked-up drawings shall be provided to the District, the other retained by the PICI for incorporation of the mark-ups into final as-built documentation.

### The instrumentation installation details on the Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the Drawings, the American Petroleum Institute (API) Recommended Practice 550 shall be followed as applicable.

### All work shall be executed in full accordance with codes and local regulations. Should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising there from.

### All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local regulations, should any work be performed contrary to said rulings, ordinances, and regulations, the PICI shall bear full responsibility for such violations and assume all costs arising there from.

### Unless specifically shown in the Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing and blow down service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

[Note to Engineer: Assure that the Field Mounted Instruments Specifications identify mounting and valve requirements as mentioned above, along with showing mounting and valve requirement details on the project’s Mechanical, Electrical & P&ID plans.]

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

### Field instruments requiring power supplies shall be provided with local electrical disconnect switch protected by breaker or fuses as required.

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

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

### The shield on each process instrumentation cable shall be continuous from source to destination and be grounded only in the control panel and in no case each shield shall be grounded at two places.

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

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

## TESTS (GENERAL)

### The PICI shall test all equipment at the factory prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the PICI shall be tested at the factory as a single fully integrated system.

### Tests shall be scheduled and performed to meet overall construction schedule requirements.

### Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

### All tests shall be conducted in accordance with prior District- approved procedures, forms and checklist. Each specific test to be performed shall be described and a space provided after it for signoff by the appropriate party after its satisfactory completion. PICI to prepare test documents and provide to the Contractor’s Commissioning Coordinator for incorporation into the overall facility Commissioning Plan.

### Copies of these signoff test procedures, forms and checklists will constitute the required test documentation.

### Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation. Define these simulations techniques in the test procedures.

### The Contractor shall require the PICI to coordinate all of his/her testing with the Commissioning Coordinator, all affected Subcontractors and the District.

### The District reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved Test Procedures.

### The District's decision shall be final regarding the acceptability and completeness of all testing.

### The PICI shall furnish the services of servicemen, all special calibration and test equipment and labor to perform the field tests.

## CALIBRATION

### All instruments and systems, including virtual signals, shall be calibrated after installation and checked in conformance with the component manufacturer's written instructions.

### This shall provide that those components having adjustable features are set carefully for the specific conditions and applications of this installation, and that the components and/or systems are within the specified limits of accuracy. Defective elements which cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced. This calibration work and Calibration test shall be accomplished by the technical field representatives of the PICI and shall certify in writing to the Contractor that for each loop or system, all calibrations have been made and that all instruments are ready to operate.

### Proof of Conformance - The burden of proof of conformance to specified accuracy and performance is on the Contractor using its designated PICI. The Contractor's designer shall supply necessary test equipment and technical personnel if called upon to prove accuracy and/or performance, at no separate additional cost to the District, wherever reasonable doubt or evidence of malfunction or poor performance may appear within the guarantee period.

## PICI TRAINING

### The cost of training programs to be conducted with District’s personnel shall be included in the Contract price. The training and instruction, insofar as practicable, shall be directly related to the systems being supplied.

### The PICI shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

### The PICI shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to District.

### The training program shall represent a comprehensive program covering all aspects of the operation, maintenance and cleaning procedures for the system.

### All training schedules shall be coordinated with, and at the convenience of the District. Shift training may be required to correspond to the District's working schedule.

### The Contractor shall provide training and instruction to thoroughly familiarize the District's operations and maintenance personnel with the use, maintenance, calibration, repair, and replacement of all components of the control system. The training shall be scheduled concurrent with the calibration, equipment testing, process system testing, and start-up testing phases of the project.

### Training shall be performed by qualified representatives of the PCIS. Training shall be specifically tailored to this project and reflect the control system installation and configuration. All training shall be conducted at the job site, unless an alternate location is approved by the District. The following table summarizes the training hours required, which shall be provided at no additional cost to the District:

|  |  |  |  |
| --- | --- | --- | --- |
| **Onsite Training Class** | **Administrators, Screen Developers Class** | **Operators Class** | **Conducted By** |
| Control System, Hardware and Instruments General Familiarity | 8 hrs | 8 hrs | PICI |

### Each training class shall be not more than 8 hours in duration. Separate classes shall be conducted for the District's operation and maintenance personnel. Operator classes shall emphasize operational theory and use of the control system. Maintenance classes shall stress troubleshooting, repair, calibration, replacement, and other technical aspects of the PCIS control system.

### Each of the training classes listed above for Operators shall be conducted twice during separate weeks to allow for scheduling of the District's personnel. A total of [48] hours of training for operations personnel shall be provided.

### Training classes shall be scheduled a minimum of 3 weeks in advance. Proposed training material, including a resume for each proposed instructor and a detailed class outline/lesson plan shall be submitted to the District at least 60 days in advance of when the training is scheduled to begin. The District shall review the submitted data for suitability and provide comments and requested changes that shall be incorporated into the training plan.

### The District reserves the right to video record each training session.

### Within 10 days of completion of each training class, the Contractor shall present to the District the following:

#### A list of all District personnel that attended the class.

#### A copy of the text utilized during the class with all notes, diagrams, and comments.

#### Copies of any videos taken during the training.

## SUPPLEMENTS

### Supplements listed below, following "END OF SECTION" are parts of this Specification:

#### Instrumentation Calibration Sheet.

#### Loop Status Report.

#### Functional Acceptance Test Sheet.

END OF SECTION

**INSTRUMENT CALIBRATION**

**COMPANY LOGO**

|  |  |  |
| --- | --- | --- |
| **COMPONENT** | **MANUFACTURER** | PROJECT |
| **TAG NO.:** | **MANUFACTURER:** | NUMBER: |
| **EQUIPMENT NAME:** | **MODEL:** | NAME: |
| **SERIAL NO.:** |
| **TYPE:** |  | LOCATION: |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FUNCTIONS** | | | | | | | | | | | | | | | |
| **Analog** | | | | | **Discrete** | | | | | Control | | | | | |
|  | | VALUE | | UNITS | Switch | Adjustable |  | Non-Adjustable |  | Control | I Yes | | I | I No | I |
| RANGE | |  | |  | Deadband | Adjustable |  | Fixed |  | Action | I Direct | | I | I Reverse | I |
| CHART | |  | |  | Reset | Automatic |  | Manual |  |  | | | | | |
| SCALE | |  | | GPM | **Non-Adjustable Switches** | | | | | PID Settings | | | | | |
| INPUT | |  | |  | Describe Installation: | | | | | Proportional Band | |  | | | |
| OUTPUT | |  | | mA |  | | | | | Integral | |  | | | |
| Incite I | I | Record I | I Transmit I **X** I Convert I | |  | | | | | Derivative | |  | | | |

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| **ANALOG CALIBRATION** | | | | | | **DISCRETE** CALIBRATION | | | | |
| Input  % | Scale Indicated | Input Signal | Output Signal | Actual Output | Display Reading | Set Point | Trip Point Rising | Reset Point Falling | Trip Point Falling | Reset Point Rising |
| 0% | 0GPM | 4.00 ma | 4.00 ma | 4.00 ma |  |  |  |  |  |  |
| 25% |  |  |  |  |  |  |  |  |  |  |
| 50% |  |  |  |  |  |  |  |  |  |  |
| 75% |  |  |  |  |  |  |  |  |  |  |
| 100% |  | 20.00 ma | 20.00 ma | 20.00 ma |  |  |  |  |  |  |

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| **NOTES:**. | | |
|  | Component Calibrated and Ready for Start-up. | |
|  |
|  | By: |  |
|  | Date: |  |
|  | Witness: |  |
|  | Date: |  |
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**LOOP STATUS REPORT**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Project Name: | | | | | Project No.: | | |
| **FUNCTIONAL REQUIREMENTS:** | | | | | | | |
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| **COMPONENT STATUS** (Check & Initial Each Item When Complete) | | | | | | | |
| Tag Number | Delivered | Tag ID Checked | Installation | Termination Wiring | Termination Tubing | Calibration |  |
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| REMARKS: |  |  |  |  |  |  |  |
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| Loop Ready for Operation | By: | | | Date: | | Loop No.: | |

Performed By:

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **TEST PHASE :**  **Control Loop Test Form** | | | | | | | |
| **Digital Input Checklist** | | | | | | | |
|  | **TB** | **PLC**  **Rack / Slot / Bit** | **PLC I/O**  **Tag** | **Point Description** | **On State** | **Off State** | **Drawing** | **Check**  **Off** |
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Date:

Witnessed: