

## SECTION 17050

### PROCESS CONTROL AND INSTRUMENTATION SYSTEMS GENERAL REQUIREMENTS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes:
  - 1. General requirements applicable to all process control and instrumentation work.
  - 2. General requirements for process control and instrumentation submittals.
  
- B. Related sections:
  - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
  - 2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
  - 3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
    - a. Section 01 31 00 - Project Management and Coordination.
    - b. Section 01 32 00 - Construction Progress Documentation.
    - c. Section 01 33 00 - Submittals Process.
    - d. Section 01 42 00 - References.
    - e. Section 01 43 00 - Quality Assurance.
    - f. Section 01 61 20 - Seismic Design Criteria.
    - g. Section 01 61 40 - Wind Design Criteria.
    - h. Section 01 73 00 - Project Execution.
    - i. Section 01 77 00 - Closeout Requirements.
    - j. Section 15050 - Basic Mechanical Materials and Methods.
    - k. Section 16050 - General Requirements for Electrical Work.
    - l. Section 16075 - Electrical Identification.
    - m. Section 17100 - Control Strategies.
    - n. Section 17761 - PLC Programming Software.
    - o. Section 17762 - Control Systems SCADA Software.
    - p. Section 17950 - Testing, Calibration, and Commissioning.
  
- C. Interfaces to Equipment, Instruments, and Other Components:
  - 1. The Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers, which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
  - 2. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional instruments, wiring, control system

inputs/outputs, controls, interlocks, electrical hardware etc., which may be necessary to make a complete, functional installation based on the actual equipment furnished:

- a. Make all changes necessary to meet the manufacturer's wiring requirements.
  3. Submit all such changes and additions to the ENGINEER for acceptance in accordance with the General Conditions.
  4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the instrumentation and control systems are completely accounted for. Include any items that appear on Drawings or in Specifications from another discipline in the scope of Work:
    - a. If a conflict between Drawings and Specifications is discovered, refer conflict to the ENGINEER as soon as possible for resolution.
  5. Loop Drawings:
    - a. Provide complete loop drawings for all systems, including packaged equipment furnished as part of a vendor furnished package, and for all pre-purchased equipment.
    - b. The minimum level of detail and format for the loop drawings must match that of the sample loop drawings included in the Contract Documents.
    - c. The OWNER and ENGINEER are not responsible for providing detailed loop diagrams for CONTRACTOR furnished equipment.
- D. All instrumentation, and control equipment and systems for the entire project to comply with the requirements of Division 17, whether referenced in the individual equipment specifications or not:
1. The requirements of Division 17 apply to all instrumentation and control work specified in other Specifications, including HVAC controls, packaged mechanical systems, LCPs, VCPs, etc.
  2. Inform all vendors supplying instrumentation, control systems, panels, and/or equipment of the requirements of Division 17.
  3. The OWNER is not responsible for any additional costs due to the failure of the CONTRACTOR to notify all subcontractors and suppliers of the Division 17 requirements.
- E. Contract Documents:
1. General:
    - a. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work.
  2. Specifications:
    - a. The General and Supplementary Conditions of the Contract Documents govern the Work.
    - b. These requirements are in addition to all General Requirements.
  3. Contract Drawings:
    - a. The instrumentation and control drawings show in a diagrammatic manner, the desired locations, and arrangements of the components of the instrumentation work. Follow the Drawings as closely as possible, use professional judgment and coordinate with the other trades to secure the best possible installation, use the entire Drawing set for construction purposes.
    - b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only, exercise professional judgment in executing the work to ensure the best possible installation:

- 1) The equipment locations and dimensions shown on plans and elevations are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all instrumentation and control equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
  - 2) The CONTRACTOR has the freedom to select any of the named manufacturers as identified in the individual specification sections; however, the ENGINEER has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the CONTRACTOR's responsibility to ensure that the equipment being furnished fits within the defined space.
- c. Installation Details:
- 1) The Contract Drawings include installation details showing means and methods for installing instrumentation and control equipment. For cases where typical details are not provided or compatible with an installed location, develop installation details that are necessary for completing the Work, and submit these details for review by the ENGINEER.
- d. Schematic Diagrams:
- 1) All controls are shown de-energized.
  - 2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
  - 3) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
  - 4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
  - 5) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences found in the Drawings or Specifications. Combine all information and furnish a coordinated and fully functional control system.

F. Alternates/Alternatives:

1. Refer to the General Conditions for substitute item provisions.

G. Changes and Change Orders:

1. Refer to the General Conditions.

## 1.02 REFERENCES

A. Code Compliance:

1. As specified in Section 01 42 00:
  - a. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.

2. The following codes and standards are hereby incorporated into these Specifications:
  - a. National Fire Protection Association (NFPA):
    - 1) NFPA 70 - National Electric Code (NEC).
    - 2) NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment, where applicable.
    - 3) NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
  - b. Underwriters Laboratories, Inc. (UL):
    - 1) UL 508 - Industrial Control Equipment.
  - c. American National Standards Institute (ANSI):
    - 1) ANSI B16.5 - Pipe Flanges and Flanged Fittings.
  - d. American Petroleum Institute (API):
    - 1) API RP551 - Process Measurement Instrumentation.
    - 2) API RP552 - Transmission Systems.
    - 3) API RP553 - Refinery Control Valves.
    - 4) API RP554 - Process Instrumentation and Control.
    - 5) API RP555 - Process Analyzers.
    - 6) API RP556 - Fired Heaters & Steam Generators.
    - 7) API RP557 - Guide to Advanced Control Systems.
  - e. American Society of Testing and Materials (ASTM):
    - 1) ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
  - f. International Society of Automation (ISA):
    - 1) ISA-5.1 - Instrumentation Symbols and Identification.
    - 2) ISA-5.2 - Binary Logic Diagrams for Process Operations.
    - 3) ISA-5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
    - 4) ISA-5.4 - Instrument Loop Diagrams.
    - 5) ISA-5.5 - Graphic Symbols for Process Displays.
    - 6) ANSI/ISA-7.00.01 - Quality Standard for Instrument Air.
    - 7) ISA-RP - 12.4 - Pressurized Enclosures.
    - 8) ANSI/ISA-18.1 - Annunciator Sequences and Specifications.
    - 9) ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
    - 10) ISA-TR20.00.01 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
    - 11) ANSI/ISA-50.00.01 - Compatibility of Analog Signals for Electric Industrial Process Instruments.
    - 12) ISA-51.1 - Process Instrumentation Terminology.
    - 13) ISA-RP60.3 - Human Engineering for Control Centers.
    - 14) ISA-71.01 - Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.
    - 15) ISA-71.02 - Environmental Conditions for Process Measurement and Control Systems: Power.
    - 16) ISA-71.03 - Environmental Conditions for Process Measurement and Control Systems: Mechanical Influences.
    - 17) ISA-71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

- B. Compliance with Laws and Regulations:
  - 1. Refer to the General Conditions.

### 1.03 DEFINITIONS

- A. Definitions of terms and other electrical and instrumentation considerations as set forth in the:
  - 1. International Society of Automation (ISA).
  - 2. International Electro Technical commission (IEC)
  - 3. Institute of Electrical and Electronic Engineers (IEEE).
  - 4. International Organization for Standardization (ISO).
  - 5. Factory Mutual or FM Global (FM).
  - 6. National Electrical Code (NEC).
  - 7. National Electrical Testing Association (NETA).
  - 8. National Fire Protection Association (NFPA).
  - 9. National Institute of Standards and Technology (NIST).
  - 10. Underwriter Laboratories (UL).
- B. Specific Definitions:
  - 1. Control Circuit: Any circuit operating at 120 volts AC or DC or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
  - 2. Panel: An instrument support system that may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term "panel" in these Contract Documents is interpreted as a general term, which includes flat surfaces, enclosures, cabinets, and consoles.
  - 3. Power Circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
  - 4. Signal Circuit: Any circuit operating at less than 50 volts AC or DC, which conveys analog information or digital communications information.
  - 5. Digital Bus: A communication network, such as Profibus, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions and diagnostic information.
  - 6. 2-Wire Transmitter (Loop Powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Specification, two-wire transmitter refers to a transmitter that provides 4 to 20 mA current regulation of a signal in a series circuit with an external 24 VDC driving potential:
    - a. Field Bus Communications signal or both.
  - 7. Powered Transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Specification, the produced signal may either be a 4 to 20 mA current signal, a Digital Bus communications signal or both.
  - 8. System Supplier - Refer to Paragraph 1.06-B in this Section.
  - 9. Furnish: Supply to the project site ready for installation.
  - 10. Install: To place in position for service or use, complete and ready for intended use.
  - 11. Provide: Furnish and install.

12. Modifications: Changing, extending, interfacing to, removing, or altering an existing circuit.

C. Acronym Definitions:

1. DPDT: Double-Pole, Double-Throw.
2. ES: Enterprise System: Computer based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
3. FAT: Factory Acceptance Test.
4. HART: Highway Addressable Remote Transducer.
5. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode, equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode, equipment is started or stopped and valves are opened or closed through a control algorithm within the PLC software. In the Off mode, the equipment is prohibited from responding from the PLC control.
6. HMI: Human Machine Interface: PLC based operator interface device consisting of an alphanumeric display and operator input devices. The HMI is typically a flat panel type of display with either a touch screen or tactile button interface.
7. ICSC: Instrumentation and Control System Contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
8. IJB: Instrument Junction boxes. A panel designed with cord sets to easily remove, replace or relocate instrument signals.
9. I/O: Input/Output.
10. IP: Internet Protocol or Ingress Protection.
11. LCP: Local Control Panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
12. LCS: Local Control Station.
13. LAN: Local Area Network: A control or communications network that is limited to the physical boundaries of the facility.
14. LOR: Local-Off-Remote control function. In the Remote mode, equipment is started or stopped, and valves are opened or closed through the PLC based upon the selection of the HOA. In the Local mode, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
15. OIT: Operator Interface Terminal. PC based interface device used for operator interface with the SCADA system.
16. P&ID: Process and Instrumentation Diagram.
17. PC: Personal Computer.
18. PCIS: Process Control and Instrumentation System: includes the entire instrumentation system, the entire control system, and all of the work specified in Division 17 and depicted on the Instrumentation Drawings.

19. PCM: Process Control Module: An enclosure containing any of the following devices: PLC, RIO.
20. PJB: Power Junction Box: An enclosure with terminal blocks that distribute power to multiple instruments.
21. PLC: Programmable Logic Controller.
22. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.
23. RTU: Remote Telemetry Unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
24. SCADA: Supervisory Control and Data Acquisition system consists of the computer-based software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software.
25. SPDT: Single-Pole, Double-Throw.
26. SPST: Single-Pole, Single-Throw
27. UPS: Uninterruptible Power Supply.
28. VCP: Vendor Control Panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
29. WAN: Wide Area Network: A control or communications network that extends beyond the physical boundaries of the facility.

#### 1.04 SYSTEM DESCRIPTION

##### A. General Requirements:

1. The Work includes everything necessary for and incidental to executing and completing the general requirements for the instrumentation and control system Work described in the Contract Drawings and Specifications and reasonably inferable there from including but not limited to:
  - a. Preparing hardware submittals for field instrumentation.
  - b. Design, develop, and draft loop Drawings, control panel designs, and all other drawing submittals specified in Division 17.
  - c. Prepare the test plan, the training plan, and the spare parts submittals.
  - d. Procure all hardware.
  - e. Provide all PCIS system hardware and software.
  - f. Fabricate panels.
  - g. Perform factory tests on panels.
  - h. Perform bench calibration and verify calibration after installation.
  - i. Oversee and certify installation of the PCIS system.
  - j. Oversee, document, and certify loop testing.
  - k. Oversee, document, and certify system pre-commissioning.
  - l. Conduct the Performance Tests.
  - m. Prepare Operation and Maintenance Manuals.
  - n. Conduct training classes.
  - o. Prepare Record Drawings.
  - p. Integrate the PCIS with instrumentation and control devices provided under other sections.
  - q. Develop all requisite loop drawings and record drawings associated with equipment provided under other Divisions of these Specifications and OWNER furnished and existing equipment.

- r. Resolve signal, power, or functional incompatibilities between the PCIS and interfacing devices.
    - s. Perform all required corrective and preventative maintenance.
  - 2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all: connections, testing, calibration of all equipment furnished by others as well as equipment furnished by the CONTRACTOR, whether or not specifically mentioned but which are necessary for successful operation.
  - 3. Provide the complete operating PCIS to perform the specified monitoring, communications, alarm, control, display, and reporting functions in accordance with the requirements of the Contract Documents.
  - 4. Coordinate all aspects of the Work between CONTRACTOR and all Subcontractors before bidding to ensure that all costs associated with a complete installation are included. The OWNER is not responsible for any change orders due to lack of coordination of the Work between the CONTRACTOR, the ICSC, the other Subcontractors or Suppliers.
  - 5. Furnish detailed, complete, and thorough operations and maintenance documentation, including, but not limited to: Operations Manuals, Maintenance Manuals, As-Built Wiring Drawings, Training Manuals, As-Built Software Documentation, and all other documentation required to operate, modify, and maintain all parts of the PCIS.
  - 6. Where demolition is shown on any Drawing, the electrical Subcontractor is responsible for disconnecting equipment electrical connections and rendering the equipment safe. The ICSC is responsible for physically removing all instrumentation to be demolished and return it either to the OWNER or dispose of it as directed by the OWNER's Representative. The ICSC shall be responsible for any program modifications needed based on the demolition of the equipment, both for the loops directly and indirectly affected.
  - 7. Portions of this project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment.
    - a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc) before performing any work.
    - b. Provide and document: interface with, modifications to, upgrade, or replacement of existing circuits, power systems, controls, and equipment.
  - 8. Revise in a manner as directed by the ENGINEER all I/O and addressing that the ENGINEER determines to be unacceptable as a result of a lack of CONTRACTOR coordination between Contract Documents and all Suppliers.
  - 9. Defective Work:
    - a. Refer to the General Conditions.
- B. Existing System:
  - 1. The plant currently uses an Allen-Bradley based PLC system. A fiber optic Ethernet network is used to connect the main process PLCs throughout the site. Process equipment are monitored and controlled from the operator work stations located in different process areas and facilities.
  - 2. The SCADA software is Wonderware InTouch Version 10.1.
  - 3. Alarms are configured using Wonderware InTouch.
  - 4. Remote terminals throughout the plant are run in a thin client architecture.



5. An Industrial SQL based Historical Data Server is used to collect and serve data.
- C. New System:
1. CONTRACTOR is responsible for integrating equipment provided under this contract in to the existing SCADA sys tem.
  2. Instrumentation and control work shall include, but not be limited to, field instrumentation and controls, process analyzers, PLC's, control panels, UPS units, operator interface panels and related items. The CONTRACTOR shall provide labor for engineering, installation, drawings and submittals, testing, start up and training.
  3. The CONTRACTOR shall provide all installation, configuration, calibration and testing to provide a fully functional control system except as described in Work by Others.
  4. New instrumentation and control devices shall be added for the monitoring and control of all sites indicated on the plans.
  5. As part of the control system, PLC based control cabinets shall be provided in the Headworks Facility Electrical Room and Sludge Pump Station.
  6. An OIS shall be placed in the headworks PLC cabinet. The OIS shall be configured to run Wonderware Terminal Services
  7. CONTRACTOR is responsible for providing all required Microsoft and Wonderware licenses required to interface new equipment to the existing system.
  8. New alarms shall be consolidated with the existing alarms into a common alarming system.
- D. Work by Others:
1. PLC-1000 is scheduled to be provided as part of the Pressure Filter Vessel Improvements Project. However, control logic for the Filter Backwash Pumps provided under this contract shall reside in PLC-1000 and be programmed by OTHERS.
    - a. CONTRACTOR is responsible for terminating field wires for new equipment at PLC-1000 at locations directed by the OWNER during construction.
    - b. CONTRACTOR shall not make any modifications to PLC-1000 which will void the manufacturer's warranty.
    - c. Contractor is responsible for coordinating and scheduling startup and testing of the Filter Backwash Pumps with the OWNER.
    - d. Contractor shall assist OTHERS with testing of the Filter Backwash Pumps.
      - 1) Refer to Section 17950 for testing requirements.
  2. Modifications to the SCADA system required for the Filter Backwash Pumps shall be by OTHERS.
    - a. CONTRACTOR shall coordinate SCADA programming efforts with the OWNER to allow OTHERS to make modifications required for the Filter Backwash Pumps.
    - b. CONTRACTOR shall allow two weeks during startup and testing for OTHERS to make modifications to the SCADA system. During this time, CONTRACTOR shall not modify the SCADA system.
  3. A communications cabinet with an Ethernet switch, fiber to copper converter, fiber optic patch panel, shall be furnished by the OWNER. CONTRACTOR

shall install the communications cabinet in the Headworks Facility Electrical Room.

E. Operating Facility:

1. Refer to Section 01 73 00.
2. Portions of this existing facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
  - a. All outages must be of minimal duration and fully coordinated and agreed to by the OWNER. Adjust the construction to meet the requirements of the OWNER.
  - b. As weather and facility demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon OWNER by its users.
  - c. Where portions of the Work are in existing facilities and require interface to existing circuits, power systems, controls and equipment, perform comprehensive and detailed field investigations of existing conditions. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
  - d. Coordinate the construction and power renovation, bear all costs, so that all existing facilities continue operation throughout construction.
  - e. This is an operating facility that must be kept fully operational throughout the construction period, all changes in schedule and any needs to reschedule are included in the CONTRACTOR's bid.
3. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.
4. Where shown or specified, replace existing field instruments with new.
5. The CONTRACTOR is responsible for the integrity and measurement accuracy of all loops. However, any defect found in existing equipment is the responsibility of the OWNER.
6. The standards of documentation, instrument tagging, cable and conductor termination, terminal identification and labeling that apply to the new installation apply equally to the existing installation.

## 1.05 SUBMITTALS

A. General:

1. Furnish submittals that are fully indexed with a tabbed divider for every component.
2. Sequentially number pages within the tabbed sections. Submittals and Operation and Maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
3. Edit all Submittals and Operation and Maintenance Manuals so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.
4. Instruct all equipment suppliers of Submittal and Operation and Maintenance Manuals of the requirements in this Section.
5. Submittal Requirements:

- a. Submit copies of shop drawings, and product data, in accordance with Section 01 33 00 in addition to the requirements of this Section:
    - 1) Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
  - b. Where Submittals are required, provide a separate submittal for each Specification section. In order to expedite construction, the CONTRACTOR may make more than one submittal per Specification section, but a single submittal may not cover more than one Specification section:
    - 1) The only exception to this requirement is when one specification section covers the requirements for a component of equipment specified in another section.
6. Exceptions to specifications and drawings:
- a. Include a list of proposed exceptions to the specifications and drawings along with a detailed explanation of each.
  - b. Any exceptions to the specification and drawings must be noted and the reason for the exception explained.
  - c. If there is insufficient explanation for the deviation, the submittal will be returned requiring Revision and Re-submittal.
  - d. ENGINEER approval of any exception is at the sole discretion of the ENGINEER. Furnish all items (materials, features, functions, performance, etc.) that are not listed as exceptions strictly in accordance with the specifications and drawings.
  - e. Replace all items that do not strictly meet the requirements of the Specifications, which were not previously approved as exceptions, even if the Submittals contained information indicating the failure to meet the requirements.
7. Submittal Organization:
- a. First page:
    - 1) Specification Section reference.
    - 2) Name and telephone number of individual who reviewed submittal before delivery to ENGINEER.
    - 3) Name and telephone number of individual who is primarily responsible for the development of the submittal.
    - 4) Place for CONTRACTOR's review stamp and comments.
  - b. Next pages:
    - 1) Provide confirmation of Specification compliance in a tabular form that individually lists each Specification section, paragraph, and subparagraphs and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.
    - 2) Include a response in writing to each of the ENGINEER's comments or questions for submittal packages which are re-submitted:
      - a) In the order that the comments or questions were presented throughout the submittal.
      - b) Referenced by index section and page number on which the comment appeared.
      - c) Acceptable responses to ENGINEER's comments are either:
        - (1) ENGINEER's comment or change is accepted and appropriate changes are made.

- (2) Explain why comment is not accepted or requested change is not made.
      - (3) Explain how requirement will be satisfied in lieu of comment or change requested by ENGINEER.
    - d) Any re-submittal, which does not contain responses to the ENGINEER's previous comments, shall be returned for Revision and Resubmittal.
    - e) No further review by the ENGINEER will be performed until a response for previous comments has been received.
  - c. Remaining pages:
    - 1) Actual Submittal data:
      - a) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
      - b) For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is intended to be used.
8. Specific Submittal requirements:
- a. Furnish the submittals required by each Section or Division 17:
    - 1) Product Data.
    - 2) Shop Drawings.
  - b. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
  - c. Adhere to wiring numbering scheme outlined in Section 16075 throughout the Project:
    - 1) Uniquely number each wire per the Specifications.
  - d. Wire numbers must appear on all equipment drawings.
9. During the period of preparation of submittals, the CONTRACTOR shall authorize direct, informal liaison between the ICSC and the ENGINEER for exchange of technical information. As a result of this liaison, certain minor refinements and revisions may be authorized informally by the ENGINEER, which do not alter the scope of Work or cause increase or decrease in the Contract Price or Times. During this informal exchange, no oral statement by the ENGINEER shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant exception to, or variation from, these Contract Documents.
10. In these Contract Documents, some items of Work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ANSI/ISA S5.1:
- a. Employ the nomenclature and numbers designated herein and on the Drawings exclusively throughout shop drawings, data sheets, and similar submittals.
  - b. Replace any other symbols, designations, and nomenclature unique to a manufacturer's, Suppliers, or Subcontractor's standard methods with those identified herein and on the Drawings.
11. Furnish submittals in the following general order, each in a separate bound set:
- a. Schedule of Values.
  - b. Product Data.
  - c. After approval of the Product Data, submit the Project Shop Drawing submittals
  - d. Loop Description Submittal.

- e. The Process Control and SCADA Software Submittal including, control system software, programming, and screens.
- f. Testing, Calibration and Start-up procedures.
- g. Operation and Maintenance Data.
- h. Training Submittals.
- i. Record Documents.

B. Product Data:

1. General:

- a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
- b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these specifications.
- c. Include:
  - 1) Catalog cuts.
  - 2) Bulletins.
  - 3) Brochures.
  - 4) Quality photocopies of applicable pages from these documents.
  - 5) Identify on the data sheets the project name, applicable specification section, and paragraph.
  - 6) Identify model number and options for the actual equipment being furnished.
- d. Legibly cross out options that do not apply or equipment not intended to be supplied.

2. Material and equipment schedules:

- a. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and instruments that are proposed:
  - 1) Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

3. Itemized instrument summary:

- a. Submit a hard copy of the instrument summary.
- b. List all of the key attributes of each instrument including:
  - 1) Tag number.
  - 2) Manufacturer.
  - 3) Model number.
  - 4) Service.
  - 5) Area location.
  - 6) Calibrated range.
  - 7) Loop drawing number.
- c. Associated LCP, VCP, PCM, or PLC.

4. Instrument Data Sheets and cut sheets:

- a. Furnish fully completed data sheets, both electronically in Microsoft Word or Excel and in hardcopy, for each instrument and component according to ISA S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. The data sheets provided with the instrument specifications are preliminary and are not complete. They are provided to assist with the completion of final instrument data sheets. Additional data sheets may be required. Include the following information on the data sheet:
  - 1) Component functional description used herein and on the Drawings.
  - 2) Manufacturers model number or other product designation.

- 3) Tag number used herein and on the Drawings.
- 4) System or loop of which the component is a part.
- 5) Location or assembly at which the component is to be installed.
- 6) Input and output characteristics.
- 7) Scale range with units and multiplier.
- 8) Requirements for electric supply.
- 9) Requirements for air supply.
- 10) Power consumption.
- 11) Response timing.
- 12) Materials of construction and of component parts that are in contact with, or otherwise exposed to, process media, and or corrosive ambient air.
- 13) Special requirements or features, such as specifications for ambient operating conditions.
- 14) Features and options that are furnished.
- b. Provide a technical brochure or bulletin ("cut sheet") for each instrument on the project. Submit with the corresponding data sheets:
  - 1) Where the same make and model of instrument is used in 2 or more applications on the project, and the process applications are nearly identical, and the materials, features and options are identical submit one brochure or bulletin for the set of identical instruments.
  - 2) Include a list of tag numbers for which it applies with each brochure or bulletin.
  - 3) Furnish technical product brochures that are complete enough to verify conformance with all Contract Document requirements, and to reflect only those features supplied with the device.
  - 4) Cross out models, features, options, or accessories that are not being provided.
  - 5) Clearly mark and identify special options and features.
- c. Organization: Index the data sheets and brochures in the submittal by systems or loops.
5. Control Panel Hardware Submittal:
  - a. Submit the following in one submittal package.
  - b. Complete and detailed bills of materials:
    - 1) Including quantity, description, manufacturer, and part number for each assembly or component for each control panel.
    - 2) Include all items within an enclosure.
  - c. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and SCADA equipment.
  - d. Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium voltage power cables.
  - e. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.
  - f. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
    - 1) The manufacturer's model number or other identifying product designation.
    - 2) Tag and loop number.
    - 3) System to which it belongs.
    - 4) Site to which it applies.
    - 5) Input and output characteristics.
    - 6) Requirements for electric power.

- 7) Device ambient operating requirements.
- 8) Materials of construction.

C. Shop Drawings:

1. General:

- a. Coordinate all aspects of the Work so that a complete, instrumentation, computer, and control system for the facility is supported by accurate shop and record drawings:
    - 1) Clearly show every wire, circuit, and terminal provided under this contract on one or more submitted wiring diagrams.
  - b. Show all interfaces between any of the following: instruments, vendor control panels, motor control centers, motor starters, variable speed drives, control valves, flow meters, chemical feeders, and other equipment related to the PCIS.
  - c. Generate all drawings developed for this project utilizing AutoCAD by Auto Desk Version 2000 or later:
    - 1) Furnish on CD-ROM disks, as well as hard copies on 11-inch by 17-inch plain bond paper.
  - d. Organize the shop drawing submittals for inclusion in the Operation and Maintenance Manuals:
    - 1) Furnish the initial shop drawing submittal bound in one or more standard size, 3-ring, D-ring, loose leaf, vinyl plastic, hard cover binders suitable for bookshelf storage.
    - 2) Binder ring size: 2 inches.
  - e. Include the letterhead and/or title block of the firm responsible for the preparation of all shop drawings. Include the following information in the title block, as a minimum:
    - 1) The firm's registered business name.
    - 2) Firm's physical address, email address, and phone number.
    - 3) OWNER's name.
    - 4) Project name and location.
    - 5) Drawing name.
    - 6) Revision level.
    - 7) Personnel responsible for the content of the drawing.
    - 8) Date.
  - f. The work includes modifications to existing circuits:
    - 1) Clearly show all modifications to existing circuits.
    - 2) In addition, show all existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
  - g. All drawings that show a modification of an existing circuit must include the name and signature of the individual who performed the field verification work, along with a statement that the individual personally performed the field verification and that the information shown is correct.
2. Shop drawing requirements:
- a. Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
  - b. Locations of conduit entrances and access plates.
  - c. Component layout and identification.
  - d. Schematic and wiring diagrams with wire numbers and terminal identification.

- e. Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
  - f. Anchoring method and leveling criteria, including manufacturer's recommendations for the seismic specified in Section 01 61 20 and wind conditions specified in Section 01 61 40.
  - g. Weight.
  - h. Finish.
  - i. Nameplates:
    - 1) Refer to Section 16075.
  - j. Temperature limitations, as applicable.
3. Loop Drawings:
- a. Submit Loop Drawings for every analog, discrete, and fieldbus signal and control circuit:
    - 1) Provide a Loop Drawing submittal that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop on this Project.
    - 2) This requirement applies to all signal and control circuits associated with equipment provided under Division 17, Division 16, as well as equipment provided under other Sections including vendor supplied equipment packages and control panels.
    - 3) Include existing and OWNER furnished equipment that is to be incorporated into the PCIS.
  - b. Show every instrument and I/O point on at least one Loop Diagram.
  - c. Provide a complete index in the front of each bound volume:
    - 1) Index the loop drawings by systems or process areas.
  - d. Provide drawings showing definitive diagrams for every instrumentation loop system:
    - 1) Show and identify each component of each loop or system using requirements and symbols from ANSI/ISA S5.4 - Instrument Loop Drawings as amended by the Contract Drawings, as defined by the most recent revision in ISA. Include all minimum and optional ISA S5.4 content and information.
    - 2) Furnish a separate drawing sheet for each system or Loop Diagram.
  - e. In addition to the ISA S5.4 requirements, show the following details:
    - 1) Functional name of each loop.
    - 2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
    - 3) Show all terminal numbers, regardless of the entity providing the equipment.
    - 4) MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.
    - 5) Designation of and, if appropriate, terminal assignments associated with, every manhole, pull-box, junction box, conduit, and panel through which the loop circuits pass.
    - 6) Show vendor control panel, instrument panel, conduit, junction box, equipment and PCIS terminations, termination identification, wire numbers and colors, power circuits, and ground identifications.
    - 7) If a circuit is continued on another drawing show the name and number of the continuation drawing on the Loop Drawing. Provide complete references to all continuation drawings whether vendor control panels, other Loop Drawings, drawings provided under



Division 16, existing drawings provided by the OWNER, or other drawings.

- 8) P&ID Drawing number.
  - 9) Interconnection drawing number.
  - 10) Electrical schematic number reference.
  - f. In addition to the above requirements, provide Loop Diagrams in accordance with the example loop diagram as indicated on the Drawings.
4. Instrument Installation Drawings:
- a. Submit instrument installation, mounting, and anchoring details for all components and assemblies, including access requirements and conduit connection or entry details.
  - b. Furnish for each instrument a dedicated 8 1/2-inch by 11-inch installation detail that pertains to the specific instrument by tag number.
  - c. For each detail, provide certification and the hard copies, by the instrument manufacturer, that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable.
  - d. For each detail, provide, as a minimum, the following contents:
    - 1) Necessary sections and elevation views required to define instrument location by referencing tank, building or equipment names and numbers, and geographical qualities such as North, South, East, West, basement, first floor, etc.
    - 2) Ambient temperature and humidity where the instrument is to be installed.
    - 3) Corrosive qualities of the environment where the instrument is to be installed.
    - 4) Hazardous rating of the environment where the instrument is to be installed.
    - 5) Process line pipe or tank size, service and material.
    - 6) Process tap elevation and location
    - 7) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
    - 8) Routing of tubing and identification of supports.
    - 9) Mounting brackets, stands, anchoring devices, and sun shades.
    - 10) Conduit entry size, number, location, and delineation between power and signal.
    - 11) NEMA ratings of enclosures and all components.
    - 12) Clearances required for instrument servicing.
    - 13) List itemizing all manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.
5. Control Panel Drawings:
- a. Layout Drawings:
    - 1) Submit panel, enclosure, console, furniture, and cabinet layout drawings for all items provided.
    - 2) As a minimum, include the following information:
      - a) To scale front, side, and plan views.
      - b) Dimensions.
      - c) Interior and exterior arrangements.
      - d) Mounting information, including conduit entrance location.
      - e) Finish data.

- f) Tag number and functional name of items mounted in and on each panel, console, and cabinet.
      - g) Nameplate legend including text, letter size, and colors.
    - b. Wiring and Piping Diagrams:
      - 1) Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
      - 2) Include the following information:
        - a) Name of panel.
        - b) Wiring and piping sizes and types.
        - c) Terminal strip numbers.
        - d) Wire tags and labels.
        - e) Functional name and manufacturer's designation for items to which wiring and piping are connected.
        - f) Electrical control schematics in accordance with ANSI standards.
    - c. Installation drawings:
      - 1) Provide site-specific installation drawings for all control equipment panels, including dimensions.
      - 2) Provide scaled drawings and show the position of the equipment at its intended installation location.
      - 3) Show the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.
      - 4) Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.
  - 6. Schematic Diagrams:
    - a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
    - b. Include device and field connection terminal numbers on all schematic diagrams.
    - c. Incorporate equipment manufacturer's shop drawing information into the schematic diagrams in order to document the entire control system.
  - 7. Control System Diagram:
    - a. Submit a complete set of control system diagrams including the following information:
      - 1) All PLCs, workstations, printers, communication devices, and communication links:
        - a) Show all PLCs with their current I/O allocation, and future I/O allocation, current plus spares provided, and maximum potential I/O based on available slots.
      - 2) All cables required for communication requirements.
      - 3) Show each component fully annotated with conduit size and number associated with the power source.
- D. Process Control & SCADA Software Submittal:
  - 1. In accordance with Product Data and Shop Drawing general requirements.
  - 2. Submit a complete description of the standard application software programs, operating system and utility programs, including modifications and explanation of how the specific functional requirements are met:

- a. Provide a cross-reference between the Specification requirements and the software submittal, in order to provide the ENGINEER the ability to identify how each specified requirement or function is met.
  3. A complete listing of the PCIS system point I/O database:
    - a. Include for each data point, relevant parameters such as range, contact orientation, limits, incremental limits, I/O card byte, I/O hardware address, and PLC assignment.
    - b. Organize on a site-by-site basis, separate by point type.
    - c. In addition to the active I/O points, list the implemented spare I/O points and the available I/O points remaining on each card, as well as other defined future points specified or shown.
  4. Detailed descriptions of procedures used to implement and modify control strategies and database construction.
  5. Preliminary overview, screens, station graphic displays, and preliminary reports.
  6. Refer to Section 17762 for additional requirements.
- E. Instrumentation and Control System Contractor Statement of Qualifications:
1. Submit statement of qualifications of the proposed ICSC in accordance with subsequent requirements of this Section.
- F. Control Descriptions:
1. For each control loop, provide a detailed functional description of the operation of the equipment, signals, and controls as shown on the P&IDs:
    - a. Include all functions depicted or described in the Contract Documents.
    - b. Include within the Control Description content:
      - 1) All specific requirements.
      - 2) All common requirements that pertain in general to all loops.
      - 3) Listing all ranges, setpoints, timers, values, counter values, etc.
- G. Testing, Calibration, and Start-up Submittal:
1. General testing submittal requirements are specified in this Section. Additional requirements are specified in Section 17950 and other Sections.
  2. Test Procedure Submittals:
    - a. Submit the proposed procedures to be followed during tests of the PCIS and its components in two parts:
      - 1) Preliminary Submittal: Outline of the specific proposed tests and examples of proposed forms and checklists.
      - 2) Detailed Submittal: After successful review of the Preliminary Submittal, submit the proposed detailed test procedures, forms, and checklists. Include a statement of test objectives with the test procedures.
  3. Provide certified and witnessed test and calibration checklists for each of the following tests:
    - a. Calibration, adjustment, and test details for all components and systems.
    - b. Factory Acceptance Tests.
    - c. Loop Validation Tests:
      - 1) Loop Validation Certifications:
        - a) After the field device loop tests have been successfully completed for all individual instruments, all separate analog control networks, all valves, all VCPs, all motors, all local operator interface panels, all motor control centers, etc., submit

a certified copy of all test forms signed by the CONTRACTOR, ICSC or System Supplier, and the OWNER's Representative, with test data entered, together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

- d. Pre-commissioning Test.
- e. Performance Test.
- 4. Factory Acceptance Test:
  - a. Include complete test procedures and forms to be used during the test.
- H. Operation and Maintenance Manuals:
  - 1. Furnish the ENGINEER with a complete preliminary set of written Operation and Maintenance Manuals 8 weeks before calibration, start-up and/or testing.
  - 2. Furnish in accordance with Section 01 33 00 and the following additional requirements.
  - 3. Submit preliminary sets of these manuals to the ENGINEER for review of format and content:
    - a. ENGINEER will return 1 set with comments.
    - b. Revise and/or amend as required and submit the requisite number of copies to the ENGINEER 15 days before Pre-commissioning of the systems.
  - 4. Incorporate changes that occur during startup and training and submit as part of the final manuals.
  - 5. Final operation and maintenance manuals shall be submitted in a password-protected, editable format.
  - 6. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
  - 7. Include Record Documents and the approved shop drawing submittals, modified for conditions encountered in the field during the work.
  - 8. Include signed results from Calibration, Loop Validation Tests, Pre-commissioning, and Performance Testing.
  - 9. Provide installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.
  - 10. Provide exploded or other detailed views of all instruments, assemblies and accessory components together with complete parts lists and ordering instructions.
  - 11. Operational Manual:
    - a. Prepare and provide a simplified version of the standard manufacturer's OIT software and system operations manual that includes basic instructions in the application of the system as required for operators in day-to-day operations.
  - 12. Spare Parts List:
    - a. Include a priced list of recommended spare parts for all the equipment furnished under this Contract:
      - 1) Include recommended quantities sufficient to maintain the furnished system for a period of 5 years.
    - b. Annotate the list to indicate which items, if any and quantity are furnished as part of this Contract.
    - c. Provide the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts.
  - 13. Control and SCADA System Software Record Documents:

- a. Include complete documentation of all the software programs provided for the entire control and SCADA systems, including:
    - 1) Listings of all application software on both hard copy and CD-ROM.
    - 2) Database, both hard copy and CD-ROM.
    - 3) Developed and documented Source Codes.
    - 4) Communication protocols.
    - 5) All documentation necessary to maintain, troubleshoot, modify, or update the software system.
    - 6) SCADA Block Diagram with IP addressing defined on all components connected on the network.
14. Organize the Operation and Maintenance Manuals for each process in the following manner:
- a. Section A - Process and Instrumentation Diagrams.
  - b. Section B - Control Descriptions.
  - c. Section C - Loop Drawings.
  - d. Section D - Instrument Summary.
  - e. Section E - Instrument Data Sheets and Brochures.
  - f. Section F - Sizing Calculations.
  - g. Section G - Instrumentation Installation Details.
  - h. Section H - Test Results.
  - i. Section I - Operational Manual.
  - j. Section J - Spare Parts List.
  - k. Section K - Control and SCADA System Software.
- I. Training Submittals:
- a. Develop and submit for review a General Training Plan. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
  - b. The ENGINEER will review the General Training Plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the ENGINEER, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system, provide more qualified instructors.
  - c. Training Course Plan submittals:
    - 1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson.
    - 2) Describe any student pre-requisites for the course or training activity.
    - 3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.
    - 4) Submit training materials.
  - d. Incorporate all submittal review comments into the course.
  - e. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.
- J. Record Documents:
1. Furnish in accordance with Section 01 77 00.
  2. Provide Record Documents of all instrumentation Drawings.

3. Record Drawing requirements:
  - a. Update Record Drawings weekly.
  - b. Record Drawings must be fully updated as a condition of the monthly progress payments.
  - c. Submit final fully updated Record Drawings upon completion of the Work for final review.
  - d. Clearly and neatly show all changes in accordance with Section 01 77 00 and the following:
    - 1) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
4. Shop Drawings:
  - a. Upon completion of the Work, update all shop drawings to indicate the final as-built configuration of the systems:
    - 1) Should an error be found in a shop drawing during installation or startup of equipment, note the correction, including any field changes found necessary, on the drawing and submit the corrections in the Record Documents.
    - 2) Update, check, and revise all wiring drawings and other submitted drawings and documents to show final installed conditions.
  - b. Provide "As-Built" Shop Drawings for all instrumentation equipment on 11-inch by 17-inch using Bond paper.
  - c. Provide electronic copies of these documents on CD-ROM disks in AutoCad Version 2000 by Autodesk .pdf. Size all Drawings to be readable and legible on 11-inch by 17-inch media.
5. Submittal Documents:
  - a. Provide an interim submittal of Record Documents after the PCIS system Pre-commissioning but before testing.
  - b. Submit final Record Documents before Substantial Completion or earlier if so specified in Section 01 77 00 or the General Requirements.
6. Review and Corrections:
  - a. Correct any Record Documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
  - b. Promptly correct and re-submit Record Documents returned for correction.

## 1.06 QUALITY ASSURANCE

- A. Manufacture instruments at facilities certified to the quality standards of ISO 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
- B. ICSC Qualifications:
  1. General information on the proposing company:
    - a. Document that the ICSC company has been actively involved in the instrumentation, PLC based control systems, and SCADA systems business for a minimum of five years and has adequate facilities, organization structure, manpower and technical and managerial expertise to properly perform the Work in conformance with these Specifications.
  2. Document that the ICSC has a qualified permanent service facility:
    - a. Said facility shall be staffed with permanent employees and equipped with the tools and test equipment necessary to calibrate, test, and start-up all of the instrumentation, control, telemetry, and SCADA systems hardware

- and software furnished under this contract, including remote diagnostic capability.
- b. Document in-house resource of permanent personnel experienced in the design and programming of equipment and systems as required by these Specifications.
  - c. Document the existence of a training program staffed by qualified instructors, to provide proper training in the operation and maintenance of equipment as described in these Specifications.
  - d. Document that the firm is a recognized or certified "system integrator partner" or similar designation for the SCADA software and PLC system being supplied for this project.
3. Similar project experience of the company:
- a. Provide a list of at least 3 successfully completed projects for a water and/or wastewater system of similar scope and complexity in which the proposing firm used components the same as those intended for use on this project. The proposing firm must have performed, for each listed project, system engineering, system fabrication and installation, documentation (including schematic, wiring and panel assembly drawings), software configuration and documentation, field testing, calibration and start-up, operator instruction and maintenance training. In addition, provide the following information for each project:
    - 1) Name of plant or system owner, contact name, and current telephone number. Design engineer's name, address, and telephone number. Failure to provide current contact information may result in the listed project being disqualified for use in meeting the minimum requirements for prequalification.
    - 2) Manufacturer and model number(s) of the PLC based control system and the computer-based SCADA system used for both hardware and software.
    - 3) Brief description of the system.
    - 4) Approximate number of input and output signals: analog, digital, and field bus.
    - 5) Brief application software description.
    - 6) Contracted cost of the system, separate by base amount and any change orders for the completed projects.
    - 7) Duration of the project and date of completion.
4. Information on the proposed project team members:
- a. Provide the name and resume of the individual persons who will be responsible for each of the following:
    - 1) Office engineering and management of this project.
    - 2) Lead for software configuration/programming.
    - 3) Individual who will be responsible for the hardware and hardware interface design.
    - 4) Individual who will be responsible for field-testing, calibration, start-up.
    - 5) Individual who will be responsible for operator training.
  - b. All of these individuals must be permanent employees of the proposing firm.
5. Determination of the proposed ICSC qualifications is at the sole discretion of the ENGINEER.

- C. Furnish all equipment listed by and bearing the label of Underwriters' Laboratories, Incorporated (UL) or of an independent testing laboratory acceptable to the ENGINEER and the Authority Having Jurisdiction.
- D. Instrumentation and Control System Subcontractor (ICSC):
  - 1. The CONTRACTOR, through the use of a qualified ICSC, is responsible for the implementation of the PCIS and the integration of the PCIS with other required instrumentation and control devices.
  - 2. The ICSC assumes full responsibility, through the CONTRACTOR, to perform all work to select, furnish, install, program, test, calibrate, and place into operation all instrumentation, controls, telemetry equipment, control panels, and SCADA system including application software, for a complete, integrated and functional PCIS system.
  - 3. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these specifications that the ICSC be responsible for the integration of the PCIS with existing devices and devices provided under other Sections with the objective of providing a completely integrated control system.

### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Store all equipment and materials delivered to the job site in a location that will not interfere with the construction or the OWNER's operations.
- B. Shipping Precautions:
  - 1. After completion of shop assembly, successful Factory Acceptance Test (FAT), pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
  - 2. Place dehumidifiers when required, inside the polyethylene coverings.
  - 3. Skid-mount the equipment for final transport.
  - 4. Provide lifting rings for moving without removing protective covering.
  - 5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.
- C. Special Instructions:
  - 1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.
- D. Tagging:
  - 1. Tag each component and/or instrument to identify its location, instrument tag number, and function in the system.
  - 2. Firmly attach a permanent tag indelibly machine marked with the instrument tag number, as given in the tabulation, on each piece of equipment constituting the PCIS.
  - 3. Tag instruments immediately upon receipt in the field.
  - 4. Prominently display identification on the outside of the package.
  - 5. Utilize the Tag and Loop Number identifications shown on the P&IDs.
- E. Delivery and Inspection:
  - 1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.



## 1.08 PROJECT OR SITE CONDITIONS

- A. Site Conditions:
  - 1. Provide a PCIS, including all equipment, raceways and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
  - 2. Seismic Classification:
    - a. Provide all equipment and construction techniques suitable for the seismic requirements for the site, as specified in Section 01 61 20.
  - 3. Wind:
    - a. Provide all equipment and construction techniques suitable for the Site wind loading criteria, as specified in Section 01 61 40.
  - 4. Altitude, Temperature and Humidity:
    - a. Refer to Section 15050.
    - b. Provide all equipment and instrumentation fully rated for continuous operation at this altitude, temperature and humidity conditions with no additional derating factors applied.
    - c. Provide additional temperature conditioning equipment to maintain all equipment and instrumentation in non-conditioned spaces or outdoors subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature as determined by the equipment manufacturer's guidelines:
      - 1) Provide all power wiring for these devices (e.g., heaters, fans, etc.), whether or not shown on the plans.
  - 5. Area Classifications:
    - a. Furnish enclosures that match the area classifications as specified in Section 16050.
  - 6. Site Security:
    - a. Abide by all security and safety rules concerning the work on the Site, as specified in Section 01 33 00.

## 1.09 SEQUENCING

- A. General:
  - 1. Refer to Section 01 31 00.
  - 2. Testing requirements are specified in Section 17950 and other Sections.
  - 3. General scheduling requirements are specified in Section 01 32 00.
  - 4. Work restrictions and other scheduling requirements are specified in Section 01 73 00.
- B. Submit proposed ICSC statement of qualifications:
  - 1. The ICSC must be approved by the ENGINEER before any other Work commences.
- C. Pre-submittal Conferences:
  - 1. Before producing any submittals, schedule a pre-submittal Conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.
  - 2. The CONTRACTOR, instrumentation and control Subcontractor, electrical Subcontractor, all manufacturers furnishing major pieces of equipment must attend, including but not limited to:

- a. Vendor Control Panels.
  - b. Motor Control Centers.
  - c. Variable Frequency Drives.
  - d. Lighting.
- D. System Configuration Meetings:
1. Review the system configuration, the system database, control schemes, displays, report formats, etc. with the ENGINEER and OWNER on at least 3 occasions during development.
  2. Preliminary Meeting: Before configuration work is begun. The ICSC must bring to this meeting examples of displays, display symbols, reports, etc to show the capabilities of the system software.
  3. Intermediate Review Meeting: Held after the initial database is entered and typical screens and reports have been entered.
  4. Final Review Meeting: Held after initial completion of all configuration work. This final meeting may not be held in conjunction with the FAT. Make final format revisions after this Review.
  5. Refer to additional requirements in Section 17100, 17761 and 17762.
- E. Factory Acceptance Test (FAT):
1. Before the delivery and installation of the PCIS system at the job site, but after the procurement, assembly, and configuration of all components, perform the FAT.
  2. Schedule the FAT after receiving approval of the FAT procedures submittal.
  3. Submit a copy of the test procedures including all forms at least 21 days before any scheduled test date.
  4. Notify the ENGINEER of scheduled tests a minimum of 15 days before the date of the test.
- F. Loop Validation Test.
1. Notify the ENGINEER of scheduled tests a minimum of 30 days before the estimated completion date of installation and wiring of the PCIS.
  2. Complete testing a minimum of 5 days before the Pre-commissioning phase of the project.
- G. Training:
1. Refer to Section 01 73 00.
  2. Complete all training before the pre-commissioning phase of the project may start.
  3. Schedule the training sessions a minimum of 15 days before the start date of the courses.
  4. Submit training manuals to the ENGINEER a minimum of 10 days before starting the training session.
  5. Within 10 days after the completion of each session, submit the following:
    - a. A list of all OWNER personnel that attended the session.
    - b. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.
- H. Pre-Commissioning Test:
1. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.

2. Acceptance of the PCIS Pre-Commissioning testing must be provided in writing by the ENGINEER before the performance testing may begin.
- I. Provide all special tools and spare parts, refer to Paragraph 1.15 of this Section, before performance testing commences, suitably wrapped and identified.
- J. Performance Testing:
  1. Complete Pre-commissioning test a minimum of 5 days before the Performance Test.
  2. Conduct a 90-day Performance Test.
- K. Substantial Completion: The following conditions be fulfilled before the PCIS is considered complete:
  1. All submittals have been completed and approved.
  2. The PCIS has been calibrated, loop tested and pre-commissioned.
  3. The OWNER training has been performed.
  4. All required spare parts, expendable supplies, and test equipment have been delivered to the OWNER.
  5. The performance test has been successfully completed.
  6. All debris associated with installation of instrumentation has been removed.
  7. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

#### **1.10 SCHEDULING**

Not Used.

#### **1.11 WARRANTY**

- A. Warrant the PCIS in accordance with the following
  1. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions in the project documents. The warranty duration shall be 36 months beyond Final Acceptance. All software and hardware components that are part of the completed system shall be covered by the warranty. The Contractor shall not provide third party warranties. In addition, provide warranty services for the existing instrumentation shown on the drawings. This warranty service shall begin with an initial cleaning and calibration of the existing instrumentation in accordance with the equipment manufacturer's recommendations to ensure proper function and operation.
  2. Provide additional warranty as specified in the individual Division 17 Specifications.

#### **1.12 SYSTEM STARTUP**

- A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
  1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the ENGINEER.

#### **1.13 OWNER'S INSTRUCTIONS**

Not Used.

#### **1.14 COMMISSIONING**

Not Used.

#### **1.15 MAINTENANCE**

- A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.
- B. Furnish all spare parts as required by other sections of the Specifications.
- C. Provide additional spare parts specified in other sections of Division 17.
- D. Submit all special tools and spare parts, suitably wrapped and identified, before performance testing commences.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Provide similar items from a single manufacturer throughout the PCIS portion of the project.
- B. Allowable manufacturers are specified in individual instrument and equipment Specifications in other sections of Division 17.

#### **2.02 EXISTING PRODUCTS**

Not Used.

#### **2.03 MATERIALS**

- A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these devices and that bear all approvals and labels as required by the Specifications.
- B. Provide materials complying with the applicable industrial standard in accordance with the General Conditions.

#### **2.04 MANUFACTURED UNITS**

Not Used.

#### **2.05 EQUIPMENT**

Not Used.

## 2.06 COMPONENTS

- A. Furnish all meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise specified to match existing equipment.
- B. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of  $\pm 0.5$  percent of full scale and a minimum repeatability of  $\pm 0.25$  percent of full scale.
- C. Signal Transmission:
  - 1. Analog Signals:
    - a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable, unless otherwise indicated.
    - b. Furnish electrical analog signals outside control panels that are 4 to 20 mA 24 VDC, except as indicated.
    - c. Analog signals within enclosures may be 1 to 5 VDC.
    - d. Electrically or optically isolate all analog signals from other signals.
    - e. All pneumatic signals: 3 to 15 psig.
    - f. Discrete input signal: as indicated in the controller hardware specification.
    - g. Discrete output signals:
      - 1) Dry contacts or TRIAC outputs (with express written approval by the ENGINEER) as needed to coordinate with the field device.
      - 2) Provide external terminal block mounted fuse with blown fuse indication for all discrete outputs.
      - 3) Interposing Relays:
        - a) Provide interposing relays for all discrete outputs.
    - h. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
    - i. Maintain the total 4 to 20 mA loop impedance to 10 percent below the published value at the loop operating voltage.
    - j. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
- D. Discrete Circuit Configuration:
  - 1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
  - 2. Alarm contacts: Fail to the alarm condition.
  - 3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.
- E. Grounding:
  - 1. Provide control panels with a signal ground bus, isolated from the power ground bus:
    - a. Provide multiple panels in one location with a common point for signal ground bus connection to ground.
  - 2. Ground single point ground shields and measurement loops at the source panel external terminals, unless otherwise noted, by bonding to the control panel signal ground bus.
  - 3. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

- F. Instrument Air:
  - 1. Provide dry, filtered control air at 30 psig nominal pressure piped to all field instruments and instrument panels requiring air:
    - a. Provide each field instrument with an integral, non-adjustable filter/regulator assembly to provide regulated air.
    - b. Provide each instrument panel requiring air with an adjustable filter/regulator assembly with gauge and an air manifold to provide air to pneumatic instruments.
    - c. Filter all air to 5 micron maximum particle size.
    - d. Provide low pressure switch to alarm on insufficient air supply.

## **2.07 ACCESSORIES**

- A. Provide flow conditioning devices or other required accessories if necessary to meet the accuracy requirements in the Contract Documents.

## **2.08 MIXES**

Not Used.

## **2.09 FABRICATION**

Not Used.

## **2.10 FINISHES**

Not Used.

## **2.11 SOURCE QUALITY CONTROL**

- A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the Specifications.
- B. Arrange with all manufacturers of the equipment and fabricators of panels and cabinets, to allow the OWNER and ENGINEER to inspect and witness the testing of the equipment at the site of fabrication:
  - 1. Equipment includes the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices.
- C. Factory Testing is specified in Section 17950 and other sections of Divisions 16 and 17.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. The ICSC is encouraged to visit the site and attend a pre-bid conference and examine the premises completely before bidding. It is the ICSC's responsibility to be fully familiar with the existing conditions and local requirements and regulations.

- B. Review the existing site conditions and examine all Shop Drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.
- C. Provide a complete instrumentation and control system:
  - 1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, and process control and instrumentation system.

### 3.02 PREPARATION

Not Used.

### 3.03 INSTALLATION

- A. Equipment locations shown on the Drawings may change due to variations in equipment size or minor changes made by others during construction:
  - 1. Verify all dimensions as indicated on the Drawings:
    - a. Actual field conditions govern all final installed locations, distances, and levels.
  - 2. Review all information shown on the Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical, instrumentation, and mechanical Shop Drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
  - 3. Make minor changes in location of equipment before rough in, as directed by the OWNER or ENGINEER.
- B. Perform all related electrical work in accordance with the applicable Sections of Division 16.
- C. The PCIS configurations are diagrammatic:
  - 1. The locations of equipment are approximate unless dimensioned.
  - 2. Where Project conditions require make reasonable changes in locations and arrangements.
- D. Field Instruments Installation:
  - 1. Install field instruments in accordance with the Contract Documents, ANSI/API 550 and 551, and the manufacturer's instructions.
  - 2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
    - a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.
    - b. Provide sun shields for all field electronic instruments exposed to direct sunlight.
  - 3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
    - a. Type of flexible conduit required for the area classification:
      - 1) Refer to Section 16050 for area classification.
    - b. Maximum length of 18 inches.
  - 4. Connect field instruments with cable as specified in Division 16, except when the manufacturer requires the use of special cable, or otherwise specified herein:

- a. Special cable applications shall be in accordance with the NEC.
5. Verify the correctness of each installation:
  - a. Polarity of electric power and signal connections.
  - b. Ensure all process connections are free of leaks.
- E. Process Sensing Lines and Air Tubing:
  1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
  2. Provide supports for rigid tubing at intervals of not more than 3 feet.
  3. Slope horizontal runs of instrument tubing at a minimum of 1/16th-inch per foot to allow for draining of any condensate.
  4. Bends:
    - a. Use proper tool.
    - b. Make bends for parallel lines symmetrical.
    - c. Make bends without deforming or thinning the walls of the tubing.
  5. Square-cut and clean all ends of tubing before being inserted in the fittings.
  6. Provide bulkhead fittings at all panels requiring pipe and/or tubing entries.
  7. Use stainless steel tubing for all piping hard piped from the air header, unless otherwise noted on the Drawings or not compatible with the fluids or atmosphere in the area:
    - a. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times maximum travel of the equipment.
- F. Conduit, Cables, and Field Wiring:
  1. Provide all PCIS equipment cables, and process LAN communication networks under Division 17.
  2. Provide terminations and wire identification as specified in Division 16.
  3. Protect all wiring from sharp edges and corners.
  4. Provide all conduits, fittings, boxes, etc. in accordance with all the requirements of Division 16.
- G. Equipment Tie-Downs:
  1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the site.
  2. All control panels, VCPs, LCPs, RTUs, PCM's, etc., shall be permanently mounted and tied down to structures.
- H. Existing Instrumentation:
  1. Clean, recondition and re-calibrate each existing instrument to be reused, removed, or reinstalled using an authorized service facility of the instrument manufacturer.
  2. Provide certification of this work before reinstallation of each instrument.
- I. Instrument Tagging:
  1. Refer to Section 16075.
  2. Provide all field-mounted instruments with nameplates:
    - a. Nameplates engraved with the instrument's full tag number as indicated on the Drawings:
      - 1) Affix tags with stainless steel wire fasteners.
  3. Provide all back of panel instruments with nameplates:



- a. Engraved with the instrument's full tag number as indicated on the Drawings:
  - 4. Provide all front of panel instruments with a nameplate:
    - a. Engraving to include the instrument's full tag number and service description.
    - b. Secure nameplates to the panel with stainless steel screws.
    - c. Use an approved adhesive if screws would violate the NEMA or other ratings of the enclosure.
- J. Cable and Conductor Termination:
  - 1. Terminate all cables and conductors on terminal blocks.
  - 2. Terminal Block Enclosures:
    - a. Suitable for the area classification as specified in Section 16050.
- K. Surge Protection: (applicable to outdoor instruments only):
  - 1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments.
  - 2. Individually fuse each 4-20 mA DC loop with a 1/16 ampere fuse between power supplies and receiver surge protectors.
  - 3. Provide voltage surge protection for 4 wire transmitters and analyzers:
    - a. Protect both power source and signal loop.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION**

Not Used.

### **3.05 REPAIR/RESTORATION**

Not Used.

### **3.06 RE-INSTALLATION**

Not Used.

### **3.07 FIELD QUALITY CONTROL**

- A. Inspection:
  - 1. Allow for inspection of PCIS installation in accordance with Section 01 43 00.
  - 2. Provide any assistance necessary to support inspection activities.
  - 3. ENGINEER inspections may include, but are not limited to, the following:
    - a. Inspect equipment and materials for physical damage.
    - b. Inspect installation for compliance with Drawings and Specifications.
    - c. Inspect installation for obstructions and adequate clearances around equipment.
    - d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
    - e. Inspect equipment nameplate data to verify compliance with design requirements.
    - f. Inspect cable terminations.
    - g. Inspect/witness instrument calibrations/verifications.
  - 4. Inspection activities conducted during construction do not satisfy inspection requirements outlined in Section 17950.

- B. Field Testing is specified in Section 17950. Additional general requirements are specified in Section 01 73 00.
- C. Installation Supervision:
  - 1. Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum, the ICSC shall provide the following services:
    - a. Installation Resources:
    - b. Coordinate with the CONTRACTOR regarding installation requirements of the Contract Documents.
    - c. Provide technical assistance to installation personnel by telephone:
      - 1) Furnish installation personnel with at least one copy of the approved submittals, including all installation details.
    - d. Periodic inspections during the construction period.
    - e. A complete check of the completed installation to ensure that it is in conformance with the requirements of the equipment manufacturer and the Contract Documents.
    - f. Field verify accuracy and calibration of all instruments.

### 3.08 ADJUSTING

- A. Control Valves:
  - 1. Stroke all control valves, cylinders, drives and connecting linkages from the control system as well as local control devices and adjust to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position.
  - 2. Check control valve actions and positioner settings with the valves in place to ensure that no changes have occurred since the bench calibration.
- B. Make all revisions necessary to the control system software, as directed by the ENGINEER. It is understood that the CONTRACTOR knows and agrees that changes will be required in the control system software during the Factory Acceptance Tests, the Pre-Commissioning, Performance Testing, Start-up and during the warranty period:

### 3.09 CLEANING

- A. Refer to Section 01 77 00.
- B. Vacuum clean all control panels and enclosures before start-up and again after final completion of the project.
- C. Clean all panel surfaces.
- D. Return to new condition any scratches and/or defects.
- E. Wipe all instrument faces and enclosures clean.
- F. Leave wiring in panels, manholes, boxes, and other locations in a neat, clean, and organized manner:
  - 1. Neatly coil and label all spare wiring lengths.
  - 2. Shorten, re-terminate, and re-label excessive spare wire and cable lengths, as determined by the ENGINEER.

G. As specified in other sections of the Contract Documents.

### 3.10 DEMONSTRATION AND TRAINING

A. Demonstration requirements are specified in Section 17950.

B. Training:

1. General:

- a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.
- b. Conduct all training at the Project Site unless another location is approved by the ENGINEER and OWNER:
  - 1) Include instruction on the use of all maintenance equipment and special tools provided under the contract.
- c. Tailor training classes to the specific needs of the class participants:
  - 1) Develop separate courses for operators, maintenance staff, and supervisors:
    - a) The specific categories and number of personnel in each category are identified below.
  - 2) Furnish training courses that are a combination of classroom and hands-on training:
    - a) To the greatest extent possible, utilize components from the OWNER's PCIS system.
    - b) Limit classes that include extensive hands-on activities to a maximum of 5 students per class.
  - 3) Present the minimum number of sessions, specified in Table 17050-3.10-T1, for each course in order to satisfy class size restrictions and limitations scheduling OWNER staff.
  - 4) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.
- d. Temporarily install a test PLC and 2 user workstations in the training area for SCADA system training classes conducted on-site:
  - 1) Configure the workstations as full-function operator stations during the training classes.
  - 2) Connect these components with a LAN in order to fully simulate system operation.
- e. Schedule individual training classes with the OWNER at least 3 weeks before the start of the class:
  - 1) Schedule all training classes as specified in Section 01 73 00.
  - 2) Each individual daily training session, travel time excluded:
    - a) Minimum duration of 4 hours.
    - b) Maximum duration of 7 hours.
    - c) Breaks scheduled at least every 90 minutes and 1 hour for lunch.
  - 3) Complete training for maintenance personnel 90-days before Performance Testing.
  - 4) Complete operator training classes before startup of the SCADA system, or any part of it:
    - a) Refer to Paragraph 1.09 of this Section.
  - 5) Schedule follow-up training classes after SCADA startup on a schedule determined by the OWNER.

- f. Furnish highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:
  - 1) Instructors are subject to the approval of the ENGINEER.
  - 2) Furnish training instructors thoroughly familiar with the PCIS system, who are members of the SCADA system implementation team.
  - 3) One of the individuals conducting the SCADA system training course must be the same individual responsible for the majority of the programming that was performed for the instrumentation and control system.
- 2. Training Manuals and Materials:
  - a. Furnish training manuals and other materials for training courses.
  - b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.
  - c. The manuals are to serve as teaching aids during presentation of the training classes.
  - d. Manuals are to serve as reference material after the training has been completed.

<b>Course Title</b>	<b>Minimum Course Length (hours per session)</b>	<b>Personnel (Estimated Number of Students)</b>	<b>Minimum Number of Sessions</b>
System Overview	1	4	2
Operator Training - Basic & Advanced	4	8	2
PLC Hardware	1	4	2
PLC Software	1	4	2
Network Equipment	2	4	2
Follow-up Training	2	4	2
Instrument Training*	2	4	2

\*Additional training may be specified in the individual Instrument Specifications.

- 3. Training Course Requirements:
  - a. System Overview Training:
    - 1) Furnish training courses that give the OWNER's supervisory level personnel an overview of all elements of the PCIS System, that focus on the overall functional aspect of elements of the control system and provide an understanding of the interaction of the various components.
  - b. Operator Training:
    - 1) Furnish training courses that instruct system operators in the efficient operation of all aspects of the PCIS that include not only the general operation of the control system but also the operation of specific system features.
    - 2) Operator's Training shall include:
      - a) Control system overview: architecture, equipment functions, software components, etc.
      - b) Display navigation, overview, and types of displays.
      - c) Process and equipment monitoring and control: basic principles and operation.

- d) Logging ON and OFF the system and description of the security and access system.
  - e) Alarm subsystem.
  - f) Trending: provide a thorough session on how to use all trending functions.
  - g) Reports: How to access, print, and review content.
  - h) Control strategies: present an average 15-minute review of each control strategy, including a hands-on demonstration of screens and operator functions for each.
  - i) Instruction on the use of all operational functionality alarm logging, trending, displays, database, reports, and control software developed for the project and incorporated in the installed PCIS System.
- c. PLC Hardware Training:
- 1) Furnish training on PLC hardware and on related components, including battery backup equipment, UPSs, HMI hardware, control circuits, and analog circuits.
  - 2) Furnish training on PLC hardware principles, product features, proper installation, operation, troubleshooting, and maintenance.
  - 3) PLC training may be provided by manufacturer's certified trainers.
- d. PLC Software Training:
- 1) Furnish training on PLC software.
  - 2) Two types of training are required, basic and project-specific:
    - a) Basic PLC software training covers the principles of PLC programming and the specific features and function of the PLC products used on this project, provided by one of the PLC Manufacturer's certified trainers.
    - b) Project-specific PLC software training covers the programming conventions, new standardized software modules, specific control strategy programs, and documentation created for the work performed under this Contract. This training includes the specific knowledge needed to modify, expand, duplicate, troubleshoot, and repair the PLC programs provided under this Contract, provided by a qualified member of the ICSC who is thoroughly familiar with the delivered system, and is one of the senior programmers who programmed the PLCs for this project.
- e. HMI Hardware and Software Training:
- 1) Provide the following:
    - a) Overview of hardware and firmware, including starting, stopping, and PLC interface.
    - b) Configuration of tag database.
    - c) Creating, editing, and saving display screens.
    - d) Troubleshooting.
- f. Network Equipment Training:
- 1) Furnish basic training on all network hardware, switch and router configuration and software, and network monitoring software.
  - 2) Include a detailed description and explanation of the installed network architecture, media, and functions.
  - 3) Furnish an overview of the function and operation of each piece of network equipment.
  - 4) Furnish training on network maintenance troubleshooting and repair.
  - 5) Furnish training on how to install spare or off-line backup equipment.

- g. Follow-up Training:
  - 1) Provide a series of on-site follow-up training classes beginning after startup of the SCADA/PCIS system. The intent for these classes is to provide the OWNER's personnel the opportunity for a review and "refresher" of the training topics and material after they have had some experience using the system.
  - 2) Mutually schedule and develop the content of these classes with the OWNER no later than 1 month before the beginning of the first session:
    - a) Schedule at the OWNER's discretion on non-consecutive days spaced out over the start-up and warranty period.
- h. Instrumentation Training:
  - 1) Furnish training covering all instruments and control panels.
  - 2) Furnish the specified quantity of training, allocated to cover new instruments and hardwired controls as described herein and specifically determined in the approved Training Plan.
  - 3) Train maintenance staff in the use, cleaning, calibration, maintenance, and troubleshooting of all the instruments furnished within this project.
  - 4) Furnish training on the operation of new hardwired controls.

### **3.11 PROTECTION**

- A. Protect all Work from damage or degradation until date of Substantial Completion.

### **3.12 SCHEDULES**

Not Used.

END OF SECTION