SECTION 17050

PROCESS CONTROL AND INSTRUMENTATION SYSTEM GENERAL

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 a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to ensure a complete and coordinated project:
      a. Items involving electrical, control, and instrumentation construction may be shown on Drawings or referred to in Specifications that do not apply specifically to electrical, control and instrumentation systems.
   2. The Drawings and Specifications are complementary to each other; what is called for by one shall be as binding as if called for by both. If a conflict between Drawings and Specifications is discovered, refer conflict to the ENGINEER as soon as possible for resolution.

C. Interfaces to Equipment, Instruments, and Other Components:
   1. The Contract Drawings, Specifications, and overall design are based on non-certified information furnished by various equipment manufacturers. This "equipment" includes, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
   2. The Instrument Specifications, ladder logic diagrams, and installation details are based on non-certified vendor information and indicate minimum scope of supply from Manufacturers.
   3. Include all labor, material, and other costs in the bid to add additional instruments, wiring, control system inputs/outputs, controls, conduit, interlocks, electrical hardware, etc., into the Work based on the Equipment Manufacturer's final certified drawings.
   4. Revise or produce new loop diagrams to meet the Equipment Manufacturer's wiring requirements.
   5. Incorporate such changes to the Instrumentation and Electrical Work at no additional cost to the OWNER in light of the CONTRACTOR's knowledge that non-certified vendor information has been used in the design, and due to the fact that the final selection of the vendor may have been by the CONTRACTOR.
   6. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional conduit, wiring, terminals, or other

electrical hardware to the design, which may be necessary to make a complete, functional installation based on the actual equipment furnished.

7. 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 ICSC's scope of work and any costs for these items shall be included for the ICSC's bid.
8. Loop Drawings:
   a. Provide complete Loop Drawings for all systems, including packaged equipment that is part of a Vendor furnished package, and for all pre-purchased equipment.
   b. The OWNER and ENGINEER are not responsible for providing detailed wiring diagrams for CONTRACTOR furnished equipment.
9. Submit all such changes and additions to the ENGINEER for acceptance before starting field installation work.

D. All instrumentation, and control equipment and systems for the entire project shall 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 Divisions and Sections, 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. Specifications:
   1. The General and Special Conditions of the Contract Documents govern the Work.
   2. These requirements are in addition to all general requirements of the project. The CONTRACTOR must comply with all requirements. The more stringent requirements apply to all construction.

F. Contract Drawings:
   1. The Contract 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.
   2. 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:
      a. 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 all instrumentation and control equipment will be compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.

b. 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.

3. Installation Details:
   a. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the ENGINEER.
   b. The typical installation details apply to all aspects of the Work, whether specifically referenced or not.
4. Schematic Diagrams:
   a. All controls are shown de-energized.
   b. Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
   c. 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 isolation, equipment coordination, or control system voltage drop considerations.
   d. Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
   e. Use control schematics 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.

G. Alternates/Alternatives:
1. The CONTRACTOR may make written application to the ENGINEER to substitute for specified items. Make requests for substitution in writing to the ENGINEER within the period specified in General Conditions, Supplemental Conditions, and/or Division 1.
   a. Requests must contain model, type, or style number, catalog sheets, standards, and all pertinent data for each substitution requested.
2. Requests for substitutions will not be considered unless all information furnished to the ENGINEER is complete.
3. The ENGINEER's decision of acceptability of substitutions or modifications is final.

H. Changes and Change Orders:
1. Base all change orders upon the items and units as reflected in the schedule of values and the submitted per unit material and labor costs. Include itemized material and labor costs each request for changes.

1.02 REFERENCES

A. Code Compliance:
1. All work specified herein is to conform to or exceed the applicable requirements of the code and standard documents listed:
   a. Where such documents have been adopted as a code or ordinance by the public agency having jurisdiction, such code or ordinance takes precedence.

2. Provide all equipment, materials, installation, and other Work to conform to the following codes and standards:
   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. International Building Code (IBC).
   d. The versions of the above documents that have been accepted by the Authority Having Jurisdiction as of the Project bid opening date apply.
3. Where the requirements set forth in these Specifications or on the Drawings are greater or more rigid than the codes or standards referenced above, the applicable Specifications or Drawings govern.
4. In the case of conflict between any above-referenced codes or standards and the Specifications or Drawings, promptly notify ENGINEER in writing and request a clarification.

B. Compliance with Laws and Regulations:
   1. Nothing contained in these Specifications or shown on the Drawings is to be construed as to conflict with any national, state, municipal, or local laws or regulations governing the installation of Work specified herein, and all such acts, ordinances, and regulations are hereby incorporated and made a part of these Specifications.
   2. Should a conflict exist between the Contract Documents and an applicable law, ordinance, or regulation, it will be assumed that the more expensive method has been bid.
   3. If a conflict between the Contract Documents and an applicable law or regulation is discovered, promptly notify the ENGINEER in writing.

C. Standards:
   1. The standards listed are hereby incorporated into these Specifications. Perform all Work specified in Division 17 to conform to, or exceed, the applicable requirements of the referenced documents to the extent that the requirements in the listed standards are not in direct conflict with provisions of Division 17. Where there is a clear, direct conflict between the listed standard and Division 17 or the Instrumentation Drawings, promptly notify the ENGINEER in writing and request a clarification.
   2. The publications are referred to in the text by the basic designation only. The latest edition, accepted by the Authority Having Jurisdiction, of referenced publications in effect at the time of the bid governs.
   3. American National Standards Institute (ANSI):
      a. ANSI B16.5 - Pipe Flanges and Flanged Fittings.
   4. American Petroleum Institute (API):
      a. API RP551 - Process Measurement Instrumentation.
      b. API RP552 - Transmission Systems.
      c. API RP553 - Refinery Control Valves.
      d. API RP554 - Process Instrumentation and Control.
      e. API RP555 - Process Analyzers.

f. API RP556 - Fired Heaters & Steam Generators.
g. API RP557 - Guide to Advanced Control Systems.

5. American Society of Testing and Materials (ASTM):
   a. ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
6. Instrumentation, Systems, and Automation Society (ISA):
   a. ISA-5.1 - Instrumentation Symbols and Identification.
   b. ISA-5.2 - Binary Logic Diagrams for Process Operations.
   c. ISA-5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
   d. ISA-5.4 - Instrument Loop Diagrams.
   e. ISA-5.5 - Graphic Symbols for Process Displays.
   f. ANSI/ISA-7.00.01 - Quality Standard for Instrument Air.
   g. ISA-RP - 12.4 - Pressurized Enclosures.
   h. ANSI/ISA-18.1 - Annunciator Sequences and Specifications.
   i. ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
   j. 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.
   k. ANSI/ISA-50.00.01 - Compatibility of Analog Signals for Electric Industrial Process Instruments.
   l. ISA-51.1 - Process Instrumentation Terminology.
   m. ISA-RP60.3 - Human Engineering for Control Centers.
   n. ISA-71.01 - Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.
   o. ISA-71.02 - Environmental Conditions for Process Measurement and Control Systems: Power.
   p. ISA-71.03 - Environmental Conditions for Process Measurement and Control Systems: Mechanical Influences.
   q. ISA-71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

1.03 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. Instrumentation, Systems, and Automation Society.
   4. National Fire Protection Association.
   5. National Electrical Testing Association.

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 Buss 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.

C. Acronym Definitions:

1. CS: Control Station: Pilot device operator interface containing only pilot lights, pushbuttons, selector switches, potentiometers, etc.
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. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode of control equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode of control equipment is started or stopped, 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.
5. 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.
6. ICSC: Instrumentation and Control System Contractor: Contractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
7. I/O: Input / Output.
8. 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.

9. LCS: Local Control Station: Local panel that contains only pilot type control devices (e.g. pushbuttons, selector switches, pilot lights. Typically, there is no logic performed at the LCS.
10. LAN: Local Area Network: A control or communications network that is limited to the physical boundaries of the facility.
11. LOR: Local-Off-Remote control function. In the Remote mode of control, equipment is started or stopped, valves are opened or closed through the PLC based upon the selection of the HOA. In Local mode of control, 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.
12. OIT: Operator Interface Terminal. PC based interface device used for operator interface with the SCADA system.
13. P&ID: Process and Instrumentation Diagram.
14. PC: Personal Computer.
15. 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 "N" series Instrumentation Drawings.
16. PCM: Process Control Module: An enclosure containing any of the following devices: PLC, RIO.
17. PLC: Programmable Logic Controller.
18. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.
19. 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.
20. 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.
21. 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.
22. 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.
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 Process Control and Instrumentation System (PCIS), to perform the specified monitoring, communications, alarm, control, display, and reporting functions in accordance with the requirements of the Contract Documents.
4. 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.
5. Where demolition is shown on any Drawing, the Electrical Contractor is responsible for disconnecting equipment electrical connections and rendering the equipment safe. Remove all conduit, wire, electrical equipment, controls, etc. associated with the items and/or areas to be demolished. 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.
6. Portions of this project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment. Perform comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc). Determine all information needed to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
7. Packaged Equipment:
   a. Instrumentation and Control interfaces as shown on the Drawings reflect design based on non-certified vendor information. It is expected that additional I/O, addressing coordination, etc. may be required by Equipment Manufacturers to complete the installation. It is incumbent upon the CONTRACTOR to coordinate these requirements with its Subcontractors to make sure that the equipment supplier provides all necessary instrumentation, control system, and interface information to the ICSC for inclusion of costs in the bid package.
   b. Provide all necessary materials and labor to complete PCIS installation whether or not on the Drawings.
   c. Changes due to failure to perform such coordination are at no additional cost to the OWNER.
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 the Packaged Equipment Vendor.

B. Existing System:
   1. Presently, the Hughson WWTP control system functions on locally automated control panels with an alarm panel (Panalarm) and Graphics Panel located in the existing Operations Building. Most of the existing equipment on the plant is being demolished or abandon under this contract and will not need to be placed on the new SCADA system. Both the alarm panel and Graphics Panel are outdated and will not be reused as part of this project. However, they must remain in service until the new plant is operational. An auto dialer is also located at the operations building to alert operations of critical failures during unstaffed hours.

2. A PLC located in MCC-AA is currently used to control the mixers, aerators, and pumps added as part of the Interim Ponds Project. This is the only known existing PLC providing control for the wastewater plant. The PLC and pump station shall be modified and reused to perform emergency storage capacity as described in Section 17101.
3. A PLC/workstation based control system is also located in the existing Operations Building, which is part of the City's Water/Collection system. This system monitors several remote lift stations through PLCs connected to the workstation via radio. This system shall be integrated into the new SCADA system sometime in the future.
    a. The system consists of a Johnson Data Telemetry Radio, Rug 9 PLC and a Dell PC running Windows XP© with Wonderware.
    b. The radio and PLC are located on an exposed plywood backpanel in the operations building; they will be relocated and placed in a wall mount enclosure as part of this project.

C. New System:
1. Instrumentation and control work shall include, but not be limited to, field instrumentation and controls, process analyzers, PLC's, computer workstation, network equipment, control panels, UPS units, software, operator interface panels and related items. The CONTRACTOR shall provide labor for engineering, installation, drawings and submittals, testing, start up and training.
2. The CONTRACTOR shall provide all installation, configuration, calibration and testing to provide a fully functional control system except as described in Work by Others.
3. New instrumentation and control devices shall be added for the monitoring and control of all plant sites, both new and existing.
4. As part of the control system, PLC based control cabinets shall be added in the new electrical buildings (Electrical Building No. 1 and RAS Pump Station - Electrical Building No. 2).
5. New workstations, related equipment, and the communications equipment rack shall be located in the remodeled Operations Facility.
6. The existing Water System SCADA system shall be relocated.
7. The new PLCs and SCADA system equipment shall be networked via a new Ethernet based fiber optic communications network.
8. The new system shall also be programmed with provisions for integrating the existing well/water SCADA system. The integration of the existing well/water SCADA system and the new wastewater SCADA system is not required as part of this contract.

D. Demolition and Rework:
1. The existing panels are scheduled for rework and portions of their functionality shall be modified for the new process control system.
    a. Existing PLC:
        1) The existing program shall be modified to allow the emergency storage pond pumps (existing lift pumps) to be paced off a new flow meter. See Section 17101 for additional requirements.
    b. MCC-AA:
        1) The MCC control circuits for the lift pumps shall be modified to allow the pumps to run until the prime of the pump is lost, indicating the

emergency storage ponds are empty. See the electrical drawings and Section 17101 for additional requirements.

2. CONTRACTOR performed supplemental design tasks related to the connection of existing equipment to the new SCADA equipment are described below.
3. Most of the existing equipment on the existing plant, which includes the alarm panel (Panalarm) and the Graphics Panel, is being demolished or abandoned under this contract. However, they must remain in service until the new plant is operational.
4. Prior to demolition or modification of the panels described above, the Contractor shall perform the following field investigations:
   a. The Contractor shall identify and tag all existing field wires entering the cabinets scheduled for demolition.
   b. The Contractor shall verify all signal loops entering the existing control cabinet and provide a report to the Owner identifying existing plant signals that are not operational prior to the demolition of the existing panels.
   c. The existing conductors entering the panels shall be pulled back or demolished as indicated on the plans.
   d. Where applicable, conductors shall be re-terminated per approved drawings.

E. Operating Facility:
1. The existing wastewater treatment plant is an operating facility. Portions of this 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 water 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.
2. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.
3. Where shown or specified, replace existing field instruments with new.
4. 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.
5. The standards of documentation, instrument tagging, cable and conductor ferruling, terminal identification and labeling which apply to the new installation apply equally to the existing installation which forms part of the modified system.

1.05 SUBMITTALS

A. Submittal Requirements:
   1. Submit copies of shop drawings, product data, operating manuals and all other required submittals in accordance with Section 01330 and other Division 1 requirements, in addition to the requirements of this Section:
      a. Show dimensions, construction details, wiring diagrams, controls, Manufacturers, catalog numbers, and all other pertinent details.
   2. 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:
      a. The only exception to this requirement is when one specification section covers the requirements for a component of equipment specified in another section.
   3. Submittals are to be fully indexed with a tabbed divider for every component. Sequentially number pages within the tabbed sections. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
   4. Edit all submittals, including 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.
   5. Exceptions to Specifications:
      a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each. Any exceptions to the Specifications must be noted, and the reason for the exception explained. If there is insufficient explanation for the deviation, the submittal will be returned requiring Revision and Re-submittal.
      b. Acceptance of any exception is at the sole discretion of the ENGINEER. Furnish all items (material, features, functions, performance, etc.) that are not listed as exceptions, strictly in accordance with the Specifications and Drawings.
      c. Replace all items that do not strictly meet the requirements of the Specifications, and were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.
   6. 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 sub-paragraphs 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:
      (1) ENGINEER's comment or change is accepted and appropriate changes are made, or
      (2) Explain why comment is not accepted or requested change is not made, or
      (3) Explain how the 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 the submittal 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 areas where the device is intended to be used.

7. Advise all equipment suppliers of submittal requirements outlined in Section 17050. These requirements must be strictly adhered to.
8. Adhere to wiring numbering scheme outlined in Section 16075 throughout the Project. Uniquely number each wire per the Specifications:
   a. Wire numbers must appear on all equipment drawings.
9. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
10. 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 duration. 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.
11. 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. Employ the nomenclature and numbers designated herein and on the Drawings exclusively throughout shop drawings, data sheets, and similar submittals. 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.

12. Furnish submittals in the following general order, each in a separate bound set:
    a. All hardware items.
    b. After successful review of the hardware items, submit the Project Drawing Submittal showing: control, interconnection, and loop drawings. Include any drawings for any existing equipment to be modified.
    c. Loop Description Submittal.
    d. The Process Control and Software Submittal including, control system software, programming, and screen.
    e. Testing and Start-up procedures.
    f. Technical Manuals.
    g. Training Submittals.
    h. Record Drawings.

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

C. Drawings - General:
    1. Coordinate all aspects of the Work so that a complete electrical power, instrumentation, computer, and control system for the facility is supported by accurate shop and record drawings:
        a. Clearly show every wire, circuit, and terminal provided under this contract on one or more submitted wiring diagrams.
    2. 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.
    3. Generate all drawings developed for this project utilizing AutoCAD by Auto Desk Version 2005 or later:
        a. Delivered on CD-ROM disks, as well as hard copies on 11 inch by 17 inch plain bond paper.
    4. Generate manuals, or portions thereof, written specifically for this project utilizing Microsoft Word 2003 or later version:
        a. Delivered on CD-ROM disks as well as hard copies on 8.5 inch by 11 inch plain bond paper.
    5. Organize the shop drawing submittals for inclusion in the Technical Manuals:
        a. 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.
        b. Binder ring size: 2 inches.
    6. 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 Drawings.
    7. 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:
        a. The Firm's registered business name.
        b. Firm's physical address, email address, and phone number.
        c. OWNER's name.

d. Project name and location.
e. Drawing name.
f. Revision level.
g. Personnel responsible for the content of the drawing.
h. Date.

8. The work includes modifications to existing circuits. "Modifications" include changing, modifying, extending, interfacing to, removing or altering an existing circuit:
   a. Clearly show all modifications to existing circuits.
   b. In addition, show all existing unmodified wiring to clearly show the functionality and electrical characteristics of the complete modified circuits.
9. Field verify existing circuits that will be modified. Any drawing that shows 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.

D. Instrument Data Sheets and Cut Sheets:
   1. Provide fully completed data sheets 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:
      a. Component functional description used herein and on the Drawings.
      b. Manufacturers model number or other product designation.
      c. Tag number used herein and on the Drawings.
      d. System or loop of which the component is a part.
      e. Location or assembly at which the component is to be installed.
      f. Input and output characteristics.
      g. Scale range and units and multiplier.
      h. Requirements for electric supply.
      i. Requirements for air supply.
      j. Materials of construction and of component parts that are in contact with, or otherwise exposed to, process media, and or corrosive ambient air.
      k. Special requirements or features, such as specifications for ambient operating conditions.
      l. Features and options that are furnished.
   2. Provide a technical brochure or bulletin ("cut sheet") for each instrument on the project. Submit with the corresponding data sheets:
      a. 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.
      b. Include a list of tag numbers for which it applies with each brochure or bulletin.
      c. 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.

d. Cross out models, features, options, or accessories that are not being provided.
e. Clearly mark and identify special options and features.

3. Organization: Index the data sheets and brochures in the submittal by systems or loops.

E. Shop Drawing Requirements:
1. 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. This requirement applies to all signal and control circuits associated with equipment provided under Division 17, Division 16, as well as equipment provided under Sections in other Divisions, including vendor supplied equipment packages and control panels. 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. Tag all loops in a manner consistent with the Contract Documents.
e. 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 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.
f. 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, pullbox, junction box, conduit, and panel through which the loop circuits pass.
6) Show vendor panel, instrument panel, conduit, junction box, equipment and SCADA System 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 package drawings, 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.

g. In addition to the above requirements, provide loop diagrams in accordance with the example loop diagram as indicated on the Drawings.

2. Instrument Installation Drawings:
   a. Submit, in hard copy format, 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) Show all 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.

3. Panel Layout Drawings:
   a. Submit panel, enclosure, console, furniture, and cabinet layout drawings for all such items provided.
   b. Include the following information, at a minimum:
      1) Front, side, and plan views to scale.
      2) Dimensions.
      3) Interior and exterior arrangements.
      4) Mounting information, including conduit entrance location.
      5) Finish data.
      6) Tag number and functional name of items mounted in and on each panel, console, and cabinet.
      7) Nameplate legend including text, letter size, and colors.

4. Panel Wiring and Piping Diagrams:
   a. Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
   b. Include the following information:
      1) Name of panel.
      2) Wiring and piping sizes and types.
      3) Terminal strip numbers.
      4) Wire tags and labels.
      5) Functional name and manufacturer's designation for items to which wiring and piping are connected.
      6) Electrical control schematics in accordance with ANSI standards.
5. Schematic Diagrams:
   a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
   b. Submit schematic diagrams:
   c. Include device and field connection terminal numbers on all schematic diagrams.
   d. Incorporate equipment Manufacturer's shop drawing information into the schematic diagrams in order to document the entire control system.
6. Submit a complete set of control system drawings which depict:
   a. All PLCs, workstations, printers, communication devices, and communication links:
      1) 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.
   b. All cables required for communication requirements.
   c. Show each component fully annotated with conduit size and number associated with the power source.
7. Equipment Cabinet Installation:
   a. Provide site-specific installation drawings for all control equipment cabinets, including dimensions.
   b. Provide scaled drawings and show the position of the equipment at its intended installation location.
   c. 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.
   d. Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.

F. Control Panel Hardware Submittal:
1. Submit the following in one submittal package.
2. Complete and detailed bills of materials:
   a. Including quantity, description, Manufacturer, and part number for each assembly or component for each control panel.
   b. Include all items within an enclosure.
3. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and control room equipment.
4. Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium voltage power cables.
5. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.

6. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
    a. The Manufacturer's model number or other identifying product designation.
    b. Tag and loop number.
    c. System of which it is a part of.
    d. Site to which it applies.
    e. Input and output characteristics.
    f. Requirements for electric power.
    g. Device ambient operating requirements.
    h. Materials of construction.

G. Process Control & SCADA Software Submittal:
1. Complete description of the standard application software programs, operating system and utility programs, including modifications and explanation of how the specific functional requirements will be met:
    a. Provide a cross-reference between the specification and the software submittal, in order to provide the ENGINEER the ability to identify how each specified section or function are met.
2. A complete listing of the SCADA 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.
3. Detailed descriptions of procedures used to implement and modify control strategies and database construction.
4. Preliminary overview, screens, station graphic displays, and preliminary reports.
5. Refer to Section 17765 for additional requirements.

H. Loop 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 Loop 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.

I. 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.
   d. Pre-commissioning Test.
   e. Performance Test.

J. Technical (Operations and Maintenance) Manuals:
   1. Consisting of 1 or more volumes, bound in standard size, 2-inch, 3-ring, D-ring, loose-leaf, vinyl plastic, hard cover binder suitable for bookshelf storage.
   2. Initially, submit 2 full 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 amended as required and submit the requisite number of copies to the ENGINEER 15 days before startup of systems.
   3. Incorporate changes that occur during startup. Supply to the OWNER four final sets of manuals as a condition of final acceptance of the project.
   4. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
   5. Organize the Technical Manuals for each process in the following manner:
      a. Section A - Process and Instrumentation Diagrams.
      b. Section B - Loop 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.
   6. Include Contract Drawings and the approved shop drawing submittals, modified for conditions encountered in the field during the work.
   7. Include signed results from Calibration, Loop Testing, Pre-commissioning, and Performance Testing in Section H - Test Results.
   8. Provide installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.
   9. Provide exploded or other detailed views of all instruments, assemblies and accessory components together with complete parts lists and ordering instructions.
   10. Operational Manual:
      a. Prepare and provide a simplified version of the standard Manufacturer's HMI and 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.

11. Spare Parts List:
    a. Include a list of recommended spare parts for all the equipment furnished under this Section:
        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.
12. 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) Source Codes.
        4) Communication protocols.
        5) All documentation necessary to maintain, troubleshoot, modify, or update the software system.

K. Training Submittals:
1. Refer to Paragraph 3.10 of this Section.

L. Record Drawings/Documents:
1. Provide complete and checked As-Built and Record Documentation as specified.
2. Keep and maintain a complete, current marked-up set of all Contract Drawings and shop drawings at the job site, that show all actual installed conditions.
3. Contract Drawings:
    a. Provide As-Built drawings, P&IDs, control system block diagrams, and control schematics.
    b. Provide 2 red-line mark-up copies of As-Built Contract Drawings.
4. Submittal Documents:
    a. Update, check, and revise all wiring drawings and other submitted drawings and documents to show final installed conditions.
    b. Submit for review paper As-Built documents.
    c. Provide an interim submittal for review of up-to-date, As-Built drawings after the SCADA system commissioning testing.
    d. Submit final Record Drawings and other Record Documents before Final Acceptance or earlier if so specified in Section 01720 or the General Requirements.
5. Review and Corrections:
    a. Correct any As-Built drawings or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
    b. Promptly correct and re-submit As-built documentation returned for correction.
    c. Complete final, approved error free As-Built documents before Final Acceptance.

M. Spare parts list:
1. Provide a priced list of recommended spare parts covering items that are furnished under this Contract with the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts.

1.06 QUALITY ASSURANCE

A. Instrumentation and Control System Contractor (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 devices provided under other Sections with the objective of providing a completely integrated control system.
   4. As a minimum, the ICSC's work includes:
      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 Technical 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.

1.07 DELIVERY, STORAGE, AND PROTECTION

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 test, pack all equipment, cabinets, panels, and consoles in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
   2. Place dehumidifiers 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.
6. Ship equipment to the site in dedicated air ride vans that requires no re-handling of the equipment on route.

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 of the P&IDs.

E. Storage and Protection:
1. Provide maximum protection to the equipment and materials while in storage.
2. Store instruments in complete conformance with the Manufacturer's recommendations.
3. Replace any instruments stored in variance with the Manufacturer's recommendations at the ENGINEER's discretion.
4. Do not store equipment outdoors.
5. Store equipment in dry permanent shelters, including in-line equipment:
   a. Provide adequate protection for stored equipment against mechanical injury.
   b. Provide space conditioning to meet the manufacturers recommendations
6. Replace or repair any device that has been damaged.
7. Thoroughly dry out and test, as directed by the ENGINEER any device that has been subject to possible injury by water:
   a. Replace any device that fails the tests.

1.08 PROJECT OR SITE CONDITIONS

A. Site Conditions:
1. Provide an electrical, instrumentation and control system, 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 electrical equipment and construction techniques suitable for the seismic requirements for the Site, as specified in Section 01612.
3. Wind:
   a. Provide all electrical equipment and construction techniques suitable for the Site wind loading criteria, as specified in Section 01614.

4. Altitude:
   a. The site is located at approximately 125 feet above mean sea level. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
5. Humidity:
   a. Furnish all components and equipment fully rated for continuous operation at 90 percent relative humidity.
6. Temperature:
   a. The facility is located in an area where the temperature will vary from a minimum of 32 degrees Fahrenheit to a maximum of 120 degrees Fahrenheit.
   b. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces 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.
   c. Furnish all instrumentation suitable for operation in the ambient conditions at the equipment installation locations:
      1) Incorporate heating, cooling, and dehumidifying devices within the outdoor and/or indoor instrumentation in order to maintain the individual devices within their rated environmental operating ranges by 10 degrees Celsius below the maximum and 10 degrees Celsius above the minimum ambient temperatures.
      2) Provide all power wiring for these devices (e.g., heaters, fans, etc.), whether or not shown on the plans.
      3) Furnish enclosures that match the area classifications as detailed in Section 16050 or as indicated on the Drawings.
7. Site Security:
   a. Abide by all security and safety rules concerning the work on the Site, as specified in Section 01329.
8. Outdoor installations:
   a. Provide all electrical, instrumentation, and control equipment installed outdoors that are suitable for operation in the ambient conditions where the equipment is located.
   b. Provide heating, cooling, and de-humidifying devices incorporated into and included with electrical equipment, instrumentation and control panels located outdoors in order to maintain the enclosures within the rated environmental operating ranges as specified in Paragraphs 1.08-A-7 and 1.08-A-07 of this Section for the equipment:
      1) Provide all wiring necessary to power these devices.
9. Furnish enclosures that match the area classifications as detailed in Section 16050 or as indicated on the Drawings.

B. Provide a PCIS system designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:
   1. Computer Interface System and in plant PLCs, etc.:
      a. Temperature range: minimum of 60 degrees Fahrenheit to a maximum of 120 degrees Fahrenheit.
      b. Thermal shock: (1.0 degrees Fahrenheit) per minute maximum.

2. Instruments and all outdoor equipment:
   a. Ambient temperature range: 17.7 degrees Celsius through 32 degrees Celsius (0 degrees Fahrenheit through 90 degrees Fahrenheit).
   b. Thermal shock: 1.0 degrees Celsius (1.8 degrees Fahrenheit) per minute maximum.

1.09 SEQUENCING

A. General:
   1. Testing requirements are specified in Section 17950 and other Sections.
   2. General scheduling requirements are specified in Section 01324B.
   3. Work restrictions and other scheduling requirements are specified in Section 01140.

B. 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 System Contractor, Electrical Contractor, all suppliers furnishing pieces of equipment must attend, including but not limited to:
      a. Vendor Control Panels.
      b. Chemical Feed Suppliers.
      c. Motor Control Centers.
      d. Switchgear.
      e. Variable Frequency Drives.
      f. Lighting.
      g. Engine Generators.

C. 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:
   1. 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.
   2. Intermediate Review Meeting: Held after the initial database is entered, and typical screens and reports have been entered.
   3. 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.
   4. Refer to additional requirements in Section 17100, 17161 and 17162.

D. 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 working days before the scheduled test date.
   4. Notify the ENGINEER of scheduled tests a minimum of 15 working days before the date of the test.

E. Loop Validation Test:
   1. Notify the ENGINEER of scheduled tests a minimum of 30 working days before the estimated completion date of installation and wiring of the PCIS.
   2. Complete testing a minimum of 5 working days before the Pre-commissioning phase of the project.
   3. 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 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.

F. Training:
   1. Complete all training before the Pre-Commissioning phase of the project may start.
   2. Schedule the training sessions a minimum of 15 working days in advance, of when the courses are to be initiated.
   3. Submit training manuals to the ENGINEER a minimum of 10 working days before starting the training session.
   4. 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.

G. 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.

H. Provide all special tools and spare parts, refer to Paragraph 1.15 of this Section, before performance testing commences, suitably wrapped, and identified.

I. Performance Testing:
   1. Complete Pre-commissioning test a minimum of 5 working days before the Performance Test.
   2. Conduct a 90-day Performance Test.

J. Acceptance: 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 ENGINEER.
   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 performance and the hardware of the PCIS, including all instrumentation, control, telemetry and SCADA equipment and associated software and installation, as specified herein, for a period of 1 year following the date of substantial completion and formal acceptance of the Work:
   1. To fulfill this obligation, provide technical service personnel designated by the ICSC.
   2. Perform services to correct any defect within 3 calendar days after notification by the OWNER of a defect.

B. Warrant the satisfactory performance of the software, equipment, and materials under the specified operating conditions:
   1. In the event that operations, tests, or inspections disclose latent defects or failure to meet the specified requirements, promptly correct or repair any such defects or non-conformance, or furnish such new equipment or parts as may be necessary for conformity to the specified requirements.

C. Replace or modify equipment, software, and materials that do not achieve design requirements after installation to attain compliance. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and attain compliance approval from the ENGINEER.

D. Provide all parts, material, labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period:
   1. Furnish spare parts and tools on site at inventory levels sufficient to meet the response and repair times specified:
      a. All spare parts and tools stored on-site shall become the property of the OWNER upon completion of the warranty period.

1.12 ~~SYSTEM STARTUP~~ (NOT USED)

1.13 ~~OWNER'S INSTRUCTIONS~~ (NOT USED)

1.14 ~~COMMISSIONING~~ (NOT USED)

1.15 MAINTENANCE

A. Include in the bid a $10,000.00 tools and spare parts allowance in the bid:
   1. Furnish the spare parts selected by the ENGINEER from the priced list of spare parts in the Hardware Submittal.
   2. Furnish a price list of all special tools required to calibrate and maintain all of the instrumentation provided under the Contract Documents. Furnish the special tools selected by the ENGINEER from the priced list.
   3. The OWNER at its discretion may elect to remove any or all of this allowance from the Contract, credit any amounts so removed to the OWNER with a reduction in the Contract Price.

B. In addition to the $10,000 spare parts allowance and allocation, furnish the following:
   1. One portable instrument calibrator current simulator with charger, pressure modules to accommodate all pressure measuring instruments furnished, and carrying case:
      a. Rochester Instrument Systems (RIS) CL-9002.
      b. Fluke 702 DPC.
      c. Transmation.
   2. A fuse for fuse replacement for every fuse used in the system.

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 electrical and instrumentation 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 standards, except where these Specifications are more stringent.

2.04 ~~MANUFACTURED UNITS~~ (NOT USED)

2.05 EQUIPMENT

A. Provide all equipment that is new, free from defects, and produced by manufacturers regularly engaged in their production.

B. All components of the equipment shall bear all approvals and labels as required by the Specifications.

C. Furnish similar equipment from a single Manufacturer.

D. Alternative Equipment and Methods: Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the ENGINEER through the "or equal" process as defined in the Specifications.

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 ±0.5 percent of full scale and a minimum repeatability of ±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 milliamperes 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: 120 VAC, unless otherwise noted.
      g. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
      h. Maintain the total loop impedance 10 percent below the published total loop impedance for 4 to 20 milliamperes signals at the rated value for the regulating device at the loop operating voltage.
      i. 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, open condition.
   3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.
   4. Discrete output signals:
      a. 120 VAC dry contacts as needed to coordinate with the field device.
      b. Provide external terminal block mounted fuse with blown fuse indication for all discrete outputs.
      c. Interposing Relays:
      d. Provide interposing relays for all discrete outputs.

E. Grounding:
   1. Provide control panels with a signal ground bus, isolated from the power ground bus:
      a. Provide multiple panels in 1 location a common point for signal ground bus connection to ground.
   2. Single point ground shields and measurement loops at the source panel external terminals 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.

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. 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.
   2. Make no shipments without the ENGINEER'S release.

B. Factory Testing is specified in Section 17950 and other sections of Divisions 16 and 17.

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.

PART 3 EXECUTION

3.01 EXAMINATION

A. Review all Drawings and Specifications and to report to the ENGINEER before bidding:
   1. Any errors.
   2. Any omissions.
   3. Any Electrical Code problems.
   4. Any Local Building Code problems.
   5. Or any points of conflict with other trades.

B. The ICSC is required to 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. Difficulties that arise

after the Contract has been awarded which could have been avoided by a more complete initial site visit are the responsibility of the ICSC to correct.

C. 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.

D. The CONTRACTOR, through the System Supplier, is responsible for the complete electrical and instrumentation work:
   1. Install all extra conduits, cables, and interfaces, as may be necessary to provide a complete and operating electrical and PCIS system.

3.02 PREPARATION

A. The construction and installation of all electrical equipment and materials must comply with all applicable provisions of:
   1. OSHA-Safety and Health Standards.
   2. State building standards.
   3. Applicable local codes and regulations

3.03 INSTALLATION

A. Perform installation work by individuals who are skilled and experienced in the installation and connection of all elements, instruments, accessories, and assemblies.

B. Perform all related electrical work in accordance with the applicable Sections of Division 16.

C. The monitoring and control system configurations are diagrammatic:
   1. The locations of equipment are approximate unless dimensioned.
   2. Where job conditions require 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.
   3. Provide sun shields for all field electronic instruments exposed to direct sunlight:
      a. Orient and shield LED, LCD, or other digital readouts to eliminate exposure to direct sunlight.
   4. Make connections from rigid conduit systems to field instruments with PVC coated flexible metal conduit:
      a. Type of flexible conduit required for the area classification.
      b. Maximum length of 18 inches.

5. 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.
6. Verify the correctness of each installation:
   a. Polarity of electric power and signal connections.
   b. Ensure all process connections are free of leaks.
7. Provide a power disconnect switch for each 120 VAC powered instrument which does not have a built-in power disconnect:
   a. Disconnect enclosure suitable for the area classification. Refer to Section 16050.

E. Make minor changes in location of equipment before rough in, as directed by the OWNER or ENGINEER.

F. 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 the area or material incompatibilities exist which would require the use of other compatible materials:
   a. Use flexible connection may be used only on moving equipment and under the constraint that the length shall be less than 1.5 times to maximum travel of the equipment.

G. Conduit, Cables, and Field Wiring:
1. Conduit is specified in Division 16.
2. Signal circuits, control wiring, signal wiring to field instruments, and other field wiring and cables are specified in Division 16.
3. Provide all PCIS equipment cables, and process LAN communication networks under Division 17.
4. Provide terminations and wire identification as specified in Section 16150.
5. Protect all wiring from sharp edges and corners.

H. 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., must be permanently mounted, and tied down to structures.

I. 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.

J. Resources for Installation Personnel:
   1. Instruct installation personnel on installation requirements of the Contract Documents.
   2. As a minimum, provide technical assistance to installation personnel by telephone.
   3. Furnish installation personnel with at least one copy of the approved shop drawings and data.

K. Instrument Tagging:
   1. Provide all field-mounted instruments with engraved lamicoid plastic nameplates as specified in Section 16075:
      a. Tags stamped or engraved with the instrument's full tag number:
         1) Affix tags with stainless steel wire fasteners.
   2. Provide all back of panel instruments with black-white-black plastic laminate nameplates engraved with the instrument's full tag number:
   3. For all front of panel instruments, include the instrument's full tag number and service description in the nameplate.
      a. Use an approved adhesive if screws would violate the NEMA or other ratings of the enclosure.
      b. Secure nameplates to the panel with stainless steel screws.

L. Electrical Marking:
   1. Machine print and clearly label all electrical devices, terminal blocks, terminals, cables, and conductors.
   2. Provide all cables and conductors with a heat shrink identification sleeve.
      a. Adhesive tape identification markers are not allowed.
      b. Provide a unique numbering system that conforms to requirements specified in Section 16075.
      c. Tag cables at both ends and at any intermediate pull box or manhole through which the cables are routed:
         1) Identify all cables.

M. Cable and Conductor Termination:
   1. Terminate all cables and conductors on terminal blocks.
   2. Terminal Block Enclosures:
      a. Install field mounted terminal blocks in NEMA 4 enclosures or NEMA 4X enclosures in wet or corrosive areas unless otherwise specified.

N. Hazardous (Classified) Areas:
   1. Instrumentation and control equipment is subject to the requirements for hazardous (classified) areas as specified in Division 16 and as indicated on the Drawings.
   2. Provide switches to be installed in a hazardous (classified) area made safe by means of suitably rated Factory Mutual approved intrinsically safe barriers or intrinsically safe relays installed in a nonhazardous area.

O. Surge Protection:
   1. Provide outdoor field instrument loops with voltage surge protection units at instruments.
   2. Individually fuse each 4-20 mA DC loop with a 1/16 ampere [slow blow] fuse between power supplies and receiver surge protectors.
   3. Provide voltage surge protection for 4 wire transmitters and analyzers with 120 VAC power sources. Protect both 120 VAC power source and 24 VDC signal loop.

3.04 ~~ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION~~ (NOT USED)

3.05 ~~REPAIR/RESTORATION~~ (NOT USED)

3.06 ~~RE-INSTALLTION~~ (NOT USED)

3.07 FIELD QUALITY CONTROL

A. Field Testing is specified in Section 17950. Additional general requirements are specified in Section 01756.

B. Manufacturer Services.
   1. Provide the following services:
      a. Perform bench calibration.
      b. Oversee installation.
      c. Verify proper installation of installed instrument.
      d. Certify installation and reconfirm Manufacturer's accuracy statement.
      e. Oversee pre-commissioning, prepare pre-commissioning validation sheets, and certify pre-commissioning.
      f. Train the OWNER's personnel.

C. Installation Supervision: Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum include the following services:
   1. Provide the installing Subcontractor with information and direction before commencement of the installation work.
   2. Provide the Instrument Installation Details specified in Article 1.05 Submittals.
   3. Periodic inspections during the construction period.
   4. 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.
   5. Field verify accuracy or calibration of all instruments.

3.08 ADJUSTING

A. Control Valves:
   1. Stroke all control valves, cylinders, drives and connecting linkages from the OIT or HMI as well as local control devices and adjusted 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 Facility Pre-Commissioning, Performance Testing, and during the Warranty period:

3.09 CLEANING

A. Vacuum clean all control panels and enclosures before start-up and again after final completion of the project.

B. Clean all panel surfaces.

C. Return to new condition any scratches and/or defects:
   1. If in the ENGINEER's opinion the panel repairs do not constitute new condition, replace these panels with new panels.

D. Wipe all instrument faces and enclosures clean.

E. Removal of Abandoned Equipment: Remove and deliver to the OWNER all existing instrumentation and control equipment that is no longer required after the new system has been put into service, whether or not shown or identified on the Drawings.

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.

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 by qualified instructors for all the instrumentation, control, telemetry, and computer monitoring and control systems furnished.
      b. 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.
      c. 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.
      d. Tailor training classes to the specific needs of the class participants:
         1) Develop separate courses for Operators, Maintenance Staff, and Supervisors.
      e. 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.

f. Schedule individual training classes with the OWNER at least 3 weeks before the start of the class.
g. Except for follow-up training, complete Operator training classes before startup of the SCADA system, or any part of it if there are early completion items:
    1) Refer to Paragraph 1.09 of this Section.
h. Complete maintenance training 90-days before Performance Testing.
i. Schedule follow-up training classes after SCADA startup on a schedule determined by the OWNER.
j. 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.
k. Furnish training instructors thoroughly familiar with the PCIS system, who are members of the SCADA system implementation team.
l. Furnish training courses that are a combination of classroom and hands-on training:
    1) To the greatest extent possible, utilize components from the OWNER's PCIS system.
m. Provide completion reports in accordance with Paragraph 1.09 of this Section.

2. Training Submittals and Instructors:
    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.
3. 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.

4. Required Training:
   a. Tailor training courses to meet the specific needs of several distinct groups of personnel:
      1) The specific categories and number of personnel in each category are identified in the following paragraphs.
      2) 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.
   b. Schedule all training classes Monday - Friday between 7:30 AM and 3:30 PM.
   c. Each individual daily training session:
      1) Minimum duration of 4 hours.
      2) Maximum duration of 7 hours.
      3) Breaks scheduled at least every 90 minutes and 1 hour for lunch.

Table 17050-3.10-T1

Course Title	Minimum Course Length (hours per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
System Overview	4	4	1
Operator Training - Basic	4	4	1
Operator Training - Advanced	4	4	2
CIS (Computer) Equipment Maintenance	2	4	2
OIT Software	2	4	2
Historian System Training	2	4	1
Reports Training	2	4	2
PLC Hardware	2	4	1
PLC Software	2	4	1
LOI/OIS Hardware and Software	2	4	2
Network Equipment	2	4	1
Follow-up Training	4	4	2
Instrument Training	4	4	1

5. 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, data base, reports, and control software developed for the project and incorporated in the installed PCIS System.

c. CIS Computer Equipment Maintenance Training:
   1) Furnish training courses that will enable maintenance technicians to perform troubleshooting and repair of all system computer equipment. Include the theory of operation of the system as a whole, including related operating system and utility software.

d. OIT Software Training:
   1) Furnish training courses that will enable the OWNER's staff to develop and maintain all aspects of the operator interface system applications.
   2) Include topics:
      a) Operating systems and utilities such as virus protection software.
      b) Point (tag) database development and modification.
      c) Graphic screen creation and editing.
      d) Scripting.
      e) I/O servers, drivers, etc.
      f) PLC interface functions and software.
      g) Displays, scripts conventions, and documentation.
      h) Trending.
      i) Alarms and events.
      j) System security, access levels, and areas of responsibility.
      k) General system maintenance, including backups, history data archive, version control, file naming and cataloging conventions, and system file house-keeping.
   3) Address not only the procedures associated with the control system's standard software packages, but in addition include material explaining the specific conventions used in developing the Project's system applications (graphics, PLC/RTU interface, scripts, control

strategies, trends, etc.). In addition, provide instruction in the use of techniques for developing and maintaining current, comprehensive documentation for all installed system applications.

e. Historian System Training:
   1) Furnish the following training:
      a) Introduction to relational databases.
      b) Introductory training on the specific relational database program used for the historian server.
      c) How to set up points for historian logging.
      d) How to develop, edit, and print custom reports, in detail.
      e) Introduction to use of the query language.
      f) System maintenance.
      g) Interface to networks outside of the SCADA system.

f. Report Training:
   1) Furnish training courses that will enable the OWNER's staff to develop and maintain all aspects of Reports.
   2) Include topics:
      a) Generation of a developed report.
      b) Generation of a new report.
      c) Modification and editing of reports.
      d) Formatting reports.
      e) Manual entry and automatic entry of data from a database.

g. 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 or by personnel highly experienced with the specific equipment and with training on PLC hardware installation, operation, troubleshooting, and maintenance.

h. 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.

i. 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.

j. 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.

k. 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 OWNER 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.
3) Provide 5 full days of follow-up training. Schedule each day of follow-up training independently of other follow-up training days.
4) Scheduled at the OWNER's discretion on non-consecutive days spaced out over the start-up and warranty period.
5) Include all necessary travel time and expense to provide the follow-up training in the bid price.

l. 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 new instruments.
4) Furnish training on the operation of new hardwired controls.

6. Audio-Visual Tapes / DVD:
a. Record all training.
b. Provide English language audio-visual recordings of the operator and maintenance training classes on the instrumentation, control, and the computer monitoring and control systems.
c. Furnish in Digital Video Disk (DVD) format.
d. These disks become the property of the OWNER and cover, in detail, the training for the specific hardware and software of all the systems provided for the project.
e. Provide pre-recorded audio-visual presentations or produce audio-visual presentations by recording the actual training sessions of the OWNER'S personnel.
f. Provide all the necessary cameras and recording equipment.
g. Provide the recorded audio-visual presentation in addition to the training material used in the training courses:
1) Recorded presentations are not a substitute for any training material.

3.11 ~~PROTECTION~~ (NOT USED)

3.12 ~~SCHEDULES~~ (NOT USED)

END OF SECTION