

SECTION 40 90 00
INSTRUMENTATION AND CONTROL
FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:
1. Section 26 05 02, Basic Electrical Requirements.
 2. Section 26 05 04, Basic Electrical Materials and Methods.
 3. Section 26 05 05, Conductors.
 4. Section 26 05 10, Network Communication System
 5. Section 40 91 00, Instrumentation and Control Components.
 6. Section 40 92 01, Control Panels.
 7. Section 40 96 00, Application Software.
 8. Section 40 99 90, Package Control Systems.
- B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.
1. Process instrumentation including primary elements, transmitters, control devices, and control panels.
 2. Programmable logic controllers.
 3. Computers, servers and networks for Human Machine Interface (HMI) and Alarm Notification.
 4. Control Panels.
 5. Network Components.
 6. Application Software:
 - a. Provided by Contractor for PLCs, HMI, and network components. Work related to supporting this activity may include:
 - 1) Coordination of all the networked (Ethernet) signals between the field devices and control system.
 - 2) Configuration and programming PLC, HMI, and network equipment at a staging site.
 - 3) Demonstration testing at staging site.
 - 4) Assistance with onsite checkout of applications software.
- C. Work Does Not Include:
1. SCADA Software.
 2. Wifi router and equipment.

3. Fire Alarm Control Panels.
4. Security System.
5. Telephone System.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section and other PIC subsections:
1. ACIO-2020-002: Cybersecurity of Building Automation and Control Systems within NPS Facilities.
 2. American National Standards Institute (ANSI).
 3. ASTM International (ASTM):
 - a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - d. B32, Standard Specification for Solder Metal.
 - e. B88, Standard Specification for Seamless Copper Water Tube.
 4. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
 5. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 6. International Society of Automation (ISA):
 - a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
 - b. S5.1, Instrumentation Symbols and Identification.
 - c. S5.4, Instrument Loop Diagrams.
 - d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
 - e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
 - f. ISA 101 Human Machine Interfaces for Process Automation Systems.
 - g. ISA 18.2 Management of Alarm Systems for the Process Industries.
 7. International Conference on Energy Conversion and Application (ICECA).
 8. National Electrical Code (NEC).

9. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 1, Industrial Control and Systems General Requirements.
10. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
11. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
12. UL: 508A, Standard for Safety, Industrial Control Panels.
13. HDR Instrument and Design Controls Standards: Memo Dated April 25, 2024.

1.03 DEFINITIONS

A. Abbreviations:

1. FDT: Factory Demonstration Test.
2. HMI: Human-Machine Interface.
3. HVAC: Heating, Ventilating, and Air Conditioning.
4. I&C: Instrumentation and Control.
5. I/O: Input and Output.
6. O&M: Operation and Maintenance.
7. OIT: Operator Interface Terminal.
8. P&ID: Process and Instrument Diagram.
9. PC: Personal Computer.
10. PIC: Process Instrumentation and Control.
11. PLC: Programmable Logic Controller.
12. RTU: Remote Terminal Unit.
13. SCADA: Supervisory Control and Data Acquisition.
14. SI: System Integrator.
15. SLDC: Single Loop Digital Controller.
16. SSDT: Staging Site Demonstration Test.
17. VFD: Variable Frequency Drive.

B. Application Software: Application Software will be provided and program by NPS's selected SI.

C. Enclosure: Control panel, console, cabinet, or instrument housing.

D. Instructor Day: 8 hours of actual instruction time.

- E. Rising/Falling: Define action of discrete devices about their setpoint.
1. Rising: Contacts close when an increasing process variable rises through setpoint.
 2. Falling: Contacts close when a decreasing process variable falls through setpoint.
- F. Signal Types:
1. Analog Signal, Current Type:
 - a. 4 mA dc to 20 mA dc signals conforming to ISA S50.1.
 - b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
 - 1) Transmitter Type: Number 2, two-wire.
 - 2) Transmitter Load Resistance Capacity: Class L.
 - 3) Fully isolated transmitters and receivers.
 2. Analog Signal, Voltage Type: 1V dc to 5V dc within panel where common high precision dropping resistor is used.
 3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
 4. Pulse Frequency Signals:
 - a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
 - b. Pulses generated by contact closures or solid state switches.
 - c. Power source less than 30V dc.
 5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.
- G. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.
1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic); Office Suites (word processor, spreadsheet, database); e-mail; security (firewall, antivirus; spam, spyware) debugging aids; and diagnostics.
 2. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, SLDC, and network devices.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
3. PIC design as shown and specified includes:
 - a. Functional requirements, performance requirements, and component specifications.
 - b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

B. Use a qualified PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
 - a. Completing detail design.
 - b. Configuring network switches.
 - c. Submittals.
 - d. Equipment, enclosures, and ancillaries.
 - e. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
 - f. Verify readiness for operation.
 - g. Verify correctness of final power and signal connections (lugging and connecting).
 - h. Adjusting and calibrating.
 - i. Starting up.
 - j. Testing and coordination of testing.
 - k. Training.
2. Verify following Work not by PIC System Integrator is provided:
 - a. Correct type, size, and number of signal wires with their raceways.
 - b. Correct electrical power circuits and raceways.
 - c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
 - d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. Non-PIC Equipment Directly Connected to PIC Equipment:
 - a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
 - b. Coordinate with Contractor and relevant subcontractors to allow required interface and operation with PIC.

- c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
- d. Test to demonstrate required interfaces and operation with PIC.
- e. Examples of items in this category, but not limited to the following:
 - 1) Valve operators, position switches, and controls.
 - 2) Chemical feed pump and feeder speed/stroke controls.
 - 3) Automatic samplers.
 - 4) Motor control centers.
 - 5) Adjustable speed and adjustable frequency drive systems.
- f. Examples of items not in this category:
 - 1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
 - 2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General Format:

- 1. Submittal Format:
 - a. Electronic Copies: Required, unless otherwise noted for specific items.
 - 1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
 - 2) Documents created specifically for Project:
 - a) Text and Graphics: Microsoft Word.
 - b) Lists: Microsoft Excel, unless otherwise noted for specific items.
 - c) Drawings: AutoCAD.

B. Action Submittals:

- 1. Bill of Materials: List of required equipment.
 - a. Group equipment items by enclosure and field, and within an enclosure, as follows:
 - 1) PIC Components: By component identification code.
 - 2) Other Equipment: By equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number and all options not defined by model number.
 - 4) Quantity supplied.
 - 5) Component identification code where applicable.

- 6) For panels, include panel reference number and name plate inscription.
 - c. Formats: Hard copy and Microsoft Excel.
2. Catalog Cuts:
 - a. I&C Components, Electrical Devices, and Mechanical Devices:
 - 1) Catalog information, marked to identify proposed items and options.
 - 2) Descriptive literature.
 - 3) External power and signal connections.
 - 4) Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces and installation details.
3. Instrument List:
 - a. Initial Instrument List is provided as a supplement to this section. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.
 - b. Applicable fields to be completed include, but are not limited to:

Instrument List Characteristics	
Item	
Tag Number	
Loop Number	
Description	
Manufacturer and complete model number	
Size and scale range	
Setpoints	
Reference P&IDs, Electrical, Mechanical, Interconnection Drawings and Installation Details Drawings	
Instrument detail number	
 - c. Submit updated version of Instrument List in Microsoft Excel.
4. Component Data Sheets: Data sheets for I&C components.
 - a. Format:
 - 1) Similar to ISA TR20.00.01.
 - 2) Microsoft Excel, one component per data sheet.
 - 3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.

- b. Content:
 - 1) Specific features and configuration data for each component, including but not limited to:
 - a) Tag Number.
 - b) Component type identification code and description.
 - c) Location or service.
 - d) Service conditions.
 - e) Manufacturer and complete model number.
 - f) Size and scale range.
 - g) Setpoints.
 - h) Materials of construction.
 - i) Options included.
 - j) Power requirements.
 - k) Signal interfaces.
 - l) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
 - c. Electronic Copies: Microsoft Excel.
- 5. Sizing and Selection Calculations:
 - a. Primary Elements:
 - 1) Complete calculations plus process data used. Example for Flow Elements:
 - a) Minimum and maximum values, permanent head loss, and assumptions made.
 - b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
 - c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
- 6. Preliminary Panel Elevation Drawings:
 - a. Provide prior to submitting Panel Construction Drawings:
 - 1) Scale Drawings: Show dimensions and location of front of panel devices.
 - 2) Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
 - 3) Submit electronic copies of Drawings.
- 7. Panel Construction Drawings:
 - a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
 - b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.

- d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
- e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
- f. Submit electronic copies of Drawings.
- 8. Diagrams:
 - a. Detailed Wiring Diagrams:
 - 1) Diagrams including:
 - a) Panel Wiring Diagrams for discrete control and power circuits.
 - b) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
 - c) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.
 - 2) Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.
 - 3) Submit electronic copies of Drawings.
 - b. Panel Wiring Diagrams:
 - 1) Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
 - 2) Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
 - c. Diagram Type:
 - 1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
 - 2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.
 - d. Item Identification: Identify each item with attributes listed.
 - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
 - 3) Components:
 - a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
 - b) Switching action (open or close on rising or falling process variable), setpoint value and units, and

- process variable description (for example, Sump Level High).
- 4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
 - 5) Relay Coils:
 - a) Tag number and its function.
 - b) On right side of run where coil is located, list contact location by ladder number and sheet number.
Underline normally closed contacts.
 - 6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
 - 7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
 - 8) Show each circuit individually. No “typical” diagrams or “typical” wire lists will be allowed.
 - 9) Ground wires, surge protectors, and connections.
 - 10) Wire and Cable Names: Show names and wire color corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.
- e. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
- 1) Conform to the minimum requirements of ISA S5.4.
 - 2) Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
 - 3) Show loop components within a panel and identify each component, component terminals, and panel terminals.
 - 4) If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
 - a) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
 - b) Identify the component by tag and description.
 - c) Identify panel and component terminal numbers.
 - 5) Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
 - 6) Divide each loop diagram into areas for panel face, back-of-panel, field, and PLC.
 - 7) One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.
 - 8) Show:
 - a) Terminal numbers, location of dc power supply, and location of common dropping resistors.

- b) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
 - c) Tabular summary on each analog loop diagram:
 - (1) Transmitting Instruments: Output capability.
 - (2) Receiving Instruments: Input impedance.
 - (3) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
 - (4) Total loop impedance.
 - (5) Reserve output capacity.
 - d) Circuit and raceway schedule names.
 - f. Communications and Digital Networks Diagrams:
 - 1) Scope: Includes connections to Ethernet network, SCADA servers, and packaged vendor systems.
 - 2) Format: Network schematic diagrams for each different type of network.
 - 3) Show:
 - a) Interconnected devices, both passive and active.
 - b) Device names and numbers.
 - c) Terminal numbers.
 - d) Communication Media: Type of cable.
 - e) Connection Type: Type of connector.
 - f) Node and device address numbers.
 - g) Wire and cable numbers and colors.
 - g. Panel Plumbing Diagrams:
 - 1) For each panel containing piping and tubing. Show type and size for:
 - a) Pipes and Tubes: Thickness, pressure rating, and materials.
 - b) Components: Valves, regulators, and filters.
 - c) Connections to panel-mounted devices.
 - d) Panel interface connections.
 - e) Submit electronic copies of Drawings.
- 9. Panel Power Requirements and Heat Dissipation:
 - a. For control panels tabulate and summarize:
 - 1) Required voltages, currents, and phases(s).
 - 2) Maximum heat dissipations Btu per hour.
 - 3) Calculations.
 - 4) Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 90 degrees F.
- 10. Installation Details: Include modifications or further details required and define installation of I&C components.
- 11. Spares (for instruments, IO modules), expendables (for analytical instruments) and test equipment.

12. PLC I/O List: Submit I/O assignment and Rack/Slot/Point.
13. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
14. Color schedule for control panels.
15. Applications Software Documentation:
 - a. Complete configuration documentation for microprocessor based programmable devices.
 - b. For each device, include program listings and function block diagrams, as appropriate, showing:
 - 1) Functional blocks or modules used.
 - 2) Configuration, calibration, and tuning parameters.
 - 3) Descriptive annotations and control narratives
 - c. Refer to PIC subsections for additional requirements.
16. Factory and Field Test Documentation:
 - a. Submit test plans prior to Factory and Field Tests.
 - b. Submit test reports and punch lists from the Factory and Field tests.
 - c. Submit final sign off documentation from the Factory and Field tests.
17. Legends and Abbreviation Lists:
 - a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
 - b. Use identical abbreviations in PIC subsections.
 - c. Submit updated versions as they occur.
18. Shop Drawings for Changes Impacting PLC and SCADA Programming:
 - a. Submit details of changes required to PLC and SCADA monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.

C. Informational Submittals:

1. Proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
2. Statements of Qualification:
 - a. PC System Integrator.
 - b. PC System Integrator's site representative.
 - c. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/configuring personnel).

3. Operation and Maintenance Data:
 - a. In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
 - 1) General:
 - a) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
 - b) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, Subparagraph Submittal Format.
 - b. Manufacturer's O&M Manuals for Components, Electrical Devices, and Mechanical Devices:
 - 1) Content for Each O&M Manual:
 - a) Table of Contents.
 - b) Operations procedures.
 - c) Installation requirements and procedures.
 - d) Maintenance requirements and procedures.
 - e) Troubleshooting procedures.
 - f) Calibration procedures.
 - g) Internal schematic and wiring diagrams.
 - h) Component and I/O Module Calibration Sheets from field quality control calibrations.
 - 2) Provide PDF file with linked index to all manuals.
 - c. List of spares, expendables, test equipment and tools provided.
 - d. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.
 4. Provide Manufacturer's Certificate of Proper Installation where specified.
 5. Testing Related Submittals:
 - a. Factory Demonstration Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures:
 - a) Proposed test procedures, forms, and checklists.
 - b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
 - 3) Test Documentation: Copy of signed off test results.
 - b. Staging Site Demonstration Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures: Proposed test procedures, forms, and checklists.

- 3) Test Documentation: Copy of signed-off test results when tests are completed.
 - c. Functional Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures: Proposed test procedures, forms, and checklists.
 - 3) Test Documentation:
 - a) Copy of signed-off test results.
 - b) Completed component calibration sheets.
 - d. Performance Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures: Proposed test procedures, forms, and checklists.
 - 3) Test Documentation: Copy of signed-off test results.
- 6. Training Module: In accordance with Section 01 79 00, Demonstration and Training.
- 7. Maintenance Service Agreement: Prior to Substantial Completion, submit service agreements signed by Contracting Officer and maintenance provider for work.
- 8. Manufacturer Service Support for Network and SCADA Equipment:
 - a. Product warranty service agreement.
 - b. Cisco's SMARTnet support for 1-year after final acceptance.
 - c. Technical Support contact numbers, days per week, hours per day.
 - d. Documentation showing that warranties, SMARTnet, etc., have been transferred to the Contracting Officer complete with contact information provided by the Contracting Officer.
 - e. Preventive maintenance schedule.
 - f. Software and firmware updates.

1.06 QUALITY ASSURANCE

A. Qualifications:

- 1. PIC System Integrator: Minimum of 10 years' experience providing, integrating, installing, and starting up similar systems as required for this Project.
- 2. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

- 1. General: Refer to Section 01 31 00, Project Management and Coordination, for PIC coordination meetings.

2. PIC Schedule Coordination Meeting:
 - a. Timing: Following Contracting Officer review of PIC Schedule.
 - b. Purpose: Discuss Contracting Officer's comments and resolve scheduling issues.
3. Training Coordination Meeting:
 - a. Timing: Following Contracting Officer review of preliminary training plan.
 - b. Purpose:
 - 1) Resolve required changes to proposed training plan.
 - 2) Identify specific Contracting Officer personnel to attend training.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01 67 00, Product Requirements.
- B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.
- C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

- A. Refer to Section 01 31 00, Project Management and Coordination, for Contractor's scheduling requirements for applications software testing.
- B. Prerequisite Activities and Lead Times:
 1. Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:
 - a. Shop Drawing Reviews by Contracting Officer:
 - 1) Prerequisite: Contracting Officer acceptance of Schedule of Values and Progress Schedule.
 - 2) Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 23, Submittal Procedures.
 - b. Test Prerequisite: Associated test procedures Submittals completed.
 2. Training Prerequisite: Associated training plan Submittal completed.
 - a. PLC and HMI Configuration Training Session 1 Prerequisite: PLC and HMI hardware and software Shop Drawings approved.
 - b. Staging Site Demonstration Test Prerequisite: PLC and HMI staging equipment delivered to staging site.

- c. PLC and HMI Shipment to Site:
 - 1) General Prerequisites:
 - a) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
 - b) FDT and SSDT completed.
- d. PLC and HMI Installation Prerequisite: Equipment received at Site.
- e. Functional Test Part 1 Prerequisite: PLC and HMI installation complete.
- f. Functional Test Part 2 Prerequisite: Functional Test Part 1 completed.
- g. Performance Test Prerequisite: Functional Test Part 2 completed and facility started up.

1.09 MAINTENANCE

A. Maintenance Service Agreement:

- 1. Duration of 2 years, unless otherwise noted in PIC subsections.
- 2. Start on date of Substantial Completion.
- 3. Performed by factory-trained service engineers with experience on PIC systems to be maintained.
- 4. PIC Systems Covered: PIC components, PLC, HMI, and network equipment.
- 5. Materials and labor for preventive maintenance and monthly Site visits.
- 6. Materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m. Monday through Friday.
- 7. Response Time: Service engineer shall be onsite within 24 hours of request by Contracting Officer.
- 8. Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.
- 9. Repair or replace components or software found to be faulty.
- 10. Replace and restock within 1 month onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.
- 11. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each Site visit.

B. Telephone/Remote Support: As specified in PIC subsections.

C. Software Subscription: As specified in PIC subsections.

1.10 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
dc power supplies	20	2
Fuses	20	5
Relays	20	3
Terminal Blocks	10	10
120V ac Isolation Transformers	10	2
Surge Suppressors	10	2

D. Expendables:

1. For following items provide manufacturer's recommended 2-year supply, unless otherwise noted:
 - a. Chemicals for analyzers.
 - b. pH Sensor Overhaul Kits: Two.
 - c. Spray pump filter adhesive; Hoffman Model A-FLTAD. One pint per panel with air filters.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide PIC functions shown on the Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software whether indicated or not, necessary to effect required system and loop performance.
- B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.
 1. If proposed or equal items require, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.
- C. Like Equipment Items:
 1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

2. Implement same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.
- D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 I&C COMPONENTS

- A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.
- B. Components for Each Loop: Major components for each loop are listed Instrument Index referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.
- C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

- A. Reference PLC components in Section 40 91 00, Instrumentation and Control Components.

2.04 NETWORK AND HMI COMPONENTS

- A. Reference Network and HMI components in Section 40 91 00, Instrumentation and Control Components.

2.05 SERVICE CONDITIONS

- A. Standard Service Conditions:
 1. The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:
 - a. Server Room, Air Conditioned:
 - 1) Temperature: 60 degrees F to 80 degrees F.
 - 2) Relative Humidity: 40 percent to 60 percent.
 - 3) NEC Classification: Nonhazardous.

- b. Inside, Air Conditioned:
 - 1) Temperature:
 - a) Normal: 60 degrees F to 80 degrees F.
 - b) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
 - 2) Relative Humidity:
 - a) Normal: 10 percent (winter) to 70 percent (summer).
 - b) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
 - 3) NEC Classification: Nonhazardous.
- c. Inside:
 - 1) Temperature: 20 degrees F to 104 degrees F.
 - 2) Relative Humidity: 10 percent to 100 percent
 - 3) NEC Classification: Nonhazardous.
- d. Outside:
 - 1) Temperature: Minus 20 degrees F to 104 degrees F.
 - 2) Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain
 - 3) NEC Classification: Nonhazardous.

B. Standard Service Conditions for Panels and Consoles:

- 1. Unless otherwise noted, in Instrument List and Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:
 - a. Freestanding Panel and Consoles:
 - 1) Inside, Air Conditioned: NEMA 1.
 - 2) Inside: NEMA 12.
 - b. Smaller Panels and Assemblies (that are not freestanding):
 - 1) Inside, Air Conditioned: NEMA 12.
 - 2) All Other Locations: NEMA 4X.
 - c. Field Elements: Outside.

C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.06 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

- 1. Physical Characteristics:
 - a. Location and Inscription: Refer to Example Control Panel Layouts and Control Panel Schedule drawings.
 - b. Materials: Laminated plastic attached to panel with stainless steel screws.

- c. Letters: 1/2-inch high, white on black background, unless otherwise noted.
 - 2. Functional Characteristics: None.
 - 3. Performance Characteristics: None.
- B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.
 - 1. Physical Characteristics:
 - a. Location and Inscription: As shown on panel drawing.
 - b. Materials: Adhesive-backed, laminated plastic.
 - c. Letters: 3/16-inch high, white on black background, unless otherwise noted.
 - 2. Functional Characteristics: None.
 - 3. Performance Characteristics: None.
- C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.
 - 1. Physical Characteristics:
 - a. Inscription: Component tag number.
 - b. Materials: Adhesive-backed, laminated plastic.
 - c. Letters: 3/16-inch high, white on black background, unless otherwise noted.
 - 2. Functional Characteristics: None.
 - 3. Performance Characteristics: None.
- D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches:
 - 1. Physical Characteristics:
 - a. Inscription:
 - 1) Refer to table under Subparagraph Standard Pushbutton Colors and Inscriptions.
 - 2) Refer to table under Subparagraph Standard Light Colors and Inscriptions.
 - 3) Refer to P&IDs on the Drawings.
 - b. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
 - c. Letters: Black on gray or white background.
 - 2. Functional Characteristics: None.
 - 3. Performance Characteristics: None.

- E. Service Legends: Component identification nameplate located on face of component.
 - 1. Physical Characteristics:
 - a. Inscription: As shown on panel drawing.
 - b. Materials: Adhesive-backed, laminated plastic.
 - c. Letters: 3/16-inch high, white on black background, unless otherwise noted.
 - 2. Functional Characteristics: None.
 - 3. Performance Characteristics: None.
- F. Nametags: Component identification for field devices.
 - 1. Physical Characteristics:
 - a. Inscription: Component tag number.
 - b. Materials: 16-gauge, Type 304 stainless steel.
 - c. Letters: 3/16-inch high, imposed.
 - d. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.
 - 2. Functional Characteristics: None.
 - 3. Performance Characteristics: None.

2.07 MECHANICAL SYSTEM COMPONENTS

- A. Reference Section 40 91 00, Instrumentation and Control Components.

2.08 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

- A. Shown on the Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on the Drawings.
- B. In Supplements that describe requirements not obvious on P&IDs or panel control diagrams.
- C. Supplemented by standard functional requirements in PIC subsections.

2.09 ELECTRICAL REQUIREMENTS

- A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.
- B. Wiring External to PIC Equipment:
 - 1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
 - 2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.

- C. I&C and electrical components, terminals, wires, and enclosures UL recognized, or UL listed.
- D. Wires within Enclosures:
 - 1. Physical Characteristics:
 - a. ac Circuits:
 - 1) Type: 600-volt, Type MTW stranded copper.
 - 2) Size: For current to be carried, but not less than 18 AWG.
 - b. Analog Signal Circuits:
 - 1) Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
 - 2) Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden 18 AWG Type 9341, Triad Beldon No. 1121A.
 - 3) Size: 18 AWG, minimum.
 - c. Other dc Circuits.
 - 1) Type: 600-volt, Type MTW stranded copper.
 - 2) Size: For current carried, but not less than 18 AWG.
 - d. Special Signal Circuits: Use manufacturer's standard cables.
 - e. Wire Identification: Numbered and tagged at each termination.
 - 1) Wire Tags: Machine printed; heat shrink.
 - 2. Functional Characteristics: None.
 - 3. Performance Characteristics: None.
- E. Terminate and identify wires entering or leaving enclosures as follows:
 - 1. Analog and discrete signal, terminate at numbered terminal blocks.
 - 2. Special signals terminated using manufacturer's standard connectors.
 - 3. Identify wiring in accordance with requirements in Section 26 05 05, Conductors.
- F. Terminal Blocks for Enclosures:
 - 1. Quantity:
 - a. Accommodate present and spare indicated needs.
 - b. Wire spare PLC I/O points to terminal blocks.
 - c. One wire per terminal for field wires entering enclosures.
 - d. Maximum of two wires per terminal for 18 AWG wire for internal enclosure wiring.
 - e. Spare Terminals: 20 percent of connected terminals, but not less than five per terminal block, unless otherwise shown on the Drawings.
 - 2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
 - a. Locate signal ground at dc power supply for loop.
 - b. Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

I. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
 - a. Is separated from nonintrinsically safe circuits as specified by NEC.
 - b. Is colored light blue and has message "Intrinsically Safe Circuits Only" on raceway cover every 6 inches.

J. Electrical Transient Protection:

1. General:
 - a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
 - b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details as shown on the Drawings.
 - c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
 - 1) Connection of ac power to PIC equipment including panels, consoles assemblies, and field-mounted analog transmitters and receivers.
 - 2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Surge Suppressors.

3. Installation and Grounding of Suppressors:
 - a. As shown. See Surge Suppressor Installation Details.
 - b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.10 PANEL FABRICATION

A. General:

1. Nominal Panel Dimensions: As shown on the Drawings.
2. Instrument Arrangements: As shown on the Drawings.
3. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
4. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
5. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
6. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Freestanding Panels:
 - a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel and on panel.
 - b. Ventilated Panels:
 - 1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
 - 2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
 - 3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
 - 4) Louver Construction: Stamped sheet metal.
 - 5) Ventilation Fans:
 - a) Furnish where required to provide adequate cooling.
 - b) Create positive internal pressure within panel.
 - c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
 - 6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.

3. Space Heaters:
 - a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
 - b. Refer to Control Panel Schedule in Article Supplements.
- C. Freestanding Panel Construction:
 1. Materials:
 - a. Sheet steel, unless otherwise noted in Control Panel Schedule in Article Supplements.
 - b. Minimum Thickness: 10-gauge, unless otherwise noted.
 2. Panel Front:
 - a. Fabricated from a single piece of sheet steel, unless otherwise shown on the Drawings.
 - b. No seams or bolt heads visible when viewed from front.
 - c. Panel Cutouts: Smoothly finished with rounded edges.
 - d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
 3. Internal Framework:
 - a. Structural steel for instrument support and panel bracing.
 - b. Permit panel lifting without racking or distortion.
 4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
 5. Adjacent Panels: Securely bolted together so front faces are parallel.
 6. Door:
 - a. Full height, fully gasketed access door where shown on the Drawings.
 - b. Latch: Three-point, Southco Type 44.
 - c. Handle: "D" ring, foldable type.
 - d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
 - e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
 - f. Front and Side Access Doors: As shown on the Drawings.
- D. Nonfreestanding Panel Construction:
 1. Based on environmental design requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
 - a. Panels Listed as Inside, Air Conditioned:
 - 1) Enclosure Type: NEMA 12.
 - 2) Materials: Steel.

- b. Other Panels:
 - 1) Enclosure Type: NEMA 4X.
 - 2) Materials: Type 316 stainless steel.
- 2. Metal Thickness: 14-gauge, minimum.
- 3. Doors:
 - a. Rubber-gasketed with continuous hinge.
 - b. Stainless steel lockable quick-release clamps.

E. Control Panel Electrical:

- 1. Power Distribution within Panels:
 - a. Feeder Circuits:
 - 1) One or more 120V ac, 60-Hz feeder circuits as shown on the Drawings.
 - 2) Make provisions for feeder circuit conduit entry.
 - 3) Furnish terminal block for termination of wires.
 - b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
 - 1) Locate to provide clear view of and access to breakers when door is open.
 - 2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
 - a) Branch Circuit Breakers: 15 amps at 250V ac.
 - 3) Breaker Manufacturers and Products: Refer to Division 26, Electrical.
 - c. Circuit Wiring: P&IDs and Control Diagrams on the Drawings show function only. Use following rules for actual circuit wiring:
 - 1) Devices on Single Circuit: 20, maximum.
 - 2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
 - 3) Branch Circuit Loading: 12 amperes continuous, maximum.
 - 4) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
 - 5) Provide 120V ac plugmold for panel components with line cords.
- 2. Signal Distribution:
 - a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
 - b. Within Panels: 4 mA dc to 20 mA dc signals may be distributed as 1V dc to 5V dc.
 - c. Outside Panels: Isolated 4 mA dc to 20 mA dc only.
 - d. Signal Wiring: Twisted shielded pairs.

- e. RTD and Thermocouple Extension Cable:
 - 1) Continuous field to panel with no intermediate junction boxes or terminations.
 - 2) RTDs in motor windings are considered a 600-volt circuit.
 - 3) Terminate thermocouple extension wire directly to loop instrument.
3. Signal Switching:
 - a. Use dry circuit type relays or switches.
 - b. No interruption of 4 mA to 20 mA loops during switching.
 - c. Switching Transients in Associated Signal Circuit:
 - 1) 4 mA dc to 20 mA dc Signals: 0.2 mA, maximum.
 - 2) 1V dc to 5V dc Signals: 0.05V, maximum.
4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
6. Internal Panel Lights for Freestanding Panels:
 - a. Type: Switched 100-watt incandescent back-of-panel lights.
 - b. Quantity: One light for every 4 feet of panel width.
 - c. Mounting: Inside and in the top of back-of-panel area.
 - d. Protective metal shield for lights.
7. Service Outlets for Freestanding Panels:
 - a. Type: Three-wire, 120-volt, 15-ampere, GFCI GFCI duplex receptacles.
 - b. Quantity:
 - 1) Panels 4 Feet Wide and Smaller: One.
 - 2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
 - c. Mounting: Evenly spaced along back-of-panel area.
8. Standard Pushbutton Colors and Inscriptions:
 - a. Use following unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black

Tag Function	Inscription(s)	Color
LR	LOCAL REMOTE	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:

- 1) Black on white and yellow buttons.
- 2) White on black, red, and green buttons.

9. Standard Light Colors and Inscriptions:

a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPENED	OPENED	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

b. Lettering Color:

- 1) Black on white and amber lenses.
- 2) White on red and green lenses.

F. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.

4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
 - a. Locking-fork-tongue or ring-tongue lugs.
 - b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
 - c. Wires terminated in a crimp lug, maximum of one.
 - d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
 - a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
 - b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
12. Conductors Carrying Foreign Voltages within a Panel:
 - a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
 - b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
13. Harness Wiring:
 - a. 120V ac: 14 AWG, MTW.
 - b. 24V dc: 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
14. Panelwork:
 - a. No exposed connections.
 - b. Allow adjustments to equipment to be made without exposing these terminals.
 - c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
15. Plastic Wire Ducts Color:
 - a. 120V ac: White.
 - b. 24V dc: Gray.
 - c. Communications Cables and Fiber Optic Jumpers: Orange.

16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
 17. Make plastic wire ducts the same depth.
 18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.
- G. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.
- H. Factory Finishing:
1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
 2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
 3. Stainless Steel and Aluminum: Not painted.
 4. Nonmetallic Panels: Similar to steel panels.
 5. Steel Panels:
 - a. Sand panel and remove mill scale, rust, grease, and oil.
 - b. Fill imperfections and sand smooth.
 - c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
 - d. Sand surfaces lightly between coats.
 - e. Dry Film Thickness: 3 mils, minimum.
 - f. Color: Manufacturer's standard.

2.11 SOURCE QUALITY CONTROL

- A. General:
1. Contracting Officer may actively participate in many of the tests.
 2. Contracting Officer reserves right to test or retest specified functions.
 3. Contracting Officer's decision will be final regarding acceptability and completeness of testing.
 4. Procedures, Forms, and Checklists:
 - a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Contracting Officer accepted procedures, forms, and checklists.
 - b. Describe each test item to be performed.

- c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
 - 5. Required Test Documentation: Test procedures, forms, and checklists signed by Contracting Officer and Contractor.
 - 6. Conducting Tests:
 - a. Provide special testing materials and equipment.
 - b. Wherever possible, perform tests using actual process variables, equipment, and data.
 - c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
 - d. Define simulation techniques in test procedures.
 - e. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect), occurs.
- B. Unwitnessed Factory Test:
- 1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
 - 2. Location: PIC System Integrator's facility.
 - 3. Integrated Test:
 - a. Interconnect and test PIC, except for primary elements and smaller panels.
 - b. Exercise and test functions.
 - c. Provide stand-alone testing of smaller panels.
 - d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.
- C. Factory Demonstration Tests (FDT):
- 1. Notify Contracting Officer of test schedule 4 weeks prior to start of test.
 - 2. Scope:
 - a. Submit FDT test procedures as a submittal at least 2 weeks prior to scheduling the FDT.
 - b. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
 - c. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
 - 3. Location: PIC System Integrator's facility.
 - 4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
 - a. Simulate each discrete signal at terminal strip.
 - b. Simulate correctness of each analog signal using current source.
 - 5. Operation of communications between PLCs and remote I/O and between PLCs and HMI computers.

6. Operation of communications between the PLC system and VFDs.
7. Loop-Specific Functions:
 - a. Demonstrate functions shown on P&IDs, control diagrams, and control descriptions:
 - 1) One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
 - 2) All required and shown functions for 100 percent of loops.
8. Nonloop-Specific Functions:
 - a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
 - b. Timing: Include tests for timing requirements.
 - c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
9. Correct deficiencies found and complete prior to shipment to Site.
10. Failed Tests:
 - a. Repeat and witnessed by Contracting Officer.
 - b. With approval of Contracting Officer, certain tests may be conducted by PIC System Integrator and witnessed by Contracting Officer as part of Functional Test.
11. Make following documentation available to Contracting Officer at test site both before and during FDT:
 - a. Drawings, Specifications, Addenda, and Change Orders.
 - b. Master copy of FDT procedures.
 - c. List of equipment to be tested including make, model, and serial number.
 - d. Approved hardware Shop Drawings for equipment being tested.
 - e. Approved preliminary software documentation Submittal.
 - f. Sign off sheet for each FDT with locations for the witnesses to sign off and document the punch lists for each test.
12. Daily Schedule for FDT:
 - a. Begin each day with meeting to review day's test schedule.
 - b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

PART 3 EXECUTION

3.01 EXAMINATION

- A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:
 1. Proper installation.
 2. Calibration and adjustment of positioners and I/P transducers.
 3. Correct control action.

4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

3.02 INSTALLATION

- A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Contracting Officer.
- B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.
- C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.
- D. Mechanical Systems:
 1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
 2. Plastic Tubing Support: Except as shown on the Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
 3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
 4. Tubing and Conduit Bends:
 - a. Tool-formed without flattening, and of same radius.
 - b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
 - c. Slope instrument connection tubing in accordance with installation details.
 - d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
 - e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
 - f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
 - g. Blow debris from inside of tubing.
 - h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
 - i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.

- j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
 - k. Provide separate support for components in tubing runs.
 - l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
 - m. Keep tubing and conduit runs at least 12 inches from hot pipes.
 - n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
 - o. Securely attach tubing raceways to building structural members.
5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

- 1. Coordinate PIC testing with Contracting Officer and affected Subcontractors.
- 2. Notify Contracting Officer of Performance Test schedule 4 weeks prior to start of test.
- 3. Contracting Officer may actively participate in tests.
- 4. Contracting Officer reserves right to test or retest specified functions.
- 5. Contracting Officer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

- 1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
- 2. Require PIC site representative to supervise and coordinate onsite PIC activities.
- 3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During preparation for testing, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing:

- 1. Prior to Performance Testing of each individual System, inspect, test, and document that associated PIC equipment is ready for operation.

2. Preparation for Testing: Performed by PIC System Integrator to test and document PIC is ready for operation.
 - a. Documentation that the relevant FDTs and resultant punch lists have been completed.
 - b. Loop/Component Inspections and Tests:
 - 1) These inspections and tests will be spot checked by Contracting Officer.
 - 2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
 - 3) Provide space on forms for signoff by PIC System Integrator.
 - 4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
 - a) Project name.
 - b) Loop number.
 - c) Tag number for each component.
 - d) Checkoffs/Signoffs for Each Component:
 - (1) Tag/identification.
 - (2) Installation.
 - (3) Termination wiring.
 - (4) Termination tubing.
 - (5) Calibration/adjustment.
 - e) Checkoffs/Signoffs for the Loop:
 - (1) Panel interface terminations.
 - (2) I/O interface terminations with PLC.
 - f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
 - g) Total loop operational.
 - h) Space for comments.
 - 5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLC I/O module and include the following:
 - a) Project name.
 - b) Loop number.
 - c) Component tag number or I/O module number.
 - d) Component code number for I&C elements.
 - e) Manufacturer for I&C elements.
 - f) Model number/serial number for I&C elements.
 - g) Summary of Functional Requirements; For Example:
 - (1) Indicators and recorders, scale and chart ranges.
 - (2) Transmitters/converters, input and output ranges.
 - (3) Computing elements' function.

- (4) Controllers, action (direct/reverse) and control modes (P, I, D).
 - (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
 - (6) I/O Modules: Input or output.
 - h) Calibrations, for example, but not limited to:
 - (1) Analog Devices: Actual inputs and outputs at 0 percent, 10 percent, 50 percent, and 100 percent of span, rising and falling.
 - (2) Discrete Devices: Actual trip points and reset points.
 - (3) Controllers: Mode settings (P&ID).
 - (4) I/O Modules: Actual inputs or outputs of 0 percent, 10 percent, 50 percent, and 100 percent of span, rising and falling.
 - (5) Space for comments.
 - c. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Contracting Officer at all times.
 - d. Contracting Officer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
 - e. FDT-Repeat:
 - 1) Repeat FDT onsite with installed PIC equipment and software.
 - 2) As listed in PIC subsections, certain portions of FDT may not require retesting.
 - 3) Use FDT test procedures as basis for this test.
 - 4) In general, this test shall not require witnessing. However, portions of this test, as identified by Contracting Officer during original FDT shall be witnessed.
 - f. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.
- 3. Functional Test:
 - a. Scope: Confirm PIC, including applications software, is ready for operation.
 - b. Refer to PIC subsections for additional requirements.
 - c. Completed when Functional Test has been conducted and Contracting Officer has spot-checked associated test forms and checklists in field.
- 4. Required Test Documentation: Test procedures, forms, and checklists. Signed by Contracting Officer and Contractor except for Functional Test items signed only by Contractor.

E. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and nonloop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make updated versions of documentation required for Performance Test available to Contracting Officer at Site, both before and during tests.
6. Make O&M data available to Contracting Officer at Site both before and during testing.
7. Follow daily schedule required for FDT.
8. Determination of Ready for Operation: When Functional Test has been completed.
9. Refer to examples of Performance Test procedures and forms in Article Supplements.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: As required by each PIC subsection.
- B. See Section 01 91 15, Total Building Commissioning, and Section 01 91 14, Process Equipment Testing and Facility Startup.

3.05 TRAINING

- A. General requirement as specified in Section 01 79 00, Demonstration and Training. Additional requirements are listed below.
- B. General:
 1. Provide an integrated training program for Contracting Officer's personnel.
 2. Perform training to meet specific needs of Contracting Officer's personnel.

3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on two working shift(s) as needed to accommodate the Contracting Officer's personnel schedule.
5. Contracting Officer reserves the right to reuse digital recordings of training sessions.

C. Operations and Maintenance Training:

1. General:
 - a. Refer to specific requirements specified in PIC subsections.
 - b. Include review of O&M data and survey of spares, expendables, and test equipment.
 - c. Use equipment similar to that provided.
 - d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations Training: For Contracting Officer's operations personnel on operation of I&C components.
 - a. Training Session Duration: 1 instructor day.
 - b. Number of Training Sessions: Two.
 - c. Location: Project Site.
 - d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
 - e. Content: Conduct training on loop-by-loop basis.
 - 1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
 - 2) Loop Operation: For example, adjusting process variable setpoints, LOCAL/REMOTE control transfer, REMOTE and LOCAL control, annunciator acknowledgement, and resetting.
 - 3) Interfaces with PIC subsystems.
3. Maintenance Training:
 - a. Training Session Duration: 1 instructor day.
 - b. Number of Training Sessions: Two.
 - c. Location: Project Site.
 - d. Course Objective: Develop skills needed for routine maintenance of PIC.
 - e. Content: Provide training for each type of component and function provided.
 - 1) Loop Functions: Understanding details of each loop and how they function.
 - 2) Component calibration.

- 3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
- 4) Troubleshooting and diagnosis for equipment and software.
- 5) Replacing lamps, chart paper, and fuses.
- 6) I&C components removal and replacement.
- 7) Periodic preventive maintenance.

3.06 CLEANING

- A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

- A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.
- B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.08 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this specification:
 1. Instrument List.
 2. PLC Input/Output List.
 3. Process Control Narrative – Overview.
 4. Preparation for Testing and Functional Test Forms:
 - a. Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
 - b. Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
 - c. I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.
 5. Performance Test Sheet: Describe Performance Test for a given loop.
 - a. List requirements of the loop.
 - b. Briefly describe test.
 - c. Cite expected results.
 - d. Provide space for checkoff by witness.

END OF SECTION

Project Name: <i>Newport News WTP</i>						Project No. <i>WDC23456.C1</i>	
FUNCTIONAL REQUIREMENTS:							
<i>1. Measure, locally indicate, and transmit RAS flow to LP-10.</i>							
<i>2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.</i>							
<i>3. Provide high RAS flow alarm on LP-10.</i>							
COMPONENT STATUS (Check and initial each item when complete)							
Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
<i>FE/FIT-10-2</i>	<i>Jan-12-21 DWM</i>	<i>Jan-12-21 DWM</i>	<i>Feb-7-21 DWM</i>	<i>Mar-5-21 DWM</i>	<i>N.A.</i>	<i>May-6-21 VDA</i>	
<i>FIC-10-2</i>	<i>Jan-12-21 DWM</i>	<i>Jan-12-21 DWM</i>	<i>Mar-5-21 DWM</i>	<i>Apr-4-21 DWM</i>		<i>May-4-21 VDA</i>	
<i>FSH-10-2</i>	<i>Jan-12-21 DWM</i>	<i>Jan-12-21 DWM</i>	<i>Mar-5-21 DWM</i>	<i>Apr-4-21 DWM</i>		<i>May-7-21 VDA</i>	
<i>FAH-10-2</i>	<i>Jan-12-21 DWM</i>	<i>Jan-12-21 DWM</i>	<i>Mar-5-21 DWM</i>	<i>Apr-4-21 DWM</i>		<i>May-7-21 VDA</i>	
<i>FCV-10-2</i>	<i>Mar-2-21 DWM</i>	<i>Mar-2-21 DWM</i>	<i>Apr-20-21 DWM</i>	<i>Apr-30-21 DWM</i>		<i>May-16-21 VDA</i>	
REMARKS: <i>None.</i>							
Loop Ready for Operation		By: <i>D.W. Munzer</i>		Date: <i>May-18-90</i>		Loop No.: <i>10-2</i>	

JACOBS

INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER

Rev.06.05.92

COMPONENT			MANUFACTURER				PROJECT					
Code: A7			Name: Leeds & Northrup				Number: WDC30715.B2					
Name: pH Element & Analyzer/Transmitter			Model: 12429-3-2-1-7		Serial #: 11553322		Name: UOSA AWT PHASE 3					
FUNCTIONS												
	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N			CONTROL? N					
Indicate? Y Record? N	Chart:			Describe:			Action? direct / reverse Modes? P / I / D					
	Scale:	1-14	pH units				SWITCH? N					
Transmit/ Convert? Y	Input:	1-14	pH units				Unit Range:					
	Output:	4-20	mA dc				Differential: fixed/adjustable Reset? automatic / manual					
ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS				Note No.	
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point		Reset Pt.
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	1.0	4.0	1.0	4.0	1.0	3.9	1.	N.A.		N.A.		
2.3	2.3	5.6	2.2	5.5	2.3	5.6	2.					
7.5	7.5	12.0	7.5	11.9	7.5	12.0	3.					
12.7	12.7	18.4	12.7	18.3	12.6	18.3	4.					
14.0	14.0	20.0	14.0	20.0	14.0	20.0	5.					
CONTROL MODE SETTINGS:			P: N.A.	I:	D:		6.					
#	NOTES:								Component Calibrated and Ready for Start-up			
	1. Need to recheck low pH calibration solutions.								By: J.D. Sewell			
									Date: Jun-6-21			
									Tag No.: AIT-12-6[pH]			

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JUNE 2025
GRCA 257282

INSTRUMENTATION AND CONTROL
FOR PROCESS SYSTEMS
40 90 00 SUPPLEMENT - 1

PARTS	Project Name: <i>SFO SEWPCP</i>	Project Number: <i>SFO10145.G2</i>			
Body	Type: <i>Vee-Ball</i>	Mfr: <i>Fisher Controls</i>			
	Size: <i>4-inch</i>	Model: <i>1049763-2</i>			
	Line Connection: <i>159 # ANSI Flanges</i>	Serial #: <i>1003220</i>			
Operator	Type: <i>Pneumatic Diaphragm</i>	Mfr: <i>Fisher Controls</i>			
	Action: <i>Linear – Modulated</i>	Model: <i>4060D</i>			
	Travel: <i>3-inch</i>	Serial #: <i>2007330</i>			
Positioner	Input Signal: <i>3-15 psi</i>	Mfr: <i>Fisher Controls</i>			
	Action: <i>Direct - air to open</i>	Model: <i>20472T</i>			
	Cam: <i>Equal percentage</i>	Serial #: <i>102010</i>			
Pilot	Action:	Mfr:			
Solenoid	Rating: <i>None</i>	Model: Serial #:			
I/P Converter	Input: <i>4-20 mA dc</i>	Mfr: <i>Taylor</i>			
	Output: <i>3-15 psi</i>	Model: <i>10-T-576-3</i>			
	Action: <i>Direct</i>	Serial #: <i>1057-330</i>			
Position Switch	Settings: <i>Closed / Open 5 deg, rising</i>	Mfr: <i>National Switch</i>			
	Contacts: <i>Close / Close</i>	Model: <i>1049-67-3</i>			
		Serial #: <i>156 & 157</i>			
Power Supply	Type: <i>Pneumatic</i>	Air Set Mfr: <i>Air Products</i>			
	Potential: <i>40 psi</i>	Model: <i>3210D</i>			
		Serial #: <i>1107063</i>			
ADJUSTMENTS	Initial	Date	VERIFICATION	Initial	Date
Air Set	<i>JDS</i>	<i>Jun-06-21</i>	Valve Action	<i>JDS</i>	<i>Jun-03-21</i>
Positioner	<i>JDS</i>	<i>Jun-06-21</i>	Installation	<i>JDS</i>	<i>Jun-03-21</i>
Position Switches	<i>JDS</i>	<i>Jun-06-21</i>	Wire Connection	<i>JDS</i>	<i>Jun-04-21</i>
I/P Converter	<i>JDS</i>	<i>Jun-07-21</i>	Tube Connection	<i>JDS</i>	<i>Jun-04-21</i>
Actual Speed	<i>JDS</i>	<i>Jun-07-21</i>			
REMARKS: <i>Valve was initially installed backwards.</i>				Valve Ready for Start-up	
<i>Observed to be correctly installed May-25-92</i>				By: <i>J.D. Sewell</i>	
				Date: <i>Jun-07-21</i>	
				Tag No.: <i>FCV-10-2-1</i>	

JACOBS PERFORMANCE TEST SHEET - EXAMPLE

Rev.06.05.92

Project Name: <i>SFO SEWPCP Plant Expansion</i>			Project No.: <i>SFO12345.C1</i>																									
Demonstration test(s): For each functional Requirement of the loop: (a) List and number the requirement. (b) Briefly describe the demonstration test. (c) Cite the results that will verify the required performance. (d) Provide space for signoff.																												
1. MEASURE EFFLUENT FLOW																												
<i>1.a With no flow, water level over weir should be zero and</i>																												
<i>FIT indicator should read zero.</i>			<i>Jun-20-21 BDG</i>																									
2. FLOW INDICATION AND TRANSMISSION TO LP & CCS																												
<i>With flow, water level and FIT indicator should be related by expression</i>																												
<i>$Q(\text{MGD}) = 429 \cdot H^{2/3}$ (H = height in inches of water over weir).</i>																												
<i>Vary H and observe that following.</i>																												
<i>2.a Reading of FIT indicator.</i>			<i>Jun-6-21 BDG</i>																									
<i>2.b Reading is transmitted to FI on LP-521-1</i>			<i>Jun-6-21 BDG</i>																									
<i>2.c Reading is transmitted and displayed to CCS.</i>			<i>Jun-6-21 BDG</i>																									
<table border="1"> <tr> <td><i>H(measured)</i></td> <td><i>0</i></td> <td><i>5</i></td> <td><i>10</i></td> <td><i>15</i></td> </tr> <tr> <td><i>Q(computed)</i></td> <td><i>0</i></td> <td><i>47.96</i></td> <td><i>135.7</i></td> <td><i>251.7</i></td> </tr> <tr> <td><i>Q(FIT indicator)</i></td> <td><i>0</i></td> <td><i>48.1</i></td> <td><i>137</i></td> <td><i>253</i></td> </tr> <tr> <td><i>Q(LI on LP-521-1)</i></td> <td><i>0</i></td> <td><i>48.2</i></td> <td><i>138</i></td> <td><i>254</i></td> </tr> <tr> <td><i>Q(display by CCS)</i></td> <td><i>0</i></td> <td><i>48.1</i></td> <td><i>136.2</i></td> <td><i>252.4</i></td> </tr> </table>				<i>H(measured)</i>	<i>0</i>	<i>5</i>	<i>10</i>	<i>15</i>	<i>Q(computed)</i>	<i>0</i>	<i>47.96</i>	<i>135.7</i>	<i>251.7</i>	<i>Q(FIT indicator)</i>	<i>0</i>	<i>48.1</i>	<i>137</i>	<i>253</i>	<i>Q(LI on LP-521-1)</i>	<i>0</i>	<i>48.2</i>	<i>138</i>	<i>254</i>	<i>Q(display by CCS)</i>	<i>0</i>	<i>48.1</i>	<i>136.2</i>	<i>252.4</i>
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Forms/Sheets Verified	By	Date	Loop Accepted By Contracting Officer																									
Loop Status Report	<i>J.D. Sewell</i>	<i>May-18-21</i>	By: <i>J.D. Smith</i>																									
Instrument Calibration Sheet	<i>J.D. Sewell</i>	<i>May-18-21</i>	Date: <i>Jun-6-21</i>																									
I&C Valve Calibration Sheet	<i>N.A.</i>																											
Performance Test	By	Date	Loop No.: <i>30-12</i>																									
Performed	<i>J. Blow MPSDC Co.</i>	<i>Jun-6-21</i>																										
Witnessed	<i>B. DeGlanville</i>	<i>Jun-6-21</i>																										

