

SECTION 40 78 00

PANEL MOUNTED INSTRUMENTS AND DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

- A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, adjust and place into satisfactory operation panel instruments and devices.
 2. Contract Documents illustrate and specify functional and general construction requirements of the panel components and do not necessarily show or specify all components, wiring, piping, and accessories required to make a completely integrated system. CONTRACTOR shall provide all piping, wiring, accessories, and labor required for a complete, workable, and integrated system.
- B. Coordination: Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.2 QUALITY ASSURANCE

- A. Qualifications:
1. Supplier:
 - a. Shall be financially sound with at least five years of continuous experience in designing, implementing, supplying, and supporting process control systems for municipal wastewater pumping stations comparable to process control systems required for the Project, relative to hardware, software, cost, and complexity.
 - b. Shall have record of successful process control system equipment installations. Upon ENGINEER's request, submit record of experience for at least five projects, each with the following information: project name, owner name and contact information, name, and contact information for contractor, name and contact information for engineer or architect, approximate and contract value of process control systems Work for which Supplier was responsible.
 - c. Shall have experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the Contract Documents.
 - d. Shall be capable of training operations and maintenance personnel in process control system applications, and in operating, programming, and maintaining the control system and equipment.
 - e. Shall have UL-approved panel shop.
 - f. Supply and support system hardware components and software packages of fully developed and field-proven standardized designs that are not a highly unique, custom, or one-of-a-kind systems.
 - g. Offer standard courses in general process control applications, programming, and maintenance of the PCS and equipment at a facility specifically utilized for training. Training facility shall have been in operation continuously for the previous two years, minimum.

- h. Possess and maintain a documented program of failure analysis.
- B. Acceptable Manufacturers:
- 1. Furnish instruments and devices by the named manufacturers or equal equipment by other manufacturers.
 - 2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
 - 3. Obtain all instruments or devices of a given type from the same manufacturer.
- C. Manufacturers' Responsibilities and Services:
- 1. System Checkout and Start-Up
 - a. CONTRACTOR, under the supervision of the PMCS Supplier, and other instrument suppliers as applicable, shall perform the following:
 - 1) Check and approve the installation of all PMCS components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.
 - 2) Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in this work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
 - b. CONTRACTOR shall provide all test equipment necessary to perform the testing during system checkout and start-up.
 - c. CONTRACTOR and Supplier shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustment, or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended.
 - d. CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments and devices and panel mounted devices as soon as calibration is completed.
 - e. CONTRACTOR shall furnish ENGINEER an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the Supplier.
 - 2. On-Site Training
 - a. Primary Sensors/Transducers and Field Instruments:
 - 1) Provide on-site operation and maintenance training by Supplier and the equipment manufacturer representatives prior to placing the equipment in continuous operation. The services of equipment manufacturer's representatives shall be provided for a minimum of eight hours for each type of instrument provided.
 - 2) Training shall accomplish the following:
 - a) Provide instruction covering use and operation of the equipment to perform the intended functions.
 - b) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance including equipment calibration.
 - c) Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.

- b. Training covering the control equipment:
 - 1) The Supplier shall provide one day of operations training covering all system components.
 - 2) Training course shall accomplish the following:
 - a) Provide all instructions necessary to operate and utilize all system components.
 - b) Provide all instruction necessary to monitor and control the system processes from the designated control panel.
 - c) Explain procedures for control of the system during scheduled or rescheduled shutdown and the subsequent start-up.
 - d) Provide instructions for regular caretaking operations.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Field Instruments:

- 1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
- 2) Instrument tag number in accordance with the Contract Documents.
- 3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
- 4) Description of construction features.
- 5) Performance and operation data.
- 6) Installation, mounting, and calibration details; instructions and recommendations.
- 7) Service requirements.
- 8) Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
- 9) Range of each device and calibration information
- 10) Descriptions of materials of construction and listing of NEMA ratings for equipment

b. Panels, Consoles, and Cabinets:

1) Layout drawings that include:

- a) Front, rear, and internal panel views to scale.
- b) Tag number and functional name of components mounted in and on panel, console, or cabinet, as applicable.
- c) Product information on panel components.
- d) Nameplate location and legend including text, letter size and colors to be used.
- e) Location of anchorage connections.
- f) Location of external wiring and piping connections.
- g) Mounting and installation details, coordinated with actual application.
- h) Proposed layouts and sizes of operator interface graphic display panels and alarm annunciator panels.

- i) Calculations substantiating panel heating and cooling provisions proposed.
 - j) Subpanel layouts and mounting details for items located inside control panels.
 - 2) Product information on panel components including:
 - a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
 - b) Instrument tag number in accordance with the Contract Documents.
 - c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets with format similar to ISA 20.
 - d) Description of construction features.
 - e) Performance and operation data.
 - f) Installation, mounting, and calibration details; instructions and recommendations.
 - g) Service requirements
 - 3) Wiring and piping diagrams, including the following:
 - a) Name of each panel, console, or cabinet.
 - b) Wire sizes and types.
 - c) Pipe sizes and types.
 - d) Terminal strip and terminal numbers.
 - e) Wire color coding.
 - f) Functional name and manufacturer's designation for components to which wiring, and piping are connected.
 - g) Lightning and surge protection grounding.
 - 4) Electrical control schematics in accordance with NFPA 79. Control schematics shall be in accordance with convention indicated in Annex D of NFPA 79. Standardized wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.
 - 5) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.
 - 6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.
- c. Field wiring and piping diagrams, include the following:
 - 1) Wire and pipe sizes and types.
 - 2) Terminal numbers at field devices and in panels.
 - 3) Fiber optic termination designations in the field and in panels.
 - 4) Color coding.
 - 5) Conduit numbers in which wiring will be located.
 - 6) Locations, functional names, and manufacturer's designations of items to which wiring, or piping are connected.
- d. Control System:
 - 1) Submit the following general information:
 - a) Detailed block diagram showing system hardware configuration and identifying model numbers of system components.

- b) Software listings for operating system, applications, and HMI.
 - c) Software language and organization.
 - d) Format, protocol and procedures for data transmission and communications with input/output modules and peripheral devices.
 - e) Control and failure modes.
 - f) Online and offline capabilities for programming, system utilities, and diagnostics.
- 2) Hardware:
- a) Layout drawings showing front, rear, end, and plan views to scale of equipment, I/O components, power supplies, and peripheral devices.
 - b) Equipment ventilation and cooling requirements.
 - c) Interconnection diagrams, including termination details, cable identification list, and cable length.
 - d) Drawings showing equipment layout.
 - e) Installation requirements, instructions, and recommendations.
- 3) Software:
- a) Licensing agreement with name of licensee, renewal requirements, release and versions, expiration dates (if any) and upcoming releases scheduled before Project completion. When upcoming releases are expected, provide descriptions, when available, of features that differ from the proposed release.
 - b) Provide information of number of run, client, and development licenses as well as I/O point count limit per license.
 - c) Standard technical and instructional documentation covering software for utility, system support, system documentation, display, communications, data logging and storage and diagnostic functions. Submit this information as electronic files.
 - d) Standard technical documentation covering all aspects of the computer system software functions and capabilities, including instruction set description and programming procedures related to monitoring, display, logging, reporting and alarming functions.
- 4) Documentation describing memory type, size and structure and listing size of system memory, I/O and data table memory and size of memory available for control programs.
- 5) System I/O Loop Wiring Diagrams: Prepare Shop Drawings on module-by-module basis and include the following information:
- a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.
 - b) Wiring types, wire numbers, and color coding.
 - c) Designation of conduits in which field I/O wiring will be installed.
 - d) Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
 - e) Prepare loop wiring diagrams in accordance with ISA 5.4.

- f) Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:
 1. Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panelboards, and motor starters. Some of this equipment may be specified in other Divisions. CONTRACTOR is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.
 2. Numbered terminal block and terminal identification for each wire termination.
 3. Identification of assigned wire numbers for interconnections. Assign each wire a unique number.
 4. Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.
 5. Junction and pull boxes through which wiring will be routed.
 6. Identification of equipment in accordance with the Contract Documents.
 2. Product Data:
 - a. Product data for field instruments in accordance with requirements for Shop Drawings in this Section.
 - b. Product data for panels, consoles, and cabinets in accordance with requirements for Shop Drawings in this Section.
 - c. Product data for field wiring and piping provided for instrumentation and control service and not included under other Sections or contracts.
 - d. Product data for control system, including software and hardware. Requirements for software product data are included in requirements for Shop Drawings under this Section.
 3. Samples:
 - a. Color charts for finish paint for metallic panels. Provide full range of paint manufacturer's standard and custom colors. Color selection will be by ENGINEER.
 - b. Color charts for fiberglass-reinforced panels. Provide full range of panel manufacturer's standard and custom colors. Color selection will be by ENGINEER.
 4. Factory Acceptance Test Procedure: Submit proposed procedures for factory testing required to comply with the Contract Documents. Test procedure shall include the following:
 - a. Visual inspection of components and assembly.
 - b. Description of hardware operational testing.
 - c. Description of software demonstration.
 - d. Description of testing equipment to be used.
 - e. Sign-off sheets to be used at time of testing.
- B. Informational Submittals: Submit the following:
1. Documents to be submitted prior to pre-submittal conference, in accordance with Section 1.3 of this specification.
 2. System Software Documentation: Submit preliminary software documentation not later than 28 days prior to scheduled start of factory testing. Software documentation shall include the following:

- a. Complete printed copies of all programming.
 - b. Complete listing of external and internal I/O address assignments, register assignments and preset constant values with function point descriptions. List unused/undefined I/O and data table registers available.
 - c. Copies of all configured HMI screens.
3. Manufacturer's Instructions:
 - a. Shipping, handling, storage, installation, and start-up instructions.
 - b. Templates for anchorage devices for materials and equipment that will be anchored to concrete or masonry.
 4. Source Quality Control Submittals:
 - a. Results of factory testing.
 5. Special Procedure Submittals:
 - a. Notification to OWNER and ENGINEER at least 14 days before readiness to begin system checkout at the Site. Schedule system checkout on dates acceptable to OWNER and ENGINEER.
 - b. Written procedure for system checkout. Submit not less than 90 days prior to starting system checkout.
 - c. Ninety days prior to starting system checkout submit written procedure for start-up.
 6. Field Quality Control Submittals:
 - a. Submit the following prior to commencing system checkout and start-up.
 - 1) Completed calibration sheets for each installed instrument showing five-point calibration (zero, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
 - b. Field calibration reports
 - c. Field testing reports.
 7. Supplier's Reports:
 - a. Installation inspection and check-out report.
 - b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 8. Qualifications Statements:
 - a. I&C Subcontractor.
 - b. I&C Supplier.
 - c. Manufacturers, when required by ENGINEER.
- C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
 - a. Submit operation and maintenance data.
 - b. Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.
 2. Record Documentation:
 - a. Prepare and submit record documents in accordance with Section 01 78 39 - Project Record Documents.
 - b. Revise all PCS Shop Drawings to reflect as-built conditions in accordance with the following.
 - 1) Use "as-built" updates of approved Shop Drawings and submittals in operation and maintenance manuals.

- 2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes inside a suitable print pocket or container inside each control panel.
- 3) Submit drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

D. Maintenance Materials Submittals: Submit the following:

1. Spare Parts and Test Equipment

a. General

- 1) Furnish the spare parts and test equipment in accordance with the Contract Documents, identical to and interchangeable with similar materials and equipment provided for the PCS under the Contract.
- 2) Provide source quality control for spare parts as part of factory testing prior to shipment of process control system equipment.
- 3) For process sensors and other analog instruments, Supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for a period of one year from date of equipment installation and that Supplier understands that OWNER reserves the right to purchase none, any, or all parts quoted. Upon request, Supplier shall submit documentation that stock of spare parts and test equipment is obtainable within 48 hours of receipt of OWNER's order.

b. Furnish the following spare parts:

- 1) Five of each type of input/output relay for each quantity of forty or fraction thereof provided under the Contract.
- 2) One of each type of PLC input/output module or card used.
- 3) One replacement power supply for each type and size provided under the Contract.
- 4) One-year supply of all expendable or consumable materials.
- 5) One per quantity of five or fraction thereof of gauges, indicators, and switches provided, complete with diaphragm seals, filled and ready to use.
- 6) One per quantity of ten or fraction thereof provided, per range of field instruments including insertion type instruments. No spares are required for inline instruments such as magnetic flow meters and flumes or venturis that include flow tubes through which flow is conveyed.
- 7) Twelve of each type and size of fuse used in instruments.

c. Furnish the following test equipment:

- 1) Three Fluke, Hewlett-Packard, or equal (latest in series) digital multimeter plus amprobe, high-voltage probe, test leads, case, and other recommended spares and accessories.
- 2) One of each set of special tools required to insert, extract, and connect internal or external connectors, including edge connectors.
- 3) One set of special calibration equipment required for system calibration.
- 4) One thermocouple calibrator, including case.
- 5) Two signal simulators (4 to 20 mA DC; 1 to 5 VDC), including case. One simulator shall be battery-powered and shall include charger.
- 6) One portable flow meter calibrator, for magnetic flow meter use only.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.

1.5 IDENTIFICATION TAGS

- A. All panel instruments and devices shall have an identification tag meeting the following requirements:
 - 1. Tag numbers shall be as listed in the Instrument Index.
 - 2. Identifying tag number shall be permanently etched or embossed onto a stainless-steel tag which shall be fastened to the device housing with stainless steel rivets or self-tapping screws of appropriate size.
 - 3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
 - 4. All instruments and devices mounted within panels shall have the stainless-steel identification tag installed so that the numbers are easily visible to service personnel. Front of panel mounted components shall have the tag attached to the rear of the device.
 - 5. Front of panel mounted components shall have nameplates, which comply with the requirements specified in Section 26 29 15 - Pump Control Panels.

PART 2 PRODUCTS

2.1 POWER SUPPLIES

- A. General: Single unit power supplies, located in control room panels, remote terminal units and field panels as required.
- B. Single Unit Required Features:
 - 1. Solid state circuitry.
 - 2. Surface mounting.
 - 3. Input Power: 120 VAC \pm 10 percent, 60 Hz.
 - 4. Output Power: 24 VDC or as required.
 - 5. Line/Load Regulation: \pm 0.005 percent.
 - 6. Ripple: 0.25 mV RMS.
 - 7. Polarity: Floating output.
 - 8. Ambient Temperature: -20°C to +71°C.
 - 9. Response Time: <20 μ S.
 - 10. Overload Protection: Internal preset.
 - 11. Include mounting brackets, fuse, and mating connector for AC power plug.
- C. Products and Manufacturers: Provide one of the following:
 - 1. Acopian Corporation, Gold Box Series A.
 - 2. Or equal.

2.2 UNINTERRUPTIBLE POWER SYSTEM

- A. Uninterruptible Power System (UPS) shall be furnished to provide a reliable source of uninterruptible power with no break in AC output power during a complete or partial interruption of incoming line power. UPS shall include audio/visual alarms. UPS shall be UL listed.
- B. Rating: 120 VAC, 60 Hz, [1500] <____> VA / [865] <____> W minimum.
- C. Description: On-line dual track power conditioner and true (0 ms transfer time) uninterruptible power supply providing isolation, line regulation and conditioning, using sealed 48 VDC maintenance free batteries and switch mode power supply for uninterrupted power with 0.5 to 0.7 power factor and 2.7 to 3.5 crest factor.
- D. Required Features:
 - 1. Surge Protection and filtering.
 - 2. Operating Temperature: 0°C to 40°C.
 - 3. Relative Humidity: 0 to 95 percent non-condensing.
 - 4. Operating Computer Interface: USB.
 - 5. AC Input: 120 VAC, 60Hz, single phase.
 - 6. AC Output: 120 VAC, 60Hz, single phase, +3 percent, -3 percent.
- E. Products and Manufacturers: Provide one of the following:
 - 1. APC #BR1500G with one (1) extended run battery pack #BR24BPG.
 - 2. Or equal.

2.3 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

- A. General:
 - 1. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
 - 2. Type:
 - a. Heavy duty, oil tight.
 - 3. Provide legend plate for indication of switch, pushbutton, or light function (e.g., "OPEN-CLOSED", "HAND-OFF-AUTO").
 - 4. Mounting: Flush mounted on control panel front, unless otherwise noted.
 - 5. NEMA rated to match panel in which mounted.
- B. Selector Switches:
 - 1. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.
 - 2. Contacts:
 - a. Provide number and arrangement of contacts as required to perform intended functions specified, but not less than one single pole, double throw contact.
 - b. Type: Double break, silver contacts with movable contact blade providing scrubbing action.
 - c. Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than 10 A resistive at 120 VAC or DC continuous.
 - 3. Switch Operator: Standard black knob.
- C. Pushbuttons (Standard or Illuminated):

1. Type: Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.
 2. Contacts: Comply with the requirements specified for selector switches.
- D. Indicating Lights:
1. Type: Compact, LED, push-to-test.
- E. Button and Lens Colors:
1. Green for indication of open, on, running.
 2. Red for indication of closed, off (ready), stopped.
 3. Amber for indication of equipment malfunction, process trouble and alarms (e.g., "HIGH LEVEL", "LOW LEVEL", etc.).
 4. Blue for indication of electrical control power on.
- F. Rotary Cam Switches:
1. Provide rotary cam switches with number of positions and poles as required to perform the required signal switching function specified and shown.
 2. Contacts:
 - a. Gold-flashed contacts housed in mechanical contact blocks with number and arrangement of contacts as required to perform intended functions.
 - b. Contact Rating: Compatible with AC or DC through-put current of signals and devices simultaneously operated by the switch contacts, but not less than 20 A at 600 VAC or 250 VDC continuous.
 3. Switch Operator: Standard black knob.
- G. Products and Manufacturers: Provide one of the following:
1. Cutler-Hammer, Type E30.
 2. Allen Bradley, Series 800.
 3. Schneider Electric, Class 9001.

2.4 DIGITAL INDICATOR

- A. General: The digital indicator shall accept an analog input and convert it to scaled numerical characters for digital display and also provide up to two alarm outputs.
- B. Required Features:
1. Display Height: 0.56-inch.
 2. Display Capacity: Four digits with decimal point position jumper selectable.
 3. Display Type: Seven segment, red LED.
 4. Accuracy: ± 0.05 percent.
 5. Analog Input: 4 to 20 mADC.
 6. Excitation Output: 15 VDC for powering transmitter.
 7. Analog Output: Proportional 4 to 20 mADC.
 8. Alarm Output: Dual with two 2 A relays.
 9. Temperature Range: 0°C to 60°C.
 10. Power: 120 VAC, + 10 to -15 percent, five watts.
 11. Enclosure: NEMA 4 splash proof.
- C. Products and Manufacturers: Provide one of the following:
1. Newport Electronics, Model Q9000E.

2. Precision Digital, Model PD690.
3. Or equal.

2.5 ANALOG INDICATOR

- A. General: Indicator Unit shall be a signal monitoring instrument that provides continuous monitoring of a process variable on a scaled vertical bar display. Indicator shall match in appearance other panel mounted instruments.
- B. Description: Indicator Unit shall display one process variable.
- C. Required Features:
 1. Input Signals: 1 to 5 VDC (into 10 megohm) or 4 to 20 mADC (into 250 ohm range resistor).
 2. Power Required: 21 to 28 VDC; nominal input current at 24 VDC is 400 mA.
 3. Displays: One segmented gas-discharge or LED vertical bar display.
 4. Display Accuracy: One percent of input span.
 5. Scale Length: Approximately 3-inches.
 6. Operating Influences:
 - a. Ambient Temperature: Maintains display accuracy ratings for temperature change within normal operating conditions.
 - b. Supply Voltage: Maintains display accuracy ratings for supply voltage variation between 21 and 28 VDC.
 - c. Electromagnetic Interference (EMI): Maintains display accuracy ratings when instrument is subjected to an electromagnetic field of up to ten volts/meter (when rack-mounted in cabinet with door closed). Display station must be installed in panel.
 7. Operating Conditions:
 - a. Ambient Temperature: 41 to 122°F (5 to 50°C).
 - b. Maximum Temperature Variation: 36°F per hr (20°C per hr).
 - c. Ambient Relative Humidity: Ten to 90 percent non-condensing.
 8. Mounting: Display station installs in a nominal 1-inch by 6-inch panel cutout and shall match in appearance other panel mounted instruments.
- D. Products and Manufacturers: Provide one of the following:
 1. OTEK Corporation, Model HI-QSLIM.
 2. Ametek/Dixson, Model BE051.
 3. Or equal.

2.6 ELECTRONIC COUNTER

- A. General: The unit shall be a self-powered, reset able, solid-state counter which provides silent, accurate and noise immune operation.
- B. Required Features:
 1. Power: Battery, five-year minimum life.
 2. Display:
 - a. Type: Liquid crystal.
 - b. Digits: Eight.
 - c. Figure Size: 1/2-inch approximately.

- d. Display Life: 50,000 hours minimum.
- 3. Count Input: Dry Contact.
- 4. Operating Temperature: 0°C to 70°C.
- 5. Operating Humidity: 60 percent non-condensing.
- 6. Enclosure: NEMA 4X.
- 7. Accuracy: 100 percent.
- 8. CMOS Circuitry.
- 9. Mounting: Provide accessories for panel mounting.
- 10. Nameplate below the LCD display shall carry the equipment name and units as shown.

C. Products and Manufacturers: Provide one of the following:

- 1. Durant, Model 53300-400.
- 2. Or equal.

2.7 CYCLE TIMER

A. Type: Adjustable, microprocessor-based multipurpose timer/counter.

B. Construction Features:

- 1. Switch selectable ranges as follows:
 - a. 0 to 0.99 seconds.
 - b. 0 to 99.9 seconds.
 - c. 0 to 999 seconds.
 - d. 0 to 9.99 minutes.
 - e. 0 to 99.9 minutes.
 - f. 0 to 999 minutes.
 - g. 0 to 99.9 hours.
 - h. 0 to 999 hours.
- 2. Repeat Accuracy:
 - a. Timer: ± 10 ms on all ranges.
 - b. Counter: 100 percent on all ranges.
- 3. Memory: Non-volatile memory that will retain entire program and present time/count periods at loss of power; programmable for both reset and non-reset power fail operation.
- 4. Operating Temperature: 32 to 140°F.
- 5. Cycle Progress Display: Three-digit display, programmable to run up to or down from the setpoint and to stop or continue up from zero after time-out/count-out.
- 6. Time/Count Periods: Three programmable presets; pulse, early and main.
- 7. Load Relays:
 - a. Type: DPDT.
 - b. Number: One early and one delayed.
 - c. Contact Ratings: Seven amps at 120 VAC.
- 8. Terminals: Screw terminals accessible at rear.
- 9. Housing: Fully gasketed, dust and watertight.
- 10. Power Input: 120 VAC.

C. Products and Manufacturers: Provide one of the following:

- 1. Automatic Timing and Controls Company, Model 365M.
- 2. Or equal.

2.8 ELECTRONIC TOTALIZER AND INTEGRATOR

- A. General:
1. Electronic integrator shall be a solid-state device to totalize a linear flow signal with respect to time. The integrated output shall be indicated on a front counter, calibrated to read directly in units of flow and shall be mounted on the panel face.
- B. Required Features:
1. Modular plug-in design.
 2. Variable dropout adjustment shall be provided to prevent erroneous counting at low flow rates.
 3. Input Signal: 4 to 20 mADC.
 4. Power Requirements: 120 VAC \pm 10 percent, 60 Hz.
 5. Accuracy: 0.5 percent of rate between 10 and 100 percent of full scale.
 6. Slide-out chassis.
 7. Suitable for flush panel mounting.
 8. Unit shall match in appearance other panel mounted instruments.
 9. Integrator Output Display:
 - a. Integrally mounted six or eight-digit LCD.
 - b. Non-reset.
 - c. Battery backed to prevent loss of display in the event of power outages.
 10. Enclosure: NEMA 4X.
 11. Ambient Operating Temperature: 0°C to 55°C.
 12. Ambient Operating Humidity: 0 to 85 percent non-condensing.
- C. Products and Manufacturers: Provide one of the following:
1. Foxboro, Model 75RTA.
 2. Precision Digital, Model PD692.
 3. Or equal.

2.9 ELAPSED TIME METER (HOUR METER)

- A. General: Unit shall be a powered, non-resettable time indicator, with easy to read analog figures.
- B. Required Features:
1. Power: 120 VAC, or 4 to 40 VDC.
 2. Accuracy: Within one percent.
 3. Capacity: Up to 99,999.9 hours (automatic recycle at zero); one-tenth hour resolution.
 4. Operating Temperature: -40°C to +68°C.
 5. Sealed against dirt and moisture.
 6. Tamperproof.
 7. Shock resistant.
 8. Panel mountable.
 9. Nameplate below display shall read "TOTAL HOURS".
- C. Products and Manufacturers: Provide one of the following:
1. Veeder-Root, 7795 Series.
 2. Honeywell, 20000 Series.

3. Or equal.

2.10 CONTROL RELAY

- A. Type: General purpose, plug-in type rated for continuous duty.
- B. Construction Features:
 1. Coil Voltages: 24 VDC or 120 VAC, as required.
 2. Contacts:
 - a. Silver cadmium oxide rated not less than 5 A resistive at 120 VAC or 24 VDC continuous.
 - b. For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 3 A resistive at 120 VAC or 28 VDC continuous shall be provided.
 3. Relays to have clear plastic dust cover.
 4. Relays to have pilot light to show energized coil.
 5. Relays to be UL recognized.
- C. Products and Manufacturers: Provide one of the following:
 1. Square D Company, Type R and/or Type K.
 2. IDEC, RR Series.
 3. Or equal.

2.11 TIME DELAY RELAY

- A. Type: Dial adjustable, plug-in type time delay relay providing ON delay timer operation.
- B. Construction Features:
 1. Contacts:
 - a. Type: DPDT.
 - b. Rating: 5 A resistive at 120 VAC, 5 A at 24 VDC.
 2. Housing: Plug-in design with dust and moisture resistant molded plastic case.
 3. Power Input: 120 VAC or 24 VDC as required.
 4. Operating Temperature: 0°C to 55°C.
 5. Unit shall have LED to show timing status.
 6. Relays to be UL recognized.
- C. Products and Manufacturers: Provide one of the following:
 1. Square D, Schneider Electric, 9050JCK11V20.
 2. Automatic Timing and Controls Company, Series 328E.
 3. IDEC, Series GT5P.
 4. Or equal.

2.12 ALTERNATOR RELAY

- A. Type: Enclosed, general purpose duplex alternating relay. Provided for alternation of the lead pump for each run cycle.
- B. Construction Features:
 1. Plug-in base.

2. Polycarbonate dust cover.
 3. Continuous rated coils with AC pickup voltages of 85% of nominal. Coil voltage as required.
 4. Contacts rated at 120 VAC, 80 percent P.F., 10 amperes continuous, 30 amps make, 3 amps break.
 5. Solid-state alternating circuit driving electro-mechanical relay coil.
 6. Relays shall feature state indicating LEDs in the cover.
- C. Products and Manufacturers: Provide one of the following:
1. Potter & Brumfield #S89R11APP1.
 2. Or equal.

2.13 CURRENT ALARM RELAY

- A. Type: Direct current, electronic setpoint control relay which accepts 4 to 20 mADC input signal and provides dry circuit contact output based on trip point setting.
- B. Performance Requirements:
1. Repeatability: Trip point repeats within ± 0.2 percent of span.
 2. Trip Adjustment: 0 to 100 percent of span.
 3. Adjustable Deadband: 1 to 15 percent of span.
- C. Construction Features:
1. Trip Adjustment: Multi-turn front panel adjustment.
 2. Contacts: DPDT relays, rated 5 A at 120 VAC or 24 VDC non-inductive.
 3. Enclosure: Standard housing designed for internal panel mounting.
 4. Power Supply: 120 VAC, 60 Hz or 24 VDC, as required.
- D. Products and Manufacturers: Provide one of the following:
1. Ronan, X54 Series.
 2. Action Pak, Model AP 1080.
 3. Or equal.

2.14 MULTIPLIER

- A. General: Computing element shall multiply or divide the signals shown. Provide sufficient quantities to accommodate all signals.
- B. Required Features:
1. Input/output bias adjustments.
 2. Process current inputs and outputs (4 to 20 mADC).
 3. Input/output isolation.
 4. 24 VDC power.
 5. Linearity: ± 0.15 percent of span.
 6. Operating Temperature: 0°C to 55°C.
- C. Products and Manufacturers: Provide one of the following:
1. Action Instruments, Model Q498.
 2. Or equal.

2.15 CURRENT AND VOLTAGE TRANSDUCER

- A. General: Transducer shall convert a sinusoidal alternating current or voltage into a DC current output, proportional to the RMS value of input.
- B. Required Features:
 - 1. Inputs: 50/60 Hz.
 - a. Current: 1A or 5A current transformer secondaries.
 - b. Voltage: 50 to 480 VAC.
 - 2. Output: 4 to 20 mADC into 0 to 500 Ohms.
 - 3. Zero adjustment: \pm Two percent minimum.
 - 4. Span adjustment: \pm Ten percent minimum.
 - 5. Accuracy: \pm 0.5 percent.
 - 6. Response time: \leq 400 ms. to 99 percent rated output.
 - 7. Operating Temperature: 0°C to 50°C.
 - 8. Operating Humidity: 0 to 95 percent non-condensing
 - 9. Output Protection: Fully protected against open or short circuit outputs.
 - 10. Overload Capacity: Two times rated current of 1.25 times rated voltage on a continuous basis.
 - 11. Surge Withstand: Conform to ANSI C37-90a.
- C. Products and Manufacturers: Provide one of the following:
 - 1. Crompton Instruments, 250 Series.
 - 2. Ametek, Exceltronic II Series.
 - 3. Or equal.

2.16 WATT TRANSDUCER

- A. General: Measure active power, in both balanced and unbalanced, single or 3 phase systems.
- B. Required Features:
 - 1. Frequency: 60 Hz.
 - 2. Voltage: 50 to 480 volts with \pm 20 percent range and 2 va maximum burden.
 - 3. Current: 1A or 5A current transformer secondaries with 0 to 125 percent range and 1 va maximum border.
 - 4. Output: 4 to 20 mADC in 0 to 500 ohms.
 - 5. Supply: 120 VAC.
 - 6. Accuracy: 0.5 percent.
 - 7. Response Time: Less than 400 msec up 99 percent rated output.
 - 8. Output Protection: Fully protected against open or short-circuited output.
- C. Products and Manufacturers: Provide one of the following:
 - 1. Crompton Instruments, 250 Series.
 - 2. Or equal.

2.17 ELECTRONIC HORN

- A. General: The horn shall be of the multi-tone electronic audible type.

- B. Required Features:
 - 1. Internal volume control.
 - 2. Field selection of up to 16 different tones.
 - 3. Power: 120 VAC or 24 VDC (provide power supply as required).
 - 4. Operating Temperature: 32 to 120°F.
 - 5. Enclosure Rating: NEMA 4X.

- C. Products and Manufacturers: Provide one of the following:
 - 1. Panalarm, Model NTZ.
 - 2. Or equal.

2.18 SPARE PARTS AND TEST EQUIPMENT

- A. CONTRACTOR shall furnish and deliver the spare parts and test equipment as outlined below, all of which shall be identical and interchangeable with similar parts furnished under this Section.

- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

- C. The following shall constitute the minimum spare parts:
 - 1. One per ten (two, if fewer than twenty) of each type of input-output relay furnished for this Contract.
 - 2. One replacement power supply for each type and size furnished for this Contract.
 - 3. A one-year supply of all expendable materials.
 - 4. One per ten (two, if fewer than twenty) of each type of panel mounted instrument including lights, pushbuttons, and PLC equipment.
 - 5. Three of each type and size of fuse used in panels and instruments.

- D. The following shall constitute the minimum test and calibration equipment:
 - 1. All tooling required to insert, extract, and connect any internal or external connector, including edge connectors.
 - 2. All special calibration equipment required for system calibration.

- E. All spare parts shall have been operated and tested in the factory as part of factory testing prior to shipment of the control system.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install each item in accordance with manufacturers recommendations and in accordance with the Contract Documents.

- B. All items shall be mounted and anchored in compliance with Section 26 29 15 - Pump Control Panels.

3.2 START-UP, CALIBRATION, TESTING AND TRAINING

- A. Comply with the requirements of Manufacturer's Responsibilities and Services described in the Quality Assurance article of this Section.

END OF SECTION