TECHNICAL SPECIFICATIONS FOR RICHARD A. HEYMAN ENVIRONMENTAL PROTECTION FACILITY – DEEP WELL INJECTION PUMP AND HVAC CITY OF KEY WEST PROJECT ID#: 199322

December 2019

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Specifications: Division 13

Instrumentation & Controls

Section 13500

INSTRUMENTATION AND CONTROL SYSTEM

PART 1 – GENERAL

1-1. SCOPE. This section covers the expansion and installation of an instrumentation and control system designated as the Supervisory Control and Data Acquisition (SCADA) System.

The system shall be furnished as specified, complete with all software, human machine interface (HMI) hardware, input/output hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training necessary for proper operation.

The System Supplier shall provide services including:

- Integrating the new Deep Well Injection pump into PLC, FP-3-1 provided by another contract, including modifying the existing program to include it in the sequencing and control.
- Provide a new FactoryTalk Historian SE software program of 1000 points and integrate the existing FactoryTalk SCADA system into the new Historian to archive existing IO points.
- Provide two new computers with one configured for the Network FTD and Historian SE Server and one configured as the Historian SE Interface and FT Live Data Server.
- Configure two existing computers to be Historian SE Clients.

1-1.02. Associated Sections. This section also includes the equipment and services specified in the following sections.

Section 13510	COMPUTER SYSTEM HARDWARE
Section 13520	COMPUTER SYSTEM SOFTWARE
Section 13530	PROGRAMMABLE LOGIC CONTROLLERS
Section 13550	SOFTWARE CONTROL BLOCK DESCRIPTIONS
Section 13563	PRESSURE AND LEVEL INSTRUMENTS
Section 13566	MISCELLANEOUS INSTRUMENTS
Section 13590	NETWORK SYSTEMS
Section 13591	METALLIC AND FIBER OPTIC COMMUNICATION CABLE AND CONNECTORS

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. The Drawings indicate locations and arrangements of equipment and may include installation details and block and one-line diagrams showing connections and interfaces with other equipment. The input/output (I/O) lists are attached as an appendix to the Programmable Logic Controllers section.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings and instrument device schedule appended to this section.

1-2.03. Codes, Permits and Agency Approvals. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Where mandated by codes, panels, assemblies, materials, and equipment shall be listed by Underwriters' Laboratories. Contractor shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment.

1-2.04. Supplier's Qualifications. Equipment and software furnished under this section and under other related sections listed in the Scope paragraph above shall be designed, coordinated, and supplied by a single manufacturer or supplier, hereinafter referred to as the System Supplier. The System Supplier shall be regularly engaged in the business of supplying computer-based monitoring, control, and data acquisition systems. The Contractor shall utilize the services of the System Supplier to coordinate all control system related items, to check-out and calibrate instruments, and to perform all testing, training, and startup activities specified to be provided.

The System Supplier shall have the following minimum qualifications:

- The supplier shall maintain a design office staffed with qualified technical design personnel.
- The supplier shall maintain competent and experienced service personnel to service the hardware and software furnished for this project.
- The intended supplier shall furnish the information requested in the Instrumentation and Control System Supplier Questionnaire bound

elsewhere in the Documents. References including contact names, telephone numbers, and general project description shall be included in the questionnaire. The users and project lists shall be for similar control equipment, software, and type of projects.

- The supplier shall have as a minimum 5 years of experience in the design, coordination and supply of computer-based monitoring, control, and data acquisition systems.

1-2.05. Coordination. Systems supplied under this section shall be designed and coordinated by System Supplier for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment. All equipment shall be designed and installed in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.

1-2.06. Related Equipment and Materials. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.

1-2.07. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with System Supplier's equipment drawings and shall be as close as practical to the tag numbers used on the Drawings and device schedules. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

1-3. GENERAL REQUIREMENTS. The drawings and specifications indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary by System Supplier, details of such departures and the reasons shall be submitted to Engineer for review with or before the first stage submittal. No departures shall be made without prior written acceptance.

The specifications describe the minimum requirements for hardware and software. Where System Supplier's standard configuration includes additional items of equipment or software features not specifically described herein, such equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.

1-3.01. Governing Standards. Equipment furnished under this section shall be designed, constructed, and tested in accordance with IEEE 519, ANSI C37.90, FCC Part 15 - Class A, and NEMA ICS-1-109.60.

1-3.02. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The System Supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications requisite for proper installation subject to acceptance by Engineer. At least three feet of clear access space shall be provided in front of all instrumentation and control system components.

1-3.03. Workmanship and Materials. System Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except for testing.

1-3.04. Corrosive Fluids. All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials. System Supplier shall submit certification that the instrument manufacturer approves the selection of materials of primary elements that are in contact with the specified process fluid to be inert to the effects of the process fluid.

1-3.05. Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation devices shall be furnished as needed for proper performance of the equipment.

1-3.06. Programming Devices. A programming or system-configuring device shall be provided for systems that contain any equipment that requires such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup.

1-4. SUBMITTALS. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in three separate stages.

The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications used on the Drawings shall be referenced where applicable.

1-4.01. First Stage Submittal. The first stage submittal shall include the following items.

a. A detailed list of any exceptions, functional differences, or discrepancies between the system proposed by System Supplier and this specification.

b. Product catalog cut sheets on all hardware and software items, clearly marked to show the model number, optional features, and intended service of each device.

c. A brief, concise description of the proposed system, including major hardware and software components and personnel training.

d. A block diagram or schematic drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships.

e. Drawings showing floor and wall space or desktop area requirements for all equipment items, including allowances for door swings and maintenance access.

f. Environmental and power requirements, including heat release information for each equipment item.

g. Standard field termination drawings for all process input/output equipment, showing typical terminations for each type of point available in the system.

h. A copy of the proposed software licenses for all software associated with the system.

i, Outline for training classes.

j. Additional Requirements identified in other Division 13 sections.

1-4.02. Second Stage Submittal. Before any equipment is released for shipment to the site and before factory testing is scheduled, the following data shall be submitted.

At System Supplier's option, the first and second stage submittals may be combined.

a. Detailed functional descriptions of all software modules specified and furnished as part of System Supplier's standard system. The descriptions shall be identified with the applicable specification

paragraph.

b. Complete panel modification drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall be to scale and shall include overall dimensions, metal thickness, door swing, mounting details, weight, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

c. Wiring and installation drawings for all interconnecting wiring between components of the system and between related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections. If panel terminal designations, inter-device connections, device features and options, or other features are modified during the fabrication or factory testing, revised drawings shall be submitted before shipment of the equipment to the site.

d. Review of drawings submitted prior to the final determination of related equipment shall not relieve System Supplier from supplying systems in full compliance with the specific requirements of the related equipment.

e. Input/output listings showing point names, numbers, and addresses. Input/output identification numbers from the contract documents shall be cross-referenced in this submittal.

f. Proposed lesson plans or outlines for all training courses specified herein, including schedule, instructors' qualifications and experience, and recommended prerequisites.

g. Standard system engineering and user manuals describing the use of the system and application programming techniques for creating reports, graphics, database, historical records, and adding new process I/O nodes to the system.

h. Additional Requirements identified in other Division 13 sections.

1-4.03. Third Stage Submittal. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be submitted before the commencement of field acceptance testing. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment and software furnished. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. If field-wiring modifications are made after these drawings are submitted, the affected drawings shall be revised and resubmitted. Additional requirements are identified in other Division 13 specification sections.

1-5. PREPARATION FOR SHIPMENT. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be kept dry at all times, and shall not be exposed to adverse ambient conditions.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.

Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.

Instrument shipment and storage requirements shall be coordinated with Engineer or Owner prior to shipment. System Supplier shall provide adequate storage and be ready to accept the shipment before shipping any equipment to the site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.

Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

1-6. DELIVERY, STORAGE, AND SHIPPING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-7. SPARE PARTS. Spare parts and consumable items are specified in other sections.

1-7.01. Packaging. All spare parts shall be delivered to Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in anti-static material. All packages shall be clearly marked with the manufacturer's name, part number or other identification, date of manufacture, and approximate shelf life.

1-7.02. Replacement. System Supplier may utilize spare parts and supplies during system installation, de-bugging, startup, or training, but shall restore all such materials and supplies to the specified quantities before final acceptance of the systems.

PART 2 - PRODUCTS

2-1. GENERAL REQUIREMENTS. All equipment furnished under each section referenced in SCOPE is a part of this section and shall be selected by System Supplier for its superior quality and intended performance. Equipment and materials used shall be subject to review.

2-1.01. Standard Products. The systems furnished shall be standard products. Where two or more units of the same type of equipment are supplied, they shall be the products of the same manufacturer; however, all components of the systems furnished hereunder need not be the products of one manufacturer unless specified herein.

To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line. Similar components of different instruments shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The design of the systems furnished hereunder shall utilize concepts, techniques and features that provide maximum reliability and ease of maintenance and repair. The systems shall include board-level devices such as light emitting diodes or other indicators to facilitate quick diagnosis and repair. Diagnostic software shall be furnished to facilitate system-level troubleshooting.

Where redundant hardware is provided, the system shall be capable of performing all specified functions, without reconfiguring hardware or software, with only one device of each category in service.

2-3. POWER SUPPLY AND INSTRUMENT SIGNAL. Power supply to all control system equipment will be 120 volts, 60 Hz, single phase. System Supplier shall be responsible for distribution of power among enclosures, consoles, peripherals, and other components of the system from the power supply receptacles and junction boxes indicated on the Drawings. Power distribution hardware shall include cables and branch circuit overcurrent protection installed in accordance with the electrical section.

Unless otherwise indicated, power supply to the instrumentation will be unregulated 120 volts ac. Unless otherwise indicated, all transmitted electronic

analog instrument signals shall be 4-20 mA dc and shall be linear with the measured variable.

2-3.01. Facility Distribution System. Equipment not indicated to be powered from an uninterruptible power source shall be suitable for being supplied from the facility distribution system and shall be capable of withstanding voltage variations of ±10 percent and harmonics up to the limits of IEEE 519 without affecting operation. System Supplier shall provide voltage conditioning or filtering equipment if necessary to meet the requirements specified.

2-3.02. Power Supplies. Power supplies for voltages other than those listed above shall be an integral part of the equipment furnished. Internal power supplies shall be regulated, current limiting, and self-protected.

2-3.03. Surge Withstand. All equipment shall meet all surge withstand capability tests as defined in ANSI C37.90 without damage to the equipment.

2-3.04. Uninterruptible Power Supply. An uninterruptible power supply (UPS) shall be furnished hereunder to power the equipment indicated on the Drawings or will be furnished under another section. System Supplier shall be responsible for coordinating the size of the UPS unit with the equipment furnished hereunder and shall advise Engineer if a unit of higher capacity is necessary.

2-4. SERVICE CONDITIONS AND ENVIRONMENTAL REQUIREMENTS. The equipment provided for the instrumentation and control system shall be suitable for the service conditions specified in the attached equipment sections.

All equipment shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall be in compliance with FCC Rules and Regulations, Part 15, for Class A computing devices.

2-4.01. Ambient Temperature and Elevation. All system equipment located in air-conditioned rooms shall be suitable for operation in ambient temperatures from 10°C to 35°C and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non-air-conditioned indoor areas shall be suitable for an ambient temperature range of 0°C to 50°C and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range -20°C to 60°C and a relative humidity of 5 to 100 percent. Heaters and air conditioning/cooling equipment shall be provided where essential to maintain equipment within its manufacturer-recommended operating ranges.

All equipment and instruments shall be designed to operate at the site elevation of 10 ft.

2-4.02. Deleterious Effects. All system equipment will be installed in areas without anti-static floor construction and without any provisions for control of particulates or corrosive gases other than ordinary office-type HVAC filtering. System Supplier shall furnish any additional air cleaning equipment, anti-static chair pads, or other protective measures necessary for proper operation of the system.

All input/output hardware shall meet or exceed, without false operation, all requirements of NEMA ICS-1-109.60, Electrical Noise Tests.

2-4.03. Noise Level. The equivalent "A" weighted sound level for any system equipment located in the control room, except printers, shall not exceed 35 dBA. The sound level for printers shall not exceed 65 dBA. Sound reduction enclosures shall be provided where necessary to comply with these limits.

2-4.04. Lightning Protection. In addition to other environmental protection specified herein, the entire system shall be provided with lightning protection. Lightning protection measures shall include the following.

2-4.04.01. Grounding. All major components of the system shall have a low resistance ground connection. Grounding system provisions indicated on the Drawings shall be modified as recommended by System Supplier.

2-4.04.02. Surge Suppressors. Surge and lightning suppressors shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) or silicon junction type, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied for the following:

- All 120 VAC power connections to PLCs, instruments and control room equipment. Surge arresters shall be Transtector "ACP-100-HW Series", Power Integrity Corporation “ZTA Series”, Phoenix Contact “Mains PlugTrab”, or MCG Surge Protection “400 Series”.
- All analog signal circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Surge protection devices shall not impede or interfere with the use of smart transmitter calibration/communication. Protection devices located near the transmitter shall be Telematic “TP48.” Protection devices in control panels shall be Transtector “PDS Series or FSP Series”, Telematic “SD Series”, Phoenix Contact “PipeTrab Series”, or Citel “BP1-24.”
- All metallic pair (twisted and untwisted) conductor local area network and data highway termination points, where any part of the data highway cable is routed outside of the building envelope. Single-port

protective devices shall be Phoenix Contact “PlugTrab Series”, Transtector “FSP” Series”, or Telematic “NP Series.”

- All serial, PLC data highway, and remote I/O network termination points where any part of the circuit is routed outside of the building envelope. Surge protection devices shall be Transtector “DRDC Series” (RS-232); Transtector “FSP Series” (RS-422), Phoenix Contact “PlugTrab Series” or Citel “E280 Series”.

2-5. SOFTWARE DOCUMENTATION. System Supplier shall furnish complete documentation on all software supplied with the systems specified herein. Operating systems, compilers, assemblers, and utility and diagnostic programs that are standard commercial products of third parties need not be included in the optical media backup. Software documentation shall consist of the following principal items.

a. One backup set of any integrated circuit or solid-state memory-based plug-in firmware used.
b. Two complete back-up copies of system and application software in executable format on optical media compatible with the system furnished.
c. Three sets of user reference manuals for all standard system and application software.
d. One set of user reference manuals for all operating system software.
e. Three sets of printed as-built reference documentation for any special software provided specifically for this contract.
f. For each licensed software product, all documentation provided by the product manufacturer shall be provided. This includes all reference manuals and any other documents that were provided by the manufacturer. One set of this documentation shall be supplied for each and every piece of equipment provided. Multiple pieces of similar equipment or software require multiple copies of this documentation.

2-6. SOFTWARE LICENSE. All software programs supplied as a standard part of System Supplier’s products for this project shall be licensed to Owner for use on the system specified herein. Such license shall not restrict Owner from using the software on the system provided hereunder or its replacement. Owner shall have the right to make copies of the software for use on the system provided. Specific requirements of System Supplier’s software license are subject to review and approval by Owner and Engineer.

2-7. INSTALLATION TEST EQUIPMENT. All necessary testing equipment for calibration and checking of system components shall be provided by System Supplier. System Supplier shall also furnish calibration and maintenance records

for all testing and calibration equipment used on the site if requested by Engineer.

PART 3 – EXECUTION

3-1. INSTALLATION REQUIREMENTS. The installation of equipment furnished hereunder shall be by the Contractor or their assigned subcontractors.

3-1.01. Field Wiring. Field wiring materials and installation shall be in accordance with the electrical section.

3-1.02. Instrument Installation. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated. Installation details for some instruments are indicated on the Drawings.

All outdoor instrumentation shall be protected from direct sun exposure. Instruments shall be placed in locations to limit south and west sun exposure. Sunshades shall be provided on instruments that are subject to the direct sun exposure. Sunshades shall be located so the opening faces north or east where possible. Sunshades shall be provided as shown on the Drawings.

3-1.03. Salvage of Existing Equipment. Existing equipment and materials removed or replaced under this contract shall be delivered to Owner at a location designated by Owner, or shall be properly disposed of at Owner's discretion. Care shall be taken to avoid damage to equipment delivered to Owner.

Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring, or openings that remain after removal of equipment and support hardware shall be removed or repaired in a manner acceptable to Owner and Engineer. Transmitters or switches containing mercury shall be removed and disposed of by personnel trained in the handling of hazardous materials and using approved procedures.

3-2. SYSTEM SOFTWARE CONFIGURATION. System software shall be configured by the System Supplier. Configuration services shall consist of the creation of the system database, report formats, operator interface graphic and tabular display screen formats, password and security implementation, and programming of control units to provide a fully functioning system. The System Supplier shall fully configure the system using data provided herein or supplied by the Engineer and/or the Owner after award of the contract.

The system that is delivered to the field for installation, checkout, and startup shall have all files, or databases, that are configurable in size, sized in a manner in which there will be 50% space available for future work after the completion of this project. This sizing should include the addition of memory modules, disk

drives, or any other device to insure the 50% spare space availability. All "tuning" of software that is dependent on space requirements shall be done prior to the completion of this project.

Tuning of software programs shall be accomplished in such a manner that the program operates at its highest performance level. These programs include, but are not limited to Microsoft SQL Server, all PLC ladder logic, and others.

3-2.01. Control System Database. The control system database shall be developed and configured by the System Supplier. The System Supplier shall enter information obtainable from the Contract Documents into the database prior to soliciting input from the Engineer and the Owner. The System Supplier shall determine the need for any "pseudo" database points and shall ascertain and enter all information needed to define these points. The System Supplier is responsible for entering all information associated with each point. This includes but is not limited to, descriptions, engineering units, associated displays, areas, security, etc. All fields associated with each database point must be completely filled out accurately.

3-2.02. Graphic Screen Displays. The System Supplier shall be responsible for developing and configuring the custom graphic displays. Each piece of major process equipment that is monitored by the control system shall be displayed on one or more graphic screen. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. These items must be done in accordance to the Configuration Standards and Conventions as described later in this section. Alarm and/or event displays shall also be provided and proven functional prior to acceptance of the system. A means of capturing and printing of all graphic screens shall also be included. The software program provided must be capable of printing the screen in a black and white (using gray scale) or color format. This program must be accessible from all terminals provided under this contract. The black and white printing shall be done in a manner in which the use of the black background is not represented in the printout. This is done to keep the utilization of ink cartridge and toner cartridge to a minimum.

All graphic screens shall be animated to indicate the current state of the piece of equipment. The following graphic screens shall be provided, as a minimum.

- Deep Injection System
- Alarm Summary
- Event Summary
- Summary screen to vector to all video trends

A minimum of 5 custom graphic displays shall be provided by the System Supplier.

3-2.03. Report Formats. Report formats shall be developed and programmed by the System Supplier using tag names defined in the database creation. Reports shall be provided as summarized below. All reports will be provided with a header on each page to indicate the contents of each column of information. Each page shall be numbered and indicate the name of the report, the date the report was printed, and the time of the printout. The printout shall also include the time span of the information shown on the report.

- Deep Injection Operating Report. A daily report, listing the pump variables (up to 5 variables) shall be provided. The report shall include hourly values and minimum/maximum/average values where appropriate.

3-2.04. Configuration Standards and Conventions. A "Software Configuration Standards and Conventions" document shall be prepared and submitted by the System Supplier. The document shall be submitted for review and approval before software configuration commences. The document shall describe and define such items as proposed graphic display process line colors/representations; symbology; color standards for "on", "off", "opened", "closed", and "alarm" conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. Before submitting the initial draft document, the System Supplier shall meet with the Engineer and/or Owner to review any of the Owner's existing standards and conventions. All copies of this submittal shall be provided in color to insure the accuracy of each item. No black and white copies will be accepted. The colors used in the printed submittal shall accurately depict the colors and shapes proposed for use on the final system.

In addition to submitting the document for review, an updated version of the document shall be submitted as part of the O&M Manuals. The document shall be revised to document any additional standards that are established throughout the configuration process.

3-2.05. Configuration Review Meetings. Proposed graphic screens and report formats shall be reviewed with the Owner and Engineer throughout the configuration process. The System Supplier's programming personnel shall attend the initial review meeting. A second review meeting shall be held at approximately 50 percent completion. Both meetings shall be held at the Owner's facilities.

3-2.06. Software Functional Requirements. General functional requirements for system configuration are indicated on the Drawings and described in the specifications. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system and may not be sufficient to fully configure the system. The System Supplier shall be responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Engineer or the

Owner.

3-3. SYSTEMS CHECK. System Supplier shall provide the services of a field manager and a trained and experienced field supervisor to assist the installation contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation.

3-3.01. Field Manager. System Supplier shall appoint a field services manager who shall be responsible for the coordination of all system check-out and startup activities, and who shall be immediately available to Engineer and Owner by phone or on site for the duration of this project.

3-3.02. Field Inspection at Delivery. The field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.

3-3.03. Field Calibration of Instruments. After each instrument has been installed, a technical representative of System Supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final settings. The adjustments of calibrated instruments shall be sealed or marked, insofar as possible, to discourage tampering. Instrument calibration shall be done before checkout of the system operation. A typical instrument calibration report is attached to the end of this section.

3-3.04. Training for Installation Personnel. Not used.

3-3.05. Field Inspection Prior to Start Up. After installation and wiring connections are complete, the field supervisor, with additional System Supplier's personnel shall verify that each external connection to the system is correctly wired and field process components and devices are functioning as intended. A minimum of 5 working days shall be included for this task, but System Supplier shall be responsible for completing the following scope of work.

3-3.05.01. Analog Signals. Analog input signals shall be simulated at the transmitting source, and verified to be received at the proper register address in the control system. Analog outputs shall be generated at the control system, and verified to be received with the correct polarity, at the respective receiving device.

3-3.05.02. Discrete Signals. Discrete input and output signals shall be simulated and verified that they are received at the respective receiving device, and at the proper voltage.

3-3.05.03. Devices by Other Suppliers. If interrelated devices furnished by other suppliers, under other contracts, or by Owner, such as valve actuators, motor

controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

3-3.05.04. System Check Out Report. The System Supplier shall submit a written report on the results of such tests to Engineer. Additional documentation shall be furnished as requested by Engineer to establish responsibility for corrective measures. System Supplier shall verify, in writing, to Engineer or Owner that System Supplier has successfully completed the external connection check before beginning system startup or field acceptance testing.

3-3.06. Start Up Assistance. After the field supervisor has completed the system check and submitted his report, System Supplier shall supply a factory-trained engineer to provide on-site start up assistance. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components. 5 working days shall be included for this task.

3-4. TESTING. The system shall be acceptance tested on site.

System Supplier shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by System Supplier and witnessed by Owner and/or Engineer.

System Supplier shall notify Engineer and Owner in writing at least 14 days before the proposed testing date. If the factory acceptance test is concluded unsuccessfully, the test shall be repeated. System Supplier shall reimburse Owner and Engineer for all expenses incurred in connection with attending repeated factory or site testing necessitated by system failure or inadequate preparation.

3-4.01. Factory Acceptance Testing. Not used.

3-4.02. Site Acceptance Testing. After installation and checkout by System Supplier's personnel, the system shall be subjected to an acceptance test.

Site acceptance testing shall be scheduled after receipt of the System Check Out Report and System Supplier shall verify that all field signal changes are reflected in the proper address locations in the system database.

The site acceptance testing shall operate without loss of basic functions. The number of working days of continuous operation for the test shall be 5. The operational demonstration shall confirm that the status, alarm, and process

variable signals are valid and are being updated appropriately, and that the discrete and analog output signals from the control system are being correctly transmitted and implemented. Any errors or abnormal occurrences shall be recorded by System Supplier's field representative. System Supplier's field representative need not be continuously present during the site acceptance testing, but shall be available to respond to the site within one hour of notification. The representative shall inspect the system for faults at least once every 24 hours and shall log or record any noted problems. The log shall include a description of the problem, its apparent cause, and any corrective action taken.

3-4.02.01. Failure of Redundant Equipment. Failure of redundant equipment shall not be considered downtime provided that automatic failover occurs as specified and, in the opinion of Engineer, the failure was not caused by deficiency in design or installation. In the event of repeated failure of any hardware component or software module, the acceptance test shall be terminated and re-started.

3-4.02.02. Completion of Test. Successful completion of the site acceptance test, including the operational demonstration, is prerequisite to Substantial Completion as specified in the Supplementary Conditions.

3-5. TRAINING. System Supplier shall conduct training courses for personnel selected by Owner. Training shall be provided in the following categories: instrument, control system maintenance, operator (pre-installation), operator (post-installation), programmer (HMI software), programmer (PLC software), networking, and supplemental shall be provided. Training shall be conducted by experienced instructors who are familiar with the specific system supplied.

3-5.01. General Training Requirements. In general, System Supplier's standard training courses may be used to meet the training objectives specified. Where standard courses do not meet these objectives, additional coursework shall be developed. Clock hour requirements for each level of training are shall be as listed. A "clock hour" is defined as one hour of instruction or supervised training exercise. Training hour requirements are the number of hours of training to be provided for each student. Additional training time shall be provided if considered necessary to meet the training objectives.

3-5.01.01. Training Costs. All costs associated with the training program; excluding travel, lodging, and per diem expenses for Owner's and Engineer's personnel to attend off-site training programs; shall be the responsibility of System Supplier and shall be included in the contract price.

3-5.01.02. Lessons. Training lesson plans and other information for the second stage submittal as defined herein shall be submitted at least 30 days prior to the start of training.

3-5.01.03. Video Recording. Not used.

3-5.02. Instrument Training. Not used.

3-5.03. Control System Maintenance Training. Not used.

3-5.04. Operator Training. Owner's personnel will utilize the system for day-to-day monitoring and/or control of the facilities. The training program shall provide operators with sufficient knowledge to move from screen to screen within the system, understand the contents of group and detailed point displays, react to and acknowledge alarms, adjust control setpoints and alarm limits, configure and print shift reports, print preconfigured reports on demand, control equipment connected to the system, and react to and resolve minor system errors.

3-5.04.01. Classes. Operator training shall include sessions as specified below.

3-5.04.01.01. Pre-installation Session. Not used.

3-5.04.01.02. Post-installation Session. The post-installation training shall include three separate, but identical, sessions for three shifts of personnel and shall be conducted at Owner's facilities. Each class shall consist of 8 hours of instruction using the lesson plan submitted and approved for use. The post-installation sessions may have to be conducted outside normal working hours to accommodate the working schedule of Owner's personnel. The post-installation training sessions shall be conducted for 4 of the Owner's operating personnel.

3-5.04.02. Content of Classes. Each session shall cover at least the following topics.

a. Power-up, "bootstrapping", and shutdown of all hardware devices.
b. Logging on and off the system and the use of passwords.
c. Access and interpretation of standard displays and diagnostics.
d. Use and care of operator workstations, servers, video displays, printers, and other control room hardware, including replenishment of supplies and replacement of ribbons and ink cartridges.
e. Moving from screen to screen within the graphic display environment.
f. Interpretation of preconfigured group and detailed point or database displays.
g. Response to and acknowledgment of alarms.
h. Adjustment of control set points and alarm limits.
i. Configuration and printing of shift and other reports by schedule or on demand.

j. Control of field equipment and devices connected to the system.

k. Manual entries to database points.

l. Generation of current (real-time) and historical custom and predefined reports and trend displays.

m. Appropriate responses to software and hardware errors.

n. Enabling and disabling individual inputs and outputs.

The operator-training program shall be developed for personnel with no prior experience with the hardware and software provided as part of the project.

3-5.05. Programmer Training (HMI Software). Not used.

3-5.06. Programmer Training (PLC Software). Not used.

3-5.07. Network Training. Not used.

3-5.08. Supplemental Training. Not used.

End of Section

INSTRUMENT NAME & SERVICE:		
BRAND & MODEL NO.:		
TAG OR LOOP NO.:		
INPUT/OUTPUT RANGE:		
INPUT	ACTUAL OUTPUT	DESIRED OUTPUT
PROPORTIONAL BAND:		
RESET:		
POSITION OF SWITCHES, JUMPERS, ETC.		
COMMENTS:		
DATE OF CALIBRATION: CALIBRATED BY:		
Black & Veatch	INSTRUMENT CALIBRATION REPORT	Figure 1-13500

Section 13510

COMPUTER SYSTEM HARDWARE

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing and installation of standard computer system hardware fully configured to work with the software specified in the computer system software section. Principal items of the computer and peripheral hardware to be furnished are specified or are indicated on the control system block diagram on the Drawings.

System Supplier shall furnish all necessary interconnecting cables, accessories, and appurtenances as well as additional computer or peripheral hardware required for proper operation and to meet the functional requirements indicated on the Drawings and specified herein.

All equipment shall be capable of tolerating and "riding through" a power interruption of 8 milliseconds or less without interruption of normal operation.

1-1.02. Control System. Section Instrumentation and Control System shall apply to all computer hardware furnished under this section.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System section .

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System section.

1-5. SPARE PARTS. Not used.

PART 2 - PRODUCTS

2-1. SYSTEM COMPUTERS. System Supplier shall ensure that all computers are configured to operate properly with all software, input/output devices, and peripherals supplied.

2-1.01. Server Computers. Each Server Computer shall be comprised of the following configuration. This configuration is to be provided as a minimum:

Processor type.	Quad Core Intel Xeon
Processor speed.	3.0 GHz
Monitor type.	LCD with LED backlight, 16:9 aspect ratio
Monitor size.	21 inch
Memory size (RAM).	16 GB
Number of Ethernet cards.	1
Enclosure style.	Tower style
Manufacturer.	Dell or Hewlett Packard Enterprise

Two (2) 300 GB SATA hard drives with integrated RAID controller.

Single CPU (with dual CPU capabilities).

16X DVD-ROM.

Integrated VGA compatible video controller.

10 MB Cache.

Six hot-pluggable hard drive bays.

Redundant power supplies.

Scroll Mouse.

Standard Windows keyboard.

2 Serial Ports standard.

4 USB Ports.

2-1.01.01. Magnetic Storage Device. Not used.

2-1.01.02. Removable Hard Drive. Not used.

2-1.01.03. DLT Tape. Not used.

2-1.01.04. CD/DVD-RW Drive. A DVD-RW (read/write) drive shall be supplied and shall be capable of Orange Book standard with a minimum of 20x read and

16x record and of playing DVD disks. DVD drive shall be manufactured by HP, Sony, Panasonic or equal. DVD drives shall be supplied with spare disks.

2-1.01.05. Serial Communications Port Expander. Not used.

2-1.02. Workstation Computers. Each Workstation Computer shall be comprised of the following configuration. This configuration is to be provided as a minimum:

Processor type.	Quad core Intel Xeon
Processor speed.	3.0 Ghz
Monitor type.	Flat Panel LCD with LED backlight
Monitor size.	21 inch
Memory size (RAM).	16 GB
Manufacturer.	Dell or Hewlett Packard

500 GB SATA hard drive.

Single CPU.

CD/DVD ROM.

256 MB AGP video card.

2 MB Cache.

One 10/100/1000 Mbps RJ-45 connectivity Ethernet cards.

Scroll mouse.

Standard Windows keyboard.

4 USB Ports

Sound Card and speakers.

2-1.02.01. Magnetic Storage Device. Not used.

2-1.02.02. CD-RW/DVD Drive. The CD-RW (read/write)/DVD drive shall be supplied and shall be capable of Orange Book standard with a minimum of 32x read and 8x record and of playing DVD disks. CD-RW/DVD drive shall be manufactured by HP, Sony, Panasonic or equal. CD-RW/DVD drives shall be supplied with spare disks.

2-1.03. Notebook Computer. Not used.

2-2. SYSTEM PRINTERS. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. Installation, field check, testing and training shall be as described in the Instrumentation and Control System section.

End of Section

Section 13520

COMPUTER SYSTEM SOFTWARE

PART 1 – GENERAL

1-1. SCOPE. This section covers computer system software to be furnished and installed by System Supplier on computer hardware specified in another section.

System Supplier shall furnish standard, field proven, fully debugged and supported software packages for this application with a minimum of additions or changes. Customized or specially written software shall be furnished only if required to meet all functional requirements specified herein.

Software is described in functional categories. System Supplier shall furnish a complete software package including the functional requirements specified, along with any additional software required for proper and efficient operation of the system.

No attempt has been made to list all software or all characteristics of software required by System Supplier to meet the functional requirements specified, nor to determine the location of the software modules within the system.

The computer control software shall meet the design conditions and performance.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all software furnished under this section. Additional software requirements are indicated in the Software Control Block Descriptions section. Software configuration programming standards shall be as discussed in the Instrumentation and Control System section.

1-2. GENERAL. Software packages shall control computer system level activities as well as higher level process control activities, allowing the process to be monitored and controlled through an interactive operator interface.

1-2.01. Interface. Users shall be able to interface to all process control activities through fully interactive software modules initiated and operated using easily recognized icons or custom symbols or driven by full-screen and pull-down menus. Selection of icons or menus shall be through pointing devices and shall not normally require the use of an alphanumeric keyboard. Systems that require the use of typed commands to move from module to module or from display to display are not acceptable.

1-2.02. Execution. Throughout the execution of all software modules, the operator shall be presented with all command or operation choices available at that point in the program to make the choices self-explanatory and unambiguous. Question-and-answer or fill-in-the-blank requests are acceptable only where file names, tag names, or other unique text or numerical information is required.

1-2.03. Configuration. All programs shall be self-configuring to obtain the size and configuration of the system from parameters contained in the various files created during system generation. No parameters related to the hardware configuration shall be hard coded into any of the software.

1-2.04. Version. All programs shall be the latest version commercially available at the time the system is delivered to Owner. Superseded versions, revisions, or releases are not acceptable.

1-2.05. Drawings. Supplementing this section, the Drawings indicate locations and arrangement of computer enclosures and provide one-line and block diagrams regarding the connection and interaction with other equipment.

1-3. SUBMITTALS. In addition to the requirements of the Instrumentation and Control System section, a complete description of the software packages and modules shall be submitted to verify compliance with this section.

1-4. DELIVERY AND SHIPPING. Delivery and shipping shall be as in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. OPERATING SYSTEM SOFTWARE. Operating system software shall be MS Windows Server 2016 on server computers and MS Windows 10 on workstation computers, without exception, and shall include a complete and unmodified operating system that provides system level functions.

2-2. PROCESS CONTROL SYSTEM HISTORIAN SOFTWARE. Process control historian software shall enable the operator to archive data accumulated by the FactoryTalk SE SCADA software from field devices connected to PLCs.

A license shall be issued for each machine loaded with process control software.

2-2.01. Approved Software. The process control system historian software shall be Rockwell Automation FactoryTalk Historian SE and required software components without exception.

2-2.02. Requirements. FactoryTalk Historian SE software program of 1000 points, Network FTD and FT Live Data Server and 4 Historian SE Clients.

The control system hardware is specified in another section.

2-3. SOFTWARE DOCUMENTATION. System Supplier shall relinquish all documentation supplied with the software furnished, such as user manuals, programmer guides, reference cards or keyboard templates, and related materials. In addition, System Supplier shall generate and submit to Owner and Engineer written documentation of any configuration work, modifications of the system, or setup of software done before or after installation of equipment on the site. Documentation shall be electronic. This includes any and all information on the development of any standard “objects,” “wizards,” or “scripts” created for the use in this project.

2-4. PLC SOFTWARE. The requirements for PLC software are specified in the Programmable Logic Controller section.

2-5. EXTENDED SUPPORT OR WARRANTY. The process control system software shall include the extended or comprehensive support service of the manufacturer. The service shall include all software updates and phone and personal support when needed. The service shall be for a period of one year after final acceptance and shall cover all software packages supplied under this contract.

2-6. TRAINING SERVICES. Training requirements are specified in the Instrumentation And Control System section.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. The System Supplier shall install the process control software on the control system hardware specified in another section.

3-1.01. Configuration. System Supplier shall install and properly configure any supplemental programs, modules, and software packages necessary to meet the functional requirements of the project as described in the Instrumentation and Control System and Software Control Block Description sections.

End of Section

Section 13530

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 – GENERAL

1-1. SCOPE. This section covers programmable logic controllers (PLCs), including associated input/output hardware to control process equipment and serve as the interface to field devices.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all equipment furnished under this section. Additional PLC software requirements are indicated in Software Control Block Descriptions section.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. Supplementing this section, the Drawings indicate the number and types of PLCs, locations of PLCs, and provide diagrams and schematics regarding connection and interaction with other equipment. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the Drawings.

1-2.03. I/O List. An input/output (I/O) field device signal listing is included as an appendix attached to this section.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System section.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System Section.

1-5. SPARE PARTS. Spare parts shall be furnished as follows:

Spare Part	Quantity
I/O modules	1 of each type used

PART 2 - PRODUCTS

2-1. GENERAL. All equipment furnished under this section shall be expressly selected by System Supplier for its superior quality for the intended purpose and shall comply with the following requirements.

2-1.01. Interchangeability. All programmable logic controller systems shall be products of the same manufacturer and of the same series or product line. Processors, local and remote input/output hardware, communications modules, and specialty modules such as coprocessors and ASCII modules shall be interchangeable among all I/O panels and systems. PLC modules and hardware by other manufacturers will be acceptable only if the PLC manufacturer does not offer suitable modules and hardware for the same functions.

2-1.02. Initial, Spare, and Future Memory (RAM). System Supplier shall provide adequate memory for the amount of I/O, control algorithms, and communications in the initial system.

Each programmable logic controller shall include provisions for future expansion and shall have 100 percent spare memory capacity and 100 percent spare data capacity installed. The spare memory capacity shall be documented by submitting to Engineer, during factory testing, a statement indicating the amounts of memory of all types being utilized and the total amount available in each system. The statement shall include an estimate of the total program and data memory necessary, including spare memory, based on the I/O hardware for the system, and previous programming experience.

2-1.03. Spare I/O. Each PLC input/output enclosure shall be provided with at least 20 percent spare inputs and outputs of each type. Spare I/O shall be installed, wired, and interfaced properly to the terminal strip. The spare I/O shall be in addition to any I/O installed and reserved for future process signals as may be indicated on the I/O list. In addition, each PLC input/output enclosure shall be capable of accommodating 20 percent of additional input/output capacity of each type as originally assembled, without the need for additional expansion racks, communication adapters, cables, or PLC power supplies.

2-1.04. Expandability. The System Supplier shall provide for 20% spare IO in the affected PLC after completion of this work.

2-1.05. Acceptable Manufacturers. The PLCs shall be Allen-Bradley without exception to match existing units. .

2-1.06. Signal Power Supplies. The existing regulated dc power supplies shall be evaluated in the PLC enclosure for analog inputs, digital outputs, digital

inputs. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or protected against short-circuiting. Output voltage regulation shall be as required by the instrumentation equipment supplied under another section. If the power supply does not have sufficient capacity for this additional IO, the System Supplier shall provide a power supply of sufficient capacity.

The loop power supply shall be separate from the power supply circuit for the processor and racks.

The power source for all digital inputs from field devices shall be separately fused for each digital input module. Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.

2-1.07. Appurtenances. The PLCs shall include all necessary hardware and software for a complete working system. All special rack or panel mounted power supplies, special interconnecting and programming cables, special grounding hardware, or isolation devices shall be furnished for proper operation of the equipment. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, intrinsically safe relays and current repeaters, surge suppression devices, and isolation devices shall be furnished and installed for proper operation of the equipment.

2-1.08. PLC Arrangement. The PLCs are existing and arranged as indicated on the Drawings.

2-1.09. Service Conditions. PLCs will be installed in air conditioned rooms and outdoors where the ambient temperature range is 10-32 °C. PLCs installed outdoors shall be furnished with sun shades.

2-2. LARGE PLC PROCESSOR.

2-2.01. Input/Output Hardware. Input/output hardware shall be arranged as indicated on the Drawings. Programmable logic controller systems shall support the following types of input/output modules.

120 volt ac digital input and output.

4-20 mA dc analog input and output.

All digital input/output hardware shall include isolation against surges of at least 1500 volts. All output hardware connected to inductive loads shall be supplied with surge suppression devices and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will be acceptable if they meet the following requirements.

2-2.01.01. Wiring Terminals. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

2-2.01.02. I/O Circuit Power Supply. Outputs for motor driven equipment will typically be powered from the driven equipment. Digital outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the Drawings or as coordinated with the controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or shall operate either interposing relays or relay-type digital output modules in the PLC cabinet.

2-2.01.03. Digital Input Modules. Digital input modules shall sense voltages between 100 and 130 volts ac and shall have LED indicators for each point to display the status of the field contact. Each input module shall be suitable for being connected to a separate voltage source and return. Return voltage may be common to the entire input module. Digital input modules shall provide complete electrical isolation between individual inputs. Digital input modules shall have multiple inputs.

2-2.01-04. Digital Output Modules. Digital output modules shall control voltages from 100 and 130 volts ac or 20 and 28 volts dc and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2.0 mA. Digital output modules shall provide complete electrical isolation between individual output circuits. Digital output modules shall have multiple outputs.

2-2.01.05. Relay Digital Output Modules. Not used.

2-2.01.06. Analog Input Modules. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Analog to digital conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog input modules shall have multiple inputs. Each input shall be fully isolated from the other inputs.

2-2.01.07. Analog Output Modules. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure and shall be capable of driving a 0 to 600 ohm load. Digital to analog conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog output modules shall have multiple outputs.

2-2.01.08. Panel Terminations. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2-2.01.09. Interposing Relays. Interposing relays shall be incorporated on all I/O circuits as shown on the PLC input/output listing, where required by the application of isolate foreign power sources, where the continuous output rating of the PLC relay digital or output module is not sufficient to power the connected device or equipment, or where otherwise required by the System Supplier's equipment. Interposing relays shall be provided for any digital output module output signal that leaves the PLC enclosure. Interposing relays shall be mounted in the PLC enclosure containing the output module that activates the relays.

2-3. MINI PLC PROCESSOR. Not used.

2-4. COMMUNICATIONS. Not used.

2-5. MEDIA CONVERTERS. Not used.

2-6. TELEPHONE NETWORKS. Not used.

2-7. SERIAL NETWORKS. Not Used.

2-8. PROGRAMMING DEVICE HARDWARE. The programming device shall be a portable laptop computer as specified in the Computer System Hardware section. System Supplier shall provide two interconnecting cables, each 5 meters long, to connect the computer to the programmable logic controller. The cables shall be shielded data cable and shall be terminated on both ends with the appropriate connectors. Connectors shall be labeled to identify the connected equipment.

2-8.01. Special Devices. System Supplier shall provide two sets of any special devices (such as null modems, adapter cards, interface converters, etc.) required to establish an operational programming line between the programmable logic controllers and programming device.

2-9. PROGRAMMING SOFTWARE. System Supplier shall furnish one licensed copy of PLC programming software for the Owner. The software shall be suitable for running on a laptop computer running Windows 10 operating system software. A full legal set of programming software documentation shall accompany each copy of the software. Each copy of the programming software shall include all necessary device drivers and add-on software packages.

2-9.01. Standard Product. The programming software shall be personal computer based and a standard product of the PLC manufacturer. The software shall be Allen Bradley RSLogix Studio 5000 Logix Designer Professional Edition.

2-9.02. PLC Simulation. The programming software shall include a PLC simulation feature that allows the program logic of a single PLC to be tested and

debugged entirely in the programming device without the PLC.

2-9.03. Programming Software Features. The programming software shall allow off-line development of all PLC-related programming, including user annotation of the program, and creation and printing of application programs and I/O cross-reference lists. Special programming tasks originally provided by System Supplier shall also be included.

On-line features shall include IEC-61131 standards program modification, ladder-logic modification, program language modification, monitoring of real-time ladder-logic execution, monitoring of program execution, monitoring and manipulation of timer and counter preset and present values, monitoring and forcing of physical I/O, and monitoring and manipulation of analog (register) and bit (binary) data table values. PLC and I/O hardware diagnostic and status information shall be accessible using the software in on-line mode.

2-10. SYSTEM ENCLOSURES. Programmable logic controllers and input/output hardware shall be housed in shop-assembled panels as indicated on the Drawings.

2-11. OPERATOR INTERFACE TERMINALS. Not Used.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. PLCs installation requirements are specified in Instrumentation and Control System section except as described herein.

Field check, testing, and training shall be as specified in the Instrumentation and Control System section.

3-2. CONFIGURATION.

3-2.01. PLC Programming and Configuration. Configuration services are specified in the Instrumentation and Control System section.

3-2.02. Communications Configuration. The communications shall be fully configured and installed by System Supplier. Communications shall be configured as shown on the Drawings.

End of Section

Section 13550

SOFTWARE CONTROL BLOCK DESCRIPTIONS

PART 1 - GENERAL

1-1. SCOPE. This section provides functional descriptions of the PLC and computer software requirements for the Instrumentation and Control System as indicated on the Drawings. These descriptions are intended to provide an overview of the operating concept of the plant process equipment rather than describing in detail every operating feature or interlock.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all systems described in this section.

PART 2 – PRODUCTS

2-1. GENERAL. The descriptions are applicable to the software specified in the Computer System Software section and Programmable Logic Controller section.

PART 3 - EXECUTION

3-1. PLC PROGRAMMING FUNCTIONAL REQUIREMENTS. The following paragraphs describe general configuration tasks that are required for the system PLC(s). These tasks shall be programmed in any applicable PLC. Each PLC may have multiple instances of each of these tasks or may have no instances of some or all of these tasks. The input/output lists (located in these documents as specified in the Instrumentation and Control System section) and detailed equipment control descriptions (included herein) shall be referenced to determine the requirements for each PLC.

The following paragraphs cover functional requirements of the software, which are generic and may or may not be related to any specific control loop.

3-1.01. Available Process Values. All PLC-generated process alarm, equipment status, and process variable values shall be available at any operator workstation.

3-1.02. Flow Values. Flow values shall be integrated, totalized, and stored in the PLC registers so the values displayed on the HMI computers and on the field processor will be identical.

3-1.03. System Failure. Failure of a PLC shall result in safe shutdown of associated process equipment. Interposing relays shall be provided where required to assure that equipment will revert to its fail-safe condition. Failure of any PLC or its communication shall be alarmed on the HMI computer.

3-1.04. HMI Computers. The HMI computers shall function as a monitoring system, not as a controller, for the process equipment. The computer shall download set points and other information to the PLCs, and the PLCs shall perform all control algorithms, so a temporary failure of the any HMI computer will not disrupt plant control.

3-1.05. Rack/Module Configuration. The rack and module definitions for each PLC, as well as the PLC communications configuration shall be completely configured to allow proper addressing of all field connected I/O points. This shall include configuration of any remote input/output (RIO) racks.

3-1.06. PLC Database Definition. The PLC database will include both field I/O points and internally generated points required for programming. All field I/O points and internal programming points shall be fully defined according to database naming conventions approved by Owner. As a minimum, each database point shall be provided with a tag name, engineering unit, alarm parameters, and description.

3-1.07. Analog Scaling. Each analog input and output will be appropriately scaled for use in internal PLC programming, monitoring by the HMI computers, or transmission to other PLCs. Requirements for raw count values shall be coordinated with the operator interface software to ensure compatibility.

3-1.08. Equipment Runtimes. For each equipment item whose "run" status is monitored by a PLC, an internal equipment runtime shall be accumulated by the respective PLC. The runtime procedure will monitor the status of the equipment "run" contact and, when the equipment is running, increment a software timer that maintains equipment runtime to within a one-minute resolution. The timer shall stop incrementing, but not reset, when the "run" contact indicates that the equipment is not running. The timer value shall increment an hour counter that maintains an integer value representing the equipment run time in hours. The counter value shall be available for display on the HMI computer. A manual reset of the runtime value shall be available at the HMI computers for personnel at the supervisor level and above.

3-1.09. Change-of-State Alarms. While equipment is controllable from the PLC ("in remote"), discrete output commands shall be compared to their respective process feedback status signal (where available) to verify proper execution. If the feedback status does not match the most recent output command (after an adjustable 2 to 300 second time delay), an alarm message shall be displayed on the HMI computer and the condition shall be logged as an alarm, requiring operator acknowledgment. The alarm shall remain energized until the proper discrete condition is sensed or until the operator resets the alarm through the HMI computer.

3-1.10. Equipment Availability. In general, equipment with PLC control has been provided with a local selector switch that transfers control to the PLC. The PLC shall monitor the position of this switch to determine if the equipment is available for PLC control. If the equipment is not available, the PLC program shall not attempt to implement remote manual or automatic status changes for the equipment. The PLC program may, however, need to implement special routines if equipment unavailability affects a sequence (as described in the detailed equipment descriptions).

3-1.11. Maintained/Momentary Outputs. The need for maintained or momentary control outputs shall be determined from the input/output listing and the electrical schematics. In general, equipment with only one control output indicated in the I/O list shall be programmed for a maintained control output. Equipment with two (or more) control outputs shall be programmed for momentary outputs. Provisions shall be made, in either case, to remove the active state (start, open, forward, initiate, etc.) control output when an equipment failure is sensed or when the equipment transitions from available to unavailable (local switch change).

3-1.12. Equipment Mode Changes. Unless otherwise indicated in the equipment control descriptions, equipment in automatic mode shall be transitioned to manual mode (and stopped) if the equipment fails or becomes unavailable or if the PLC processor resets.

3-1.13. Manual/Auto Bumpless Transfer. Unless otherwise indicated in the equipment control descriptions, equipment changes from automatic to manual control shall be bumpless. Equipment running or stopped in automatic mode shall remain running or stopped when manual mode is selected.

3-2. HMI FUNCTIONAL REQUIREMENTS. The following paragraphs describe general configuration tasks that are required for the HMI and related software.

3-2.01. Database. The system database, including field I/O and internal points shall be established according to the database point naming conventions approved by Owner. Database generation for field I/O shall include all required coordination with PLC level addresses. If no Owner database point naming conventions are available, the database names shall utilize an ISA or ISA-like tag name.

In the default scheme, the format of the tag name is XXX-YYY-ZA.

XXX is the ISA function designation.
YYY-ZA is the unique loop designation defined by the P&IDs.

Where possible YYY-ZA will correspond to the loop numbers on the P&IDs. Otherwise, a unique number shall be assigned. Z is a number (1, 2, 3) to designate similar loops associated with trains of equipment. A is a letter (A, B,

C) to designate identical functions within the same loop. For instance, if there are two ferric sulfate metering pumps and the loop number chosen is 222, the remote status input for pump number one might be HS-222-1 and the remote status input for pump number two might be HS-222-2. If there is more than one switch input for either pump the tag name would be HS-222-1A and the second switch would be HS-222-1B.

Function designations currently defined are listed below:

AI's (Analog Inputs)

AIT - Analytical Input	PDIT - Differential Pressure Input (Headloss)
EIT - Voltage Input	PIT - Pressure Input
EIIT - VAR Input	ST - Speed or Rate Input
FIT - Flow Input	TIT- Temperature Input
IIT - Current Input	WIT - Weight Input
JIT - Power Input	ZT - Position Input
LIT - Level Input	

AO's

AC - Residual Proportioning Control	SC - Speed or Rate Control
FC - Flow Proportioning Control	ZC - Position Control

DI's

AAH - Analytical Alarm High	PDSH - High Differential Status
AAL - Analytical Alarm Low	PS - Pressure Alarm Hi/Lo or Unspecified
FSH - High Flow Status	PSL - Low Pressure Status
FSL - Low Flow Status	PSLL - Low Pressure Cutoff Alarm
HS - Hand Switch Status	WAL - Low Weight Alarm
JA - Electrical Alarm	XA - General or Unspecified Alarm
LSH - High Level Status	YA - Equipment Overload Alarm (Failure)
LSHH - High Water Cutoff Alarm	YS - Equipment Run Status
LSL - Low Level Status	ZSC - Position Closed Status
LSLL - Low Water Cutoff Alarm	ZSO - Position Open Status

DO's

LC - PLC Generated LWCO Output

XC - General Control Output

YC - Equipment Start/Stop Command

ZCC - Equipment Close Command

ZCO - Equipment Open Command

Initially, the facility database shall be configured so all database points are defined as belonging to a specific area (as allowed by the graphical interface software). The areas designated for the facility shall be coordinated with Owner. If Owner has no existing standards for area designations, all points can be placed in appropriate areas selected by System Supplier.

3-2.02. Trend Displays. Trend displays shall be developed to present real-time and historical process data in an X-Y graph format. Real-time trends shall utilize current process values to generate temporary graphs that do not retain data values. Historical trends shall utilize historically collected data and shall access the data files directly for use in the trend display. Historical trends shall allow paging forward and back to the limits of the collected data. The trending package shall be configured to automatically retrieve historical data from the proper data file to accommodate the paging functions. Content of the trends will be determined after meeting with Owner. 6 real-time trend displays and 6 historical trend displays shall be provided.

3-2.03. Alarms. Complete system alarming shall be configured. This shall include configuration of graphical alarm displays, and configuration of audible alarms through the HMI speakers. All process or system alarms shall appear on an alarm summary screen and the alarm banner of each process graphic. Alarms and events shall be color coded on the alarm summary screen, with initial colors based on Owner conventions or the default colors associated with the graphics package. The colors may be adjusted after meeting with Owner. Alarm prioritizing and area assignments (if any) shall be coordinated with Owner at the first configuration meeting.

For LOW or LOW-LOW analog or discrete alarms which do not apply if associated equipment is not operating, provisions shall be made to prevent/Lock generation of the alarm unless the associated equipment is operating. This shall include alarms such as low amperage alarms for pumps that are not running. This may also include low flows or pressures when associated pumps are not operating (this will only apply if periodic operation of the equipment is considered normal).

All alarms/events shall be time stamped when displayed or printed. Unacknowledged alarms shall not automatically clear from the alarm summary if

they return to normal before being acknowledged.

3-2.04. Reporting. System reporting shall be accomplished using the standard operator interface software-reporting package. All necessary report development, including macro development in spreadsheets, shall be supplied to access real-time and historical data for reporting. 10 historical, monthly facility reports shall be provided.

3-2.05. Historical Data Collection. System data shall be collected for historical archiving and for use in trending and reporting functions. Requirements for data collection shall be as needed to support the trends and reports developed.

3-2.06. Manual Entry of Data. The human machine interface (HMI) computers shall allow manual entry of laboratory data and other variables, which shall then be available for display and use in reports. Operator entered commands from any of the HMI computers shall be logged at all HMI computers.

3-3. EQUIPMENT CONTROL AND CONTROL MODE OVERVIEW. The following paragraphs explain the general format and control modes that are used in the detailed equipment descriptions. These paragraphs apply to the attached, project specific, equipment control descriptions included herein.

3-3.01. General. Appended to this section are the equipment control programming requirements, with requirements for both PLC programming and the minimum operator interface functions. The HMI requirements represent the anticipated display generation requirements and shall be adjusted if the PLC programming warrants adjustment.

3-3.02. Control Modes. There are two general control modes available for the process equipment: 1) remote manual, and 2) remote auto. Remote manual control provides a means for operators to adjust equipment status or setpoint, through the HMI, using manually initiated commands. Remote automatic control provides a means for automatically changing equipment status or setpoint based on measured process parameters, calculated values, or operator setpoints. Some equipment may have more than one remote auto mode.

Descriptions for local control are included in the detailed equipment control descriptions. They are provided primarily for documentation purposes and for information. These controls are hardwired and require no programming effort.

3-4. DETAILED EQUIPMENT CONTROL DESCRIPTIONS. The following paragraphs describe specific function requirements for various software control blocks in the control system. These descriptions are intended to provide an overview of the operational concept for the facilities, rather than describing in detail every operating feature or interlock.

The existing algorithms of the existing Deep Injection PLC shall be modified, existing local operator interface terminal (OIT) screens and I/O modules added as needed and required instrumentation supplemented to accommodate the increased control of the processes of the wastewater treatment plant. New programming and program modifications are:

- Modification of existing Effluent PLC, FP-3-1, hardware and software to incorporate and facilitate control of the new Deep Well Injection Pump in the existing algorithm being executed in the PLC.

3-4.01. Deep Well Injection Pump.
The algorithm in FP-3-1 PLC is existing and is to be expanded to accommodate Pump 3. The pumping configuration is Base Load (Pump 3) and Duty where the duty pump can be either Pump 1 or Pump 2.

A. Pump 3 is the smallest pump and shall be the Base Load pump.
B. A maximum of two pumps (Lead and Duty) may run at any time. The third (Standby) pump shall be prevented from running.
C. Automatically alternate the Pump 1 and 2 selection of Duty and Standby if pump 1 or pump 2 are running and the pump has been running for 24 hours or when both pumps stop.
D. Pumps 1 and 2 are existing.

Associated Equipment
Pumps 6-2-1 (existing), Pumps 6-2-2 (existing), Pumps 6-2-3 (new),

Associated PLC
FP-3-1 PLC

Associated P&ID(s)
I-05

Local Manual Mode
Local manual control of the Pump shall be from the Pump AFD. With the pump's Local/Off/Remote selector switch at the AFD in the "Local" position the pump shall start. Pump speed is adjusted on the AFD. The pump shall stop when the Local/Off/Remote selector switch at the AFD is placed in the "Off" position.

Local Automatic Mode
None.

Remote Manual Mode
Remote manual control of the Pump shall be from the PLC. With the pump's Local/Off/Remote selector switch at the AFD in the "Remote" position and the pump is in software "Manual" as set at the HMI, the pump shall start when the

software “Start” button on the HMI is pressed. The pump shall stop when the software “Stop” button is pressed. Speed is adjusted on the HMI display.

Remote Auto Mode
Remote automatic control of the Pump shall be from the PLC. With the pump’s Local/Off/Remote selector switch at the AFD in the "Remote" position and the pump is in software “Automatic” as set at the HMI, the pump shall run as described below.

Wetwell Control
When the level in the effluent wetwell rises above an operator adjustable level setpoint as measured by existing level transmitters LIT-6-2-1 and LIT-6-2-2, and after an operator adjustable time delay, start the lead pump (Pump 3) against the closed discharge valve at minimum speed. When the pressure switch PS 6-2-3 closes indicating pressure, the discharge valve opens. The PLC shall then adjust pump speed to maintain the Effluent Pump Station wetwell level. Stop the lead pump when level falls below an operator adjustable stop level setpoint for an operator adjustable time delay setpoint.

With the lead pump running, if the wetwell level continues to rise out of the programmed deadband, with the lead pump running at >95 percent maximum speed for greater than an operator adjustable time delay setpoint, start the Duty Pump. Ramp the Duty Pump to maintain wetwell level while stopping the lead pump. Stop the duty pump when level falls below an operator adjustable stop level setpoint for an operator adjustable time delay setpoint and restart the lead pump.

Pumps shall shutdown when running in remote auto mode on Low Low Level. Pumps shall shutdown when running in remote auto or remote manual modes under the following conditions: Discharge Valve Fail to Open (50 Seconds), Pump High Temperature, No Power Available, and No Flow as measured by the existing deep well flow meter.

Flow Override Control
If flow to a deep injection well exceeds an operator entered setpoint, initially set at 17000 gpm, inhibit pump speed from increasing preventing windup of the PID loop. When flow drops to less than the setpoint reenable speed control.

Level Transmitter Selection
The operator shall select the existing level transmitter, LIT-6-2-1 or LIT-6-2-2, to be used. If the active transmitter fails, automatically switch to the other transmitter.

Alarms

- Fault,

- No Power
- Temperature High
- Fault,
- Seal Water Fail.
- Discharge Valve Fail to Open (50 Seconds)
- Wetwell Level Low (analog)
- Level Transmitter Deviation (5%)

Status Indications

The HMI shall indicate the following status:

- VFD In-Remote,
- Running,
- Discharge Valve Remote,
- Discharge Valve Open,
- Discharge Valve Closed,
- Speed Feedback,

PLC Powerup

On PLC powerup, control of the pump shall be set to remote manual mode.

Power Failure

Control of the pump shall resume with the control mode established prior to the power failure.

End of Section

Section 13563

PRESSURE AND LEVEL INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of pressure instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System section.

1-4. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings or Instrument Device Schedule.

2-1.02. Programming Device. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. PRESSURE INSTRUMENTATION.

2-2.01. Pressure and Pressure Sensing Level Transmitters. Not used.

2-2.02. Premium Accuracy Pressure Transmitters. Not used.

2-2.03. Differential Pressure Transmitters. Not used.

2-2.04. Premium Accuracy Differential Pressure Transmitters. Not used.

2-2.05. Flange-Mounted Pressure Sensing Level Transmitters. Not used.

2-2.06. Ultrasonic Level Transmitters. Not used.

2-2.07. Admittance Probe Level Transmitters. Not used.

2-2.08. Submersible Pressure Sensing Level Transmitters. Not used.

2-2.09. Bubbler System Components. Not used.

2-2.10. Fixed-Mount Float Type Level Switches. Not used.

2-2.11. Weighted Float Type Level Switches. Not used.

2-2.12. Adjustable Deadband Float Type Level Switches. Not used.

2-2.13. Electrode/Conductance Relay Level Switches. Not used.

2-2.14. Flange-Mounted Displacement Float Type Level Switches. Not used.

2-2.15. Flood Level Switches. Not used.

2-2.16. Ultrasonic Level Switches. Not used.

2-2.17. Pressure Switches. Pressure switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches mounted inside panels shall have NEMA Type1 housings. All other switches shall have weatherproof housings. Switches shall be differential type where indicated in the Instrument Device Schedule. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or viton and the connection port shall be stainless steel.

Panel-mounted and surface-mounted switches shall be provided with 1/4 inch NPT connections. All stem-mounted switches shall be provided with 1/2 inch NPT connections.

All pressure switches shall be ranged in psi and all vacuum switches in inches of water. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac.

Each switch shall be provided with a threaded end, ball-type shutoff valve. Shutoff valve materials shall be compatible with the process fluid. Where the process is not specified, valves shall have AISI Type 316 stainless steel wetted parts and Teflon seals. Multi-port valves shall have all unused ports plugged. Shutoff valve construction shall be as detailed in the Miscellaneous Instruments section.

Where indicated on the Drawings or in the Instrument Device Schedule, a diaphragm seal shall be provided for the respective switch. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless-steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the switch with the system under pressure. The lower housing shall be provided with a tapped and plugged 1/4 inch NPT flushing connection. Each diaphragm seal and the switch served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal.

Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R.

2-2.18. Radar Level Transmitters. Not used.

2.2.19. Guided Wave Level Transmitters. Not used.

2-2.20. Field-Mount Pressure Gauges. Pressure gauges shall be of the indicating dial type, with C-type phosphor bronze Bourdon tube; stainless steel rotary geared movement; phenolic or polypropylene open front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

Gauge dial shall be 4-1/2 inch size, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees or more than 270 degrees of arc.

Surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stem-mounted gauges shall be provided with 1/2 inch NPT connections. Where

indicated in the Drawings or on the Instrument Device Schedule, stem mounted gauges shall have an adjustable viewing angle to allow the gauge to be positioned for optimum viewing.

All pressure gauges shall measure in psi and all vacuum gauges in inches water. All gauges shall have a suitable range to give mid-scale readings under normal conditions. Gauge accuracy shall be 0.5 percent of scale range.

Each gauge shall be provided with a threaded end, ball-type gauge valve. Gauge valve materials shall be compatible with the measured process. Where the process is not defined, gauge valves shall have AISI Type 316 stainless steel wetted parts and Teflon seals. Multi-port gauge valves shall have all unused ports plugged. Gauge valve construction shall be as detailed in the Miscellaneous Instruments section.

Where indicated on the Drawings or in the Instrument Device Schedule, a diaphragm seal shall be provided for the respective gauge. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the gauge with the system under pressure. The lower housing shall be provided with a tapped and plugged 1/4 inch NPT flushing connection. Each diaphragm seal and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

Gauges shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All gauges, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at gauge locations prior to installation of the gauge or diaphragm seal.

Each gauge shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or the Instrument Device Schedule.

Unless otherwise indicated, mounting and installation hardware shall be Type 316L stainless steel.

Pressure gauges shall be Ashcroft "1279 Duragauge", or equal.

2-2.21. Annular Type Pressure Sensors. Not Used.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 13566

MISCELLANEOUS INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of all miscellaneous instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple miscellaneous instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

1-3 SUBMITTALS. Submittals shall be made as specified in Instrumentation and Control System section.

1-4 SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.

2-1.02. Programming Device. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. MISCELLANEOUS INSTRUMENTS.

2-2.01. Field-Mounted Process Indicators. Not used.

2-2.02. Milliamp Calibrator. Not used.

2-2.03. Pressure Calibrator. Not used.

2-2.04. Multi-function Instrument Calibrator. Not used.

2-2.05. Manometer. Not used.

2-2.06. Proximity (Door) Switches. Not used.

2-2.07. Vibration Switches. Not used.

2-2.08. Instrument Shutoff Valves. Instrument shutoff valves shall be provided for instruments as indicated on the Drawings and as detailed in the specifications. The indicated shutoff valves shall be provided by System Supplier for all instruments furnished under the Panel Mounted Instruments section, Flow Instruments section, Pressure and Level Instruments section, Analytical Instruments section, and the Miscellaneous Instruments section. Shutoff valves shall be compatible with the measured process and shall be selected in accordance with the manufacturer's recommendations for the specified process. Unused ports of multi-port gauge valves shall be plugged. An instrument shutoff valve schedule shall be submitted indicating the quantity, material, size, and associated instrument. Permanent tagging of the instrument valves is not required. However, temporary hand-written tags or other means of identification shall be provided to ensure that the appropriate valve is installed for a given instrument.

Instrument shutoff valves shall be D/A Manufacturing, Anderson-Greenwood, or equal.

2-2.09. Limit Switches. Not used.

2-2.10. Modulating Valve Positioners. Not used.

2-2.11. Current-to-Pressure Transducers. Not used.

2-2.12. Valve Position Transmitters. Not used.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 13590

NETWORK SYSTEMS

1-1. SCOPE. The Network Systems section covers the furnishing of all hardware and software for network systems for the Instrumentation and Control System. Principal components of the network systems shall be as indicated on the block diagram Drawings and as described below.

System Supplier shall furnish all necessary equipment, interconnecting cables, accessories, and appurtenances for proper network operation and to meet the functional requirements indicated on the Drawings and specified herein. Configuration of all hardware shall be provided by the System Supplier.

Equipment and services provided under the Network section shall be subject to the general requirements specified in the Instrumentation and Control System section. Supplementing this section, network data, special requirements, and options may be indicated on the Drawings

1-1.01. Control System. The Instrumentation and Control System section shall apply to all systems described herein. All applicable requirements specified in the Instrumentation and Control System section shall apply to equipment and services provided herein.

1-1.02. Network Functional Description. The network system shall provide communications between the operator workstations, servers, and PLCs.

1-2. GENERAL. System Supplier shall select the equipment for its superior quality and the intended performance. The System Supplier shall install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the following requirements.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. Supplementing this section, the Drawings indicate locations and arrangement of hardware and enclosures, provide mounting details, and may show other information regarding the connection and interaction with other equipment.

1-2.03. Governing Standards. Governing Standards for network systems shall be as specified in the Instrumentation and Control System section.

1-2.04. Power and Instrument Signals. Unless otherwise specified, electric power supply to the network equipment will be unregulated 24 volts dc or 120 volts ac.

1-2.05. Appurtenances. Special power supplies, special cable, special grounding, and isolation devices shall be furnished for proper performance of the equipment.

1-2.06. Interchangeability and Appearance. To the extent possible, components used for similar types of functions and services shall be the same brand and model line. Similar components of different network hardware shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

1-2.07. Programming Devices. A programming or system-configuring device, or software required for programming, shall be provided for systems that contain any equipment that requires such a device or software for routine maintenance and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup. Programming software shall be licensed to the Owner.

1-3. SUBMITTALS. Submittals shall be made in accordance with the requirements of the Instrumentation and Control System section and as listed below.

The submittals shall include the following items for the Network Design submittal (to be provided with the First Stage Submittals):

a. A complete network topology diagram, detailing all hardware, cabling and the interconnections between all connected equipment. Interconnections to existing installed equipment and Owner-furnished equipment shall be included in the diagram.

b. A complete listing of IP addresses to be assigned to all equipment furnished under this contract shall be provided. The assignment of IP addresses shall be coordinated with the Owner.

All above documentation shall also be provided in the O&M manuals.

1-4. DELIVERY, SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

1-5. CONNECTION TO OWNER NETWORKS. Network hardware and software

provided shall be compatible with the Owner's existing network systems wherever a system interconnection is provided. System Supplier shall verify existing systems to ensure compatibility.

All connections to the Owner's existing network shall be fully coordinated between the Owner and the System Supplier. Prior to connecting to the existing network, the System Supplier shall provide a written request to the Owner for an Owner's representative to be available when existing systems are disconnected and at the time of any new connections.

1-6. COORDINATION WITH OWNER. The System Supplier shall coordinate all demolitions, installations and rework on the existing networks with the Owner and the Engineer. No work shall be performed without the written consent of the Owner. The System Supplier shall submit a written request to perform work on the existing network, including date, time, scope of work, length of time, and any Owner's support that may be required.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum Ethernet network device stipulations.

2-2. NETWORK CABLING SPECIFICATIONS. Individual network equipment and related devices shall be coordinated with items provided in the following sections:

13591 Metallic and Fiber Optic Communications Cable and Connectors

2-3. ETHERNET NETWORK HARDWARE. Ethernet network hardware shall be provided as specified and/or as shown on the Drawings. All specified functionality of provided Ethernet network equipment shall adhere to the IEEE 802 standards. Ethernet Hubs will not be accepted for network systems. Ethernet switches shall be provided to connect multiple network segments together, selectively forwarding traffic between the segments.

2-3.01. Ethernet Switches. Not used.

2-3.02. Industrial (Panel-Mounted) Ethernet Switches. Each switch mounted in process areas shall include the following functionality:

a. Ports: Switch shall support the quantity of 10/100BaseTX ports and 100BaseFX fiber ports to meet the functionality indicated on the Drawings, with a minimum of 20% spare auto-negotiating 10/100Base-T, RJ-45 ports, and two multimode fiber uplink ports. A minimum of four UTP ports shall be provided.

b. Each switch connection shall automatically sense the network speed of the devices to which it is connected.

c. Capable of ring-based media redundancy with 30 ms recovery time.

d. Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.

e. Prioritization: IEEE 802.1p QoS Support.

f. Network Segregation: Port VLAN.

g. Management: SNMPv3 and Browser-based management shall be supported.

h. IGMP snooping supported.

i. LED indication of the link activity for each port.

j. Environmental: Suitable for installation in industrial environments. Operating Temperature Range: 0 to 60C. Optional -40 to 60C rating availability.

k. Redundant 24 VDC power supply inputs

l. Conformal coating option for use in hazardous environments.

m. Mounting: DIN-rail mounted suitable for panel installation.

n. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.

Switches shall be GarretCom Magnum 6K Series, Hirschmann RS-20 series, Moxa 508A series, N-Tron 708FX series, SIXNET SL-8MG Series , or equal.

2-3.03. Network Routers. Not used.

2-3.04. Network Firewall. Not used.

2-3.05. Ethernet Connectors. Ethernet wiring connectors shall be RJ-45 male modular plug connectors.

2-3.05.01. Standard RJ45 Connectors. Standard connectors shall be polycarbonate, clear connectors. Connectors shall conform to RJ-45 and ISO 8877 standards. Contacts shall be gold plated with a 0.5A current rating and a -25º to 60º C temperature rating. Connectors shall accept unshielded Cat-5e or Cat-6, AWG 24, solid conductor cable.

2-3.05.02. Industrial RJ45 Connectors. Not used.

2-3.06. Media Converters. Not used.

2-3.07. Frame Relay Routers. Not used.

2-4. ETHERNET NETWORK SOFTWARE. Not used.

2-3. SPARE PARTS. Spare parts shall be provided as specified below.

Spare parts	Quantity
Switches	1 of each type

PART 3 - EXECUTION

3-1. NETWORK INSTALLATION REQUIREMENTS. Additional network installation requirements are specified in the Instrumentation and Control System section. Networks shall be installed and tested in accordance with the following requirements.

3-2. NETWORK CONFIGURATION. The System Supplier shall fully configure all network devices. All device selections shall be fully coordinated with the Owner to ensure compatibility with existing systems and standards.

3-2.01. Ethernet Switches. The System Supplier shall fully configure all Ethernet switches. The following shall be configured:

a. Unused ports shall be disabled for security purposes.

b. Spanning Tree or other appropriate redundancy scheme shall be configured for all redundant links. Trunking or other bandwidth sharing redundancy schemes shall be utilized where available to minimize switching times and increase available bandwidth.

c. Management Password Security

d. Quality of Service, with any traffic to/from PLCs getting priority over all other traffic.

3-2.02. Routers. Not used.

3-2.03. Firewalls. Not used. The firewall shall be configured to deny all traffic, except for traffic specifically allowed in the ruleset.

3-2.04. Network Configuration Report. The System Supplier shall provide a configuration report to the Owner detailing all connections, addresses, and port assignments

3-2.05. Management Software. Management software shall be fully configured for all network devices provided.

3-3. NETWORK TESTING. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test.

3-3.01. Field Testing. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test. Specific testing requirements are described in the individual network specification sections.

3-3.02. Systems Check. A technical representative of System Supplier shall participate in the checkout of network systems. Systems check requirements shall be as specified in the Instrumentation and Control System section.

3-3.01. Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

3-3.02.02. Ethernet Network Minimum Test Requirements. The following minimum tests are to be performed by the System Supplier:

a. Verify Link Integrity Status LED is lit on both sides of each link
b. Verify proper operation and failover of each redundant component and redundant link.
c. Verify alarming of each link failure.
d. Verify bandwidth Usage

3-3.02.03. Ethernet Network Test Reports. Upon completion and testing of the installed Ethernet network, the System Supplier shall submit test reports to the Engineer in printed form. Test reports are to show all test results performed by the System Supplier for each port and piece of equipment. Date of calibration of the test equipment is also to be provided.

3-4. NETWORK TROUBLESHOOTING. It is the System Supplier's responsibility to provide trouble-free and reliable networks. The System Supplier shall employ any means necessary to ensure operational networks. The System Supplier shall obtain any needed test equipment, including but not limited to time-domain reflectometers, protocol analyzers and network sniffers, to troubleshoot any problems. The System Supplier shall utilize the services of a trained and certified Network Engineer that is regularly involved in troubleshooting network problems, in the event that operational or reliability problems exist. Acceptable certifications include Cisco CCNP, Cisco CCIE, or Network Professional Association Certified Network Professional (CNP).

3-5. CUSTOMER TRAINING. Training for networks is covered under Network Training in the Instrumentation and Control System section.

End of Section

Section 13591

METALLIC AND FIBER OPTIC COMMUNICATION CABLE AND CONNECTORS

PART 1 - GENERAL

1-1. SCOPE. The Metallic and Fiber Optic Communications Cable and Connectors section covers the furnishing and installation of cable systems to provide communications for the Instrumentation and Control System as indicated on the Drawings.

Accessories and appurtenances shall be provided as specified herein to provide a complete and properly operating system.

Equipment and services provided under this section shall be subject to the General Computer Control System Requirements specified in the Instrumentation and Control System Section and the Network Systems section. Supplementing the Metallic and Fiber Optic Communications Cable and Connectors section, network data, special requirements, and options are indicated on the Drawings.

1-2. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System section.

1-2.01. Qualifications. The name, address and telephone number of the proposed contractor or subcontractor, including specific personnel to perform the work shall be included with the submittals. Provide the experience record of the subcontractor and personnel in performing work similar to that specified. Include the agency, contact person, and telephone number of at least three (3) previous network installation projects completed by the proposed subcontractor. The Engineer shall review and approve the network installation subcontractor and personnel prior to any of the related work being performed. This review will be conducted during the project submittal phase, as described below.

1-2.02. Drawings and Data. All material and equipment documentation shall be submitted for review in accordance with the Submittals section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment.

Product data shall include the following in the Submittals section:

a. Cut sheets and catalog literature for proposed fiber optic cable, and fiber optic cable accessories (pigtails, connectors, etc.)
b. Manufacturer specifications and data that clearly shows that the fiber optic cable meets all requirement specified herein.

c. Sample of the proposed cable.

d. Physical dimension drawings of all fiber optic accessories.

e. Proposed fiber identification sequence and labeling.

f. Provide off-line maintenance aids and on-line diagnostics to check the performance of the communication links and interfaces of devices on the data highway.

g. Provide a Recommended Spare Parts List (RSPL).

h. Provide a list of recommended special tools for fiber installation testing or maintenance.

1-2.03. Operations and Maintenance Manuals. Operation and Maintenance Manuals shall have the following items included in addition to those items specified in other sections:

a. Description of all components.

b. Methods of connection.

c. Connection diagram.

d. OTDR trace plots for all fibers.

1-3. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section.

1-4. QUALIFICATIONS. Due to the specialized nature of installing, splicing, terminating, and testing optical fiber cable, the Contractor shall utilize personnel who are experienced in such practices. The installing Contractor or Subcontractor shall have performed similar installation and testing work on at least three projects of similar size and complexity. The personnel assigned to the installation and testing shall also have experience on at least three projects of similar size and complexity.

PART 2 - PRODUCTS

2-1. GENERAL. All fiber optic cable, fiber optic hardware and accessories shall be designed, assembled and connected in accordance with the requirements of these Specifications and the Drawings.

2-2. ETHERNET UNSHIELDED TWISTED PAIR (UTP) CABLE. Ethernet cables and connectors shall be provided for a complete and working system, and/or as shown on the Drawings. Cable for Ethernet wiring shall be UTP Cat-5e or Cat-6 cable. Cable shall be Cat-5e for network speeds up to 100 MHz, and

Cat-6 for network speeds greater than 100 MHz. Jacket color coding for cables shall be as follows:

a.	Standard Cat-5e PLC Networks.	Blue
b.	Standard Cat-5e Enterprise Networks.	White
c.	Standard Cat-6.	Yellow
d.	Crossover cables.	Red

Cable shall meet the following characteristics:

2-2.01. Category 5e UTP Cable. Not used.

2-2.02. Category 6 UTP Cable. Cat-6 cable shall meet the following requirements:

a. 24 AWG
b. 4 pair solid strand FEP Teflon insulation
c. 100 Ohm impedance
d. 1-250 MHz frequency range
e. Min attenuation 19.9 Db
f. 100 Ohm impedance
g. Min NEXT 44.3dB/100MHz
h. Min PS-NEXT 42.3dB/100MHz
i. Min ELFEXT 27.8dB/100MHz
j. Min PS-ELFEXT 24.8dB/100MHz
k. Min return loss 20.1 dB/100 MHz
l. Max delay skew 45 ns
m. Max propagation delay 540 ns

Plenum rated cable shall have FEP insulation jacketing and FEP insulation for conductors. Non plenum rated cable shall have PVC insulation jacketing and polyethylene insulation for conductors. Cat-6 cable shall be Belden 1872 or equal.

2-2.03. Ethernet Patch Cables. Pre-wired and terminated patch cables with RJ-45 connectors and lever protecting boot shall be furnished for all connections to computers, network equipment, and controller equipment except where physical conditions (i.e. length over 12 ft. or conduit size) require unterminated wire to be installed. Patch cables shall be Cat-5e for networks speeds up to 100 MHz, and

Cat-6 for networks speeds greater than 100 MHz and shall meet the requirements of Cat-5e and Cat-6 cable specified in this section. Straight through cables shall be wired using the T568-B standard for both connectors as shown in section 3-1.01. Crossover cables shall be wired using the T568-A standard for one connector and the T568-B standard for the opposite end.

2-3. FIBER OPTIC CABLE. Not used.

2-4. PLC COMMUNICATIONS MEDIA. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. The System Supplier shall be responsible for the coordination of the installation of all cable furnished hereunder. The System Supplier shall be responsible for the termination of all cable furnished hereunder.

3-1.01. Cable Damage. If the cable becomes damaged during installation, the Contractor shall stop work and notify the Engineer immediately. The Owner and Engineer will decide whether to replace the entire reel of cable or to install a splice at the damaged section. If the Owner decides to replace the entire reel of cable, the Contractor shall begin the installation at the last designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the Owner. Installation of new cable to replace damaged cable shall not be a basis of extra payment or contract completion time. In addition to installation of the new cable, the Contractor shall reimburse the Owner for the entire cost of the replacement reel of cable. This cost will be withheld from the contract price. If the Owner decides to install a splice at the damaged point, and the cable is damaged a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at the Contractor's expense.

3-1.02. Ethernet Cable Installation. Straight through cables shall be wired using the T568-B standard for both connectors as shown in the table below (connector pin numbers are left to right with the clip down). Crossover cables shall be wired using the T568-A standard for one connector and the T568B standard for the opposite end as shown in the table below.

Connector Pin	568A Wiring Conductor	568B Wiring Conductor
1 2	White/Green Green	White/Orange Orange
3 6	White/Orange Orange	White/Green Green
4 5	Blue White/Blue	Blue White/Blue
Connector Pin	568A Wiring	Connector Pin

7 8	White/Brown Brown	White/Brown Brown

3-1.03. Fiber Optic Cable Installation. Not used.

3-2. CABLE TESTING. After the network cabling has been installed, each network cable shall be tested.

3-2.01. Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

3-2.02. Ethernet UTP Cable Testing. The System Supplier shall utilize the previously specified test equipment, and additional tools as needed to validate the Ethernet UTP cable installation. All test equipment shall bear current calibration certification from a certified calibration laboratory, as appropriate. Each cable shall be tested for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs. A check off sheet shall be utilized, shall be signed by the technician testing the cables, and shall be submitted for approval. Any identified faults shall be corrected at no additional cost.

3-2.03. Fiber Optic Cable Testing. Not used.

End of Section