SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide, through the services of a single Control Systems Integrator (CSI), all components, system installation services, as well as all required and specified ancillary services, in connection with the Instrumentation and Control System (ICS).

B. The system shall include all materials, labor, tools, fees, and documentation required to furnish, install, test, and place into operation, a complete and operable ICS as shown and/or specified within this section, related ICS specification sections, and subsections within equipment specifications.

C. The system shall include all measuring elements, signal converters, transmitters, specialty cables, control panels, digital hardware and software, remote telemetry units (RTU), signal and data transmission systems, interconnecting wiring and such accessories as shown, specified, and/or required to provide the functions indicated, whether specifically mentioned or not.

D. The specifications provided within this section shall be applied to all of the Instrumentation and Control specifications, Sections 40 60 00 through 40 80 00, as well as additional specifications sections as referenced. The ICS shall be provided as a single and complete system as specified herein and as specified within the following ICS specifications:

1. Section 40 62 00 – Computer System Hardware and Ancillaries
2. Section 40 63 00 – Programmable Logic Controllers
3. Section 40 66 00 – Network and Communication Equipment
4. Section 40 67 17 - Process Control Panels and Hardware
5. Section 40 68 13 – Process Control (HMI) Software
6. Section 40 70 00 – Instrumentation for Process Systems

E. For the purposes of these specifications the Control Systems Integrator shall be referred to as the CSI. Where references are made to the SCADA System Programmer or the SSP, it shall be understood that all application software services will be provided by others outside the scope of this Contract. Although the SSP will provide programming services outside of this Contract, that in no way relieves the CSI from providing all materials, labor, documentation, etc., including coordination, programming, startup, and testing services, as necessary to ensure the complete system is fully capable of providing all specified functions,

whether provided by the CSI or programmed by the SSP. Additional clarifications of responsibilities are provided herein and within related ICS specifications, as it pertains to the relationship between the CSI and the SSP. The Owner may elect to have the SSP's cost as part of the Contractor's bid tabulation. This should be coordinated with the Owner at the time of the bid if not already defined herein.

F. The Contractor shall be ultimately responsible for installation of the ICS. However, the CSI will include installation within the scope of their contract to provide the installation of the complete system as specified. The CSI shall also coordinate this work with the Contractor to ensure that the proper type, size, and number of wires with their conduits are provided and installed. This coordination shall ensure the proper electrical power circuits are provided for all components and systems.

G. The Contractor's responsibilities shall be to provide all additional materials and work necessary to supplement the materials and work provided by the CSI; thereby satisfying all requirements that are within ICS specification sections.

H. The Contractor shall coordinate structural work, penetrations, painting, etc., as required for installation of a complete ICS. In-line or integrally mounted items (such as flow elements, level sensors, etc.) shall be installed under the supervision of the CSI.

I. The Contractor shall be responsible for coordinating interfaces between ICS equipment provided under the ICS specification sections and the equipment provided under other sections of the specifications such as OEM equipment. The Contractor shall verify and coordinate space requirements, process equipment power supply and voltage, process equipment control power supply and voltage, compatibility of control signals, details of equipment installation and interconnection. Coordination shall include distribution of approved shop drawings to all vendors, subcontractors, etc., involved in the control interface. Likewise, the Contractor shall ensure that instrumentation and control devices such as PLC equipment, network equipment, and field instruments, provided under other sections of the specifications, are compatible and of the same quality and characteristics as similar devices specified under the ICS specification sections.

J. Where specific equipment manufacturers and model numbers are provided without additional named manufacturer, the equipment is to be provided as named to match Owner's existing inventory.

1.2 SCOPE

A. The scope listed within this subsection pertains to major items of supply. Refer to the complete Contract Documents for all requirements.

B. ADD ADDITIONAL SCOPE HERE

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Division 11 – Equipment

1. Refer to individual product specifications within specification sections for additional requirements specific to those devices. Instrumentation and control equipment supplied as part of packaged systems shall be integrated into the ICS as specified and be in compliance with these specification sections. (Modify Equipment Specification sections to reference these sections).

B. Division 12 – Furnishings

1. Coordinate all ICS equipment installations within furnishings, to ensure proper fit, clearance, accessibility, environmental conditions, etc., are provided satisfactory to the equipment manufacturer and Owner.

C. Division 13 – Special Construction

1. Refer to individual product specifications within specification sections for additional requirements specific to those devices. Instrumentation and control equipment supplied as part of packaged systems shall be integrated into the ICS as specified.

D. Division 23 – Mechanical

1. Refer to individual product specifications within specification sections for additional requirements specific to those devices. Instrumentation and control equipment supplied as part of packaged systems shall be integrated into the ICS as specified and be in compliance with these sections.

E. Division 26 - Electrical

1. Where electrical subcomponents are to be provided as part of ICS equipment, but for which there is no specification, provide in accordance with Division 26- Electrical. These subcomponents shall be compatible and of the same quality and characteristics as similar devices specified under Division 26 - Electrical. If possible, the same make and/or model supplied under Division 26 shall be provided.

2. The following work shall be provided under Division 26 – Electrical:

a. Conduit, raceways, and installation of wire and cable for all instrumentation and control system signal wiring, grounding

systems, special cables and network cables except as noted.

b. Instrumentation and control system signal field wire.

c. Grounding systems for all ICS equipment.

d. Mounting of ICS electrical enclosures (i.e. control panels, SPD boxes, electronic instrumentation, etc.) with exclusion of final measuring elements of instrumentation (i.e. flow tubes, sensors in process piping, etc.) which shall be as coordinated by the Contractor.

## 1.4 DEFINITIONS AND ABBREVIATIONS

A. The following definitions and abbreviations are used throughout the specifications and drawings when referring to instrumentation and control equipment, functions, and service. Definitions and abbreviations are not listed for those used in common industry practice except where to provide explicit meaning. Refer to ISA, IEEE, and other industry standard references for those not listed herein.

CSI……Control System Integrator
ICS……Instrumentation and Control System
OIT……Operator Interface Terminal
OWS……Operator WorkStation
PID……Proportional-Integral-Derivative Control
SCADA……....Supervisory Control and Data Acquisition
SSP……SCADA System Programmer
SPD…….....Surge Protective Device
RTU……..Remote Telemetry Unit
PLC……Programmable Logic Controller

## 1.5 CODES AND STANDARDS

A. The ICS shall comply with the Owner's most recently adopted version of the National Electric Code, National Electric Safety Code, OSHA, and with all applicable federal, state, county, municipal, and electrical utility codes and regulations, as well as the Contract Documents. In the event of any conflict between these codes, regulations, and Contract Documents, the most restrictive shall apply.

B. The Instrumentation and Control System shall comply with the following codes and standards as well as any others within the specifications and drawings. In the event of any conflict between these codes, regulations, standards, and Contract Documents, the most restrictive shall apply.

1. Applicable federal, state, and local code requirements.

2. Applicable standards of the National Fire Protection Association (NFPA).

a. National Electrical Code (NEC).

b. Standard for Electrical Safety in the Workplace (NFPA 70E).

3. Applicable standards of the Underwriter's Laboratories, Inc. (U.L.)

   a. UL 508 Industrial Control Equipment.
   b. UL 508A Industrial Control Panels.

4. Applicable standards of the Institute of Electrical and Electronics Engineers (IEEE)

5. Applicable standards of the National Electrical Manufacturers Association (NEMA)

   a. NEMA 250 Enclosures for Electrical Equipment (1000 V Maximum).
   b. NEMA ICS 1 Industrial Control and Systems: General Requirements.
   c. NEMA ICS 6 Enclosures for Industrial Control and Systems.

6. Applicable standards of the International Society of Automation (ISA)

   a. S5.1 Instrumentation Symbols and Identification.
   b. S5.4 Instrument Loop Diagrams.
   c. S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
   d. TR20.00.01 Specification Forms for Process Measurement and Control Instruments.

## 1.6 SUBMITTALS

A. Submittals shall be provided in accordance with the requirements set forth in the General Conditions, Section 01 33 00 – Submittal Procedures, and as specified herein.

B. Every submittal shall have a separate section entitled "Requested Deviations from ICS Specifications" which shall clearly define and clearly explain all requested deviations and exceptions of the Instrumentation and Control System to this Specification. Only those deviations requests listed in this section will be reviewed.

C. Submit complete, orderly, and indexed submittals as listed below. Partial submittals that do not contain sufficient information for a complete review or are unclear will not be reviewed and will be returned as not approved, resubmit.

D. After all changes or corrections resulting from the review of the system supplier's drawings have been made, panels may be built and instrumentation devices may be supplied in accordance with the approved drawings. One set of "as shipped" prints shall be included in the panels when shipped from the system supplier's wiring and assembly shop.

E. The following major list of submittals shall be provided as a minimum. Major submittals are generally listed in the order they are to be provided. Refer to related ICS specification sections and equipment subsections for additional submittals and submittal requirements.

1. Preliminary Design Review/Project Plan Submittal
2. Process Instrumentation Submittal
3. SCADA System Hardware and Control Panel Submittal
4. Wireless Communications Path Field Survey and System Submittal
5. Fiber Optic Communications System Submittal
6. SCADA System Software Submittal
7. Specialty Communications Submittal
8. Training Submittal
9. Testing Submittal
10. Tools, Supplies, and Spare Parts List Submittal
11. Preliminary and Final Operation and Maintenance Manuals

F. Preliminary Design Review/Project Plan Submittal

1. The Project shall provide an overview of the proposed system including system architecture diagrams, the approach to work, the proposed work schedule indicating milestones and potential meetings, project personnel and organization, details of factory and field testing, details of training programs, and a paragraph-by-paragraph review of the specifications indicating any proposed deviations. The schedule shall illustrate all major project milestones including the following:

    a. Schedule for all subsequent project submittals, coordinated with the Contractor's overall project schedule. Schedule shall include review dates for each submittal listed under the schedule.
    b. Tentative dates for all project design review meetings.
    c. Schedule of manufacture and staging of all instrumentation and control system equipment.
    d. Schedule for all testing.
    e. Schedule for shipment of all instrumentation and control system equipment and peripheral devices.
    f. Schedule for equipment start up.
    g. Schedule for all training.
    h. Project organization chart including responsibilities and contact information.

2. No other submittals will be allowed prior to acceptance of the Project Plan.

G. Process Instrumentation Submittal

1. This submittal shall provide complete documentation of all field devices and other instrument and control equipment not specified to be submitted elsewhere. The submittal shall include an index/table of contents with cross references to individual devices and equipment.

   a. Provide data sheets for each component listing all model numbers, options and ancillary devices that are being provided.

      The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

      1) Plant Equipment Number and ISA tag number per the project P&IDs and/or Loop Diagrams.
      2) Product (item) name used herein and on the Contract Drawings.
      3) Owner Asset Number
      4) Manufacturers complete model number.
      5) Location or service of the device.
      6) Input - output characteristics.
      7) Power requirements
      8) Range, size, and graduations.
      9) Alarm and Process Set Points.
      10) Physical size with dimensions, enclosure NEMA classification, hazardous classification and mounting details.
      11) Bills of material for all equipment assemblies including quantities, manufacturer, model number, description, and tagging cross reference.
      12) Materials of construction of all components.
      13) Options included for the device.
      14) Instrument or control device sizing calculations where applicable.
      15) Certified calibration data on all flow metering devices.

   b. Provide manufacturer equipment specification sheets and literature which shall fully describe the device, the intended function, how it operates and its physical environmental and performance characteristics. Information provided shall include data supporting the information provided in

the data sheet and shall highlight all options and equipment details to clarify the specific device to be provided. As a minimum, the specification sheets shall include the following:

1) Dimension, rigid-clearances.
2) Mounting or installation details which includes mounting racks, sun shields, SPDs, cabling between sensor and transmitter (where applicable), etc.
3) Connection.
4) Electrical power or air requirements.
5) Materials of construction.
6) Environmental characteristics.
7) Performance characteristics.

c. The submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards, equipment layouts and installation details in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

H. SCADA System Hardware and Control Enclosures Submittal

1. Provide detailed drawings covering control panels, consoles and/or enclosures which shall include:

a. Cabinet assembly and layout drawings to scale. These shall include both front and interior layouts and include reference to the assembly bill of material. Dead-front panel details shall show enclosure with and without outer door. Enclosures requiring sun shields, air-conditioning units, and other equipment and accessories shall be included on layout scaled drawings.

b. Material, fabrication, and painting specifications.

c. Panel construction details such as NEMA rating, panel thickness, structural stiffeners and mounting brackets, door hinges, latches, etc.

d. Color selection samples for selection by the Owner’s representative.

e. Bills of material for each control panel assembly to include item number, device cross reference designation, manufacturer, model number, description and quantity.

f. Panel nameplate schedule for exterior and interior of control panel which lists the nameplate inscriptions and service legends of all panel equipment and components.

g. Control panel design calculations including power supply loading/sizing, UPS loading/sizing, heat dissipation/heating and cooling requirements and I/O module layout with spare point availability.

h. Panel wiring diagrams showing all power connections to equipment within and on the panel, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes and grounding. This wiring diagram shall be in ladder logic format and shall reference the appropriate loop drawing for continuations or details where required. Show all wire numbers and terminal block designations.

i. For modifications to existing equipment or control panels, provide scaled drawings and details which indicate all modifications and new equipment to be provided including updated bills of material, panel layouts, and wiring diagrams, power supply/UPS loading, etc.

2. Provide detailed loop diagrams on a single 11-in x 17-in or 8.5-in x 11-in sheet for each monitoring or control loop. The loop diagram shall show all components of the loop both analog, digital, and discrete including all relays, switches, dropping resistors, etc. which are being provided for proper operation. Loop numbers used shall correspond to the loop numbers indicated in the Contract Documents. The format shall be the International Society of Automation, Standard for Instrument Loop Diagrams, ISA-S5.4 plus the following requirements:

   a. On each diagram, present a tabular summary of (1) the output capability of the transmitting instrument, (2) the input impedance of each receiving instrument, (3) an estimate of the loop wiring impedance based on wire sizes and approximate length used, (4) the total loop impedance, (5) reserve output capacity.

   b. Show all interconnecting wiring between equipment, panels, terminal junction boxes and field mounted components. The diagrams shall show all components and panel terminal board identification numbers and all wire numbers. This diagram shall include all intermediate terminations between field elements and panels (e.g. terminal junction boxes). The diagrams shall be coordinated with the electrical contractor and shall bear his mark showing this has been done.

   c. Show location of all devices.

d. Provide instrument description showing type, manufacturer, model number, range, set points and operation (e.g. fail open, open on energize, normally closed, etc.) as applicable.

e. Show all instrument loop power or instrument air requirements back to termination on terminal block or bulkhead, fuse block (including fuse size), etc., as applicable.

3. This submittal shall provide complete documentation of the proposed hardware (PLCs, communications equipment, peripherals, etc.) including:

a. A system block diagram(s) showing in schematic form, the interconnections between major hardware components such as control centers, panels, consoles, computers and peripheral devices, telemetry equipment, local digital processors and like equipment. The block diagram shall reflect the total integration of all digital devices in the system and shall reflect any human/machine interface locations. All components shall be clearly identified with appropriate cross references to the location of each.

The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communication links.
Coordinate project IP addressing scheme and include all device addresses as part of the block diagram.

b. Data sheet for each hardware component, listing all model numbers, optional, auxiliary and ancillary devices that are being provided.

The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information.

1) Equipment Number and ISA tag number per the Loop Diagrams (where applicable).

2) Product (item) name used herein and on the Contract Drawings.

3) Manufacturers complete model number.

4) Location of the device.

5) Input - output characteristics.

6) Range, size, and graduations.

7) Physical size with dimensions, enclosure NEMA classification and mounting details.

8) Materials of construction of all components.

9) Power supply device sizing calculations where applicable.

c. Equipment specification sheets which shall fully describe the device, the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:

1) Dimensions and working clearances.

2) Mounting or installation details.

3) Connection diagrams.

4) Electrical power requirements (volts, amps).

5) Materials of construction.

6) Environmental characteristics.

7) Performance characteristics.

d. The submittal shall contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards, and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

4. The submittal shall contain a complete system Input/Output (I/O) and termination list for the local control PLC panel in Microsoft Excel format. The list shall be sorted in Excel, first by ISA tag name and second by I/O type (i.e. AI, AO, D1, DO, PI, PO. etc.) and third by I/O type. The list shall contain as a minimum the following for each active point and spare point:

a. Full ISA instrument tag (or notation as spare).

b. Type of I/O (i.e., DI, DO, AI or AO).

c. I/O terminal point physical location (panel name, PLC or RIO unit number, rack, slot, point, etc.).

d. I/O point address.

e. Point name.

f. Terminal Strip and Number

I. Wireless Communications Path Field Survey and System Submittal

1. This submittal shall provide complete documentation of the proposed hardware (wireless communications equipment, antennas, mounting structures, accessories and peripherals, etc.) including:

a. Data sheets for each hardware component, listing all model numbers, optional, auxiliary and ancillary devices

that are being provided. The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

1) Product (item) name used herein and on the Contract Drawings.

2) Manufacturer's complete model number.

3) Location of the device.

4) If using licensed frequency, list the frequency and allowable output power per the license.

5) Input - output characteristics.

6) Physical size with dimensions, enclosure NEMA classification and mounting details.

7) Materials of construction of all components.

8) Power supply device sizing calculations where applicable.

b. A complete wireless communications system block diagram(s) showing in schematic form, the interconnections between major hardware components such as: control centers, panels, telemetry equipment, wireless equipment and like equipment. The block diagram shall reflect the total integration of all wireless devices in the system. All components shall be clearly identified with appropriate cross references to the location of each. The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communication links.

2. Radio Path Field Survey Report

a. The Control System Integrator shall conduct a radio path field survey prior to installation of equipment, using field RF measurements at each site, to determine antenna type, location, bearing, and height to achieve maximum signal strength. Antenna types, cable types, and lengths shall be established to provide minimum specified performance requirements. In addition, the report shall provide the following:

1) Survey methods used and assumptions taken.

2) List of equipment and software used in the study.

3) Topographical maps of all communication paths,

with elevation profiles.

4) Signal strengths using approved wireless equipment and a listing of equipment at each site required to achieve the results. The final installed equipment configuration shall be taken into account to include losses due to lightning protection and additional connectors, cables, etc.

5) Calculations to support the 20 dB fade margin in relation to the radio received sensitivity has been attained.

6) Signal to noise radio values.

7) Access point location utilized for testing.

8) Mounting instructions for antennas at each site (coordinates, elevation, bearing, cable length, etc.)

9) Path reports giving a summary of results

3. Radio Communications “As Installed” Report & Testing: Upon completion of the installation of the wireless communications system, the CSI shall perform system testing to confirm the operating efficiency of each site. Testing shall confirm the operation of the system to the requirement as specified herein. The results of this testing, including signal strength and signal to noise ratio values shall be submitted as a benchmark of the system operation. All stations not conforming to the included system performance requirements shall be corrected and retested. Refer to Testing submittals for the required test plan documentation.

J. Fiber Optic Communications Submittal

1. This submittal shall provide complete documentation of the proposed hardware including:

a. Complete manufacturer’s product data which shall include the fiber optic cables, connectors, patch panels, spares, and test equipment. Product data sheets shall include the manufacturer’s name and complete catalog or part number for each item, the manufacturer’s descriptive literature, catalog data sheets, and any power supply requirements.

b. Complete layout and installation proposed which shows cable and routing, location of all patch panels, cable size and type, installation details including materials used for installation, estimated pulling tensions, and overall system loss for each fiber.

c. Certification of compliance stating the fiber optic cable, anticipated layout, and components are compatible and acceptable for use in compliance with specification section 40 66 33, Metallic and Fiber-Optic Communication Cabling and Connectors.

d. Fiber optic power budget for each cable run. The budget shall include transmitter power, receiver sensitivity, connector losses, cable losses, and a 3dB aging margin. Fiber optic transmission line shall maintain a minimum of 3dB safety margin.

e. Resumes of the certified installation personnel who will actually conduct and supervise the installation.

f. Catalog data sheets providing all data listed, under specification section 40 66 33, for the cable specified which includes the manufacturer's installation requirements such as maximum pulling tensions, sidewall pressures, minimum bending radius, cable reel dimensions, etc.

g. Training plan and schedule for fiber optic cable termination training.

h. Installation test reports as specified.

i. Fiber Optic Aerial Installation, provide the following:

1) List of equipment to be utilized during installation.

2) Field and route inspection report.

3) Fiber route planning details which includes a site layout and/or map with location and distance between each pole.

4) Documentation confirming the tensile strength, crush resistance, impact resistance, and repeated bending resistance of the cable. The report shall show that the specified cable load requirements will not cause fiber degradation or attenuation under the maximum load.

5) Sag, tension, and blowout charts for span lengths for the appropriate environmental conditions for CITY, STATE, as defined by the National Electric Safety Code (NESC). Values to be clearly documented shall include maximum span length, nominal sag at installation, nominal axial load, maximum vertical sag at stated environmental conditions, and maximum stringing tension with zero fiber strain. Installation sag shall be less than 1%.

6) Ability calculation of existing pole lines and guys to support the new cable, as well as any restrictions imposed by the pole owner.

7) Clearance from electric power lines and other cables that may sag near the fiber optic cable. Determine the clearances between the proposed fiber optic cable plant and existing facilities on a

case-by-case basis by referring to the National Electrical Safety Code (NESC), local safety codes, and owner standard operation procedures.

8) Safety procedure documentation.

K. SCADA System Software Submittal

1. Software submittals shall include the following as a minimum:

   a. Bill of materials with software names, vendors, and complete listings of included software modules.

   b. Standard manufacturer's literature describing the products.

   c. Description of function of software in ICS System.

   d. Minimum system (processor and memory) requirements.

   e. All software shall be licensed to the owner.

2. Submit information on the following software:

   a. Operator Interface (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).

   b. Control software (block oriented and/or ladder logic).

   c. Office-type products, such as spreadsheets, word processors, etc.

   d. Historian software

   e. Database management software.

   f. Communications software, including all applicable local and wide area network software.

   g. Authentication software

   h. Programmable logic controller programming software (where applicable).

   i. Software configuration, including:

      1) Graphic display organization.

      2) Database configuration for real-time, historical, etc. databases

      3) Trends.

      4) System security.

      5) Formats for all reports, including all required calculations.

      6) Intercommunications between software products required to implement system functions.

      7) Equipment backup and restore configuration and

requirements.

3. Control Strategies

   a. Provide control strategy documentation that includes control strategy diagrams (either block oriented logic or ladder logic diagrams, as appropriate) to describe the control of all processes. The control strategy submittals shall contain the following as a minimum:

      1) An overall description of the program structure.

      2) A detailed description of the program and how it will meet the specified control requirements. The written description shall follow the format of the functional control descriptions contained herein.

      3) A listing of inputs and outputs to the control strategy.

4. Application Software

   a. Provide application software documentation that contains program descriptions for the operation, modification and maintenance of all application programs provided for the digital system.

   b. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project.

5. PLC Program

   a. Provide the PLC software logic and documentation in ladder logic and / or function block format.

   b. The PLC program documentation shall include individual rung, network, and /or command descriptions with comments to clearly identify function and intent of each code segment. Link between “contact” and” coil” shall be clearly presented, the function of each timer described, the purpose of each subroutine labeled and defined. Program documentation shall be clear enough to allow determination of compliance with the process control logic as shown on the drawings and specified herein.

   c. Provide information on hardware and software configuration which includes the details of the performance of the communications system. Include description of drivers used, where applicable, and the impact of drivers on the controller memory configuration. Any specific communication block memory addresses shall be defined.

   d. Provide memory usage report for each controller which indicates both used and unused memory addresses.

Include constant and variable memory assignment records that tabulate area, location, number, and description of each numeric constant or variable stored in memory.

e. Provide cross reference index of I/O allocation, controller memory address, HMI or OIT graphic systems address, and HMI or OIT graphic screen where the I/O point will appear. Every physical I/O point as well calculated or virtual I/O required for the implementation of the process scheme shall be included.

f. Where existing PLC program modifications are required, provide software documentation which includes annotated software program listing, I/O address mapping, I/O arrangement, and wiring diagrams.

6. Graphic Displays

a. Provide all proposed graphic displays required to perform the control and operator interface functions specified herein. Graphic displays shall include each pop-up display type, process overview displays, trends, network overview display, and plant overview. The graphic displays shall follow the Owner's existing display design as much as possible including using established libraries of blocks and objects/widgets. Any deviation from the Owner's standards shall clearly be identified in the submittal so it can be approved.

b. Displays shall be printouts of actual process and control graphics implemented in the system. The quantity of graphic displays to be provided shall be as required to depict all monitoring and control requirements defined herein and in the contract documents. All processes and equipment shown on the P&ID drawings shall be shown in a similar manner.

c. Provide graphic displays for review by the OWNER and the ENGINEER at least sixty (60) days prior to commencement of factory testing.

d. The Contractor shall allow for one (1) major cycle of revisions to the displays prior to factory testing and one (1) minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the ENGINEER. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the OWNER.

e. Two (2) of the required submittals in each revision cycle shall be full color prints of the entire set of displays.

7. Historical Data Management and Reports

a. A complete listing of all signals to be collected and stored. This listing shall include data sampling rate and duration for which the data will be immediately accessible.

b. A complete list of all reports to be developed and/or modified.

c. Quantity and format of reports shall be coordinated with the Owner prior to this submittal.

L. Specialty Communications Submittal

1. The specialty communications submittal shall provide complete documentation of the proposed hardware and software including:

a. A network diagram(s) showing schematic form, the interconnections, either hardwired or wireless, between major hardware components such as the PLC and/or master station and field equipment (VFDs, motorized valves, etc.). The diagram shall provide details on type of communications (Modbus RTU Serial or TCP/IP, Ethernet, HART, DeviceNet, etc.) and also reference all interconnecting cabling requirements and/or wireless equipment for the data communication links between the PLC and/or master station and field equipment. All components shall be clearly identified with appropriate cross references to the location of each.

b. Data sheet for each hardware and software component, listing all model numbers, optional, auxiliary and ancillary devices that are being provided.

The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

1) Equipment number and ISA tag number per the loop diagrams, where applicable.

2) Product (item) name used herein and on the Contract Drawings.

3) Manufacturers complete model number.

4) Location of the device.

5) Input-output characteristics.

6) Range, size, and graduations.

7) Physical size with dimensions, enclosure NEMA classification, and mounting details.

8) Material of construction of all components.

9) Power supply device sizing calculations where applicable.

c. Equipment specification sheets which shall fully describe the device, the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:

1) Dimensions and working clearances.

2) Mounting or installation details.

3) Connection diagrams.

4) Electrical power requirements (volts, amps).

5) Materials of construction.

6) Environmental characteristics.

d. Submit information on the following control network software where applicable:

1) Information on the operator interface software provided by the manufacturer to interface with the control network system.

2) Software configuration and parameters to set up and operate the control network system.

3) Software graphic displays as required for monitoring and control the control network system which includes full system diagnosis, configuration, and report generation. Displays shall be printouts of each type of control graphics implemented in the control network system. The quantity of graphic displays to be provided shall be as required to depict all monitoring and control requirements defined herein and in the contract documents.

M. Training Submittals

1. Definition of each course.
2. Specific course attendance.
3. Schedule of training courses including dates, duration, equipment requirements, and location of each class.
4. Resumes of the instructors who will conduct the training class.

N. Testing Submittals

1. The test plan shall be submitted after all equipment submittals have been approved by the Owner and/or Engineer.

2. The test plan shall demonstrate that the CSI has designed and configured a system that meets the design specifications. The documents for the test plan shall be structured so that it is easily understood what the inputs are, what the predicted outputs should be, and what the actual outputs are. The test plan should have sign-off and date block for the CSI, the Contractor, and the Owner.

3. The complete test plan should include but not be limited to the following:

   a. Expected impact to Maintenance of Plant Operations (MOPO)
   b. Possible unexpected impact to Maintenance of Plant Operations (MOPO)
   c. Test assumptions and methods
   d. Test Equipment List
   e. Test Personnel Staffing and Qualifications
   f. Test Schedule with time allotted for each task
   g. System hardware and software summary.
   h. Communications test to the various PLCs for Discrete and Analog I/O data transfer.
   i. RSSI and signal to noise ratio values and result for each location.
   j. Fiber optic cable and termination tests. Long range commutation medium testing to be performed by 3rd party to Fiber installer.
   k. 100 percent I/O point test including all spare points based upon the previously submitted System I/O list.
   l. Functional and Control strategy tests.

4. Test Procedures: Submit the procedures proposed to be followed during the test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Testing may not be started until all Testing Submittals have been approved.

5. Test Documentation: Submit a copy of the signed off test procedures upon completion of each required test.

6. Parameters/Calibration Information: Specific parameter and/or calibration information entered and used to set up the field instruments furnished under this contract.

O. Tools, Supplies, and Spare Parts Lists Submittal

1. This submittal shall include a list of all required and recommended spares. The following information shall be provided in table format:
   a. Specification Section
   b. Tag name
   c. Description
   d. Quantity
   e. Manufacturer
   f. Model, part, order number
   g. Local distributor and manufacturer contact information. Contact information shall include address, phone number, and website.

P. Operational and Maintenance Manuals

1. Prior to installation of any equipment onsite, preliminary O&M manuals shall have been submitted and approved. No installation of equipment shall be permitted without the Contractor maintaining an updated version of these preliminary O&M manuals onsite for the Owner's and Engineer's use.

2. After all field changes or corrections made during installation and field check out have been completed, then all system supplier documentation, including drawings, shall be revised to reflect the "as installed, corrected and accepted" condition of the system and final record copies of O&M manuals for the system shall be provided to the Owner and Engineer for approval.

3. Final system documentation shall be provided in 3-hole type binders of archival quality (e.g. slant D or elliptical binding, vinyl with metal hinge or extra heavy weight vinyl, etc.) with a binding no larger than three (3) inches. Materials shall be printed on 8.5" x 11" or 11" x 17" tear resistant paper or ring reinforced paper where tear resistant is not available. Drawings shall be either folded to fit within an 8.5" x 11" binder or in an 11" x 17" 3-hole binder. Each binder shall include fifteen percent (15%) spare space for the addition of future material. Tear resistant paper shall be Xerox Never Tear or equal.

4. Final system documentation shall also be provided in an electronic format. Electronic documentation shall be organized and provided on CD or USB Drive which shall include all CAD drawings, manuals and word processing documents. Electronic documentation format shall be primarily Adobe .pdf with additional documents provided in AutoCAD, Microsoft Office, HTML or as approved by the Engineer or Owner. Organization of the electronic documentation shall be such as to allow point and click navigation from a table of contents to the particular documents with the ability to return to the table of contents from any location with one mouse click. Electronic documentation shall pass an anti-virus and malware check before

submitted to the Owner. Results of this check shall be provided to the Owner. The Owner reserves the right to check the electronic documentation prior to accepting it.

5. AutoCAD drawings files shall include all supporting files, symbol libraries and print configurations needed to support future modifications and properly print additional drawing copies.

6. All electronic media (i.e. software, electronic documentation, configuration files/reports, device backups, etc.) shall be provided with two (2) backup copies, each organized into a separate binder. Media storage binders shall include but not be limited to the following:

    a. Table of contents

    b. Archival media holders (e.g. CD, DVD, USB Drive, etc.)

    c. Support contacts (i.e. company, phone, internet link, etc.)

    d. Software system requirements and installation instructions

7. Laminated or water/tear resistant copies of all applicable instrumentation and control system drawings shall be supplied in drawing pocket of each control enclosure after “as installed, corrected, and accepted" revisions have been made to the enclosure.

8. Operation and Maintenance manuals shall include but not be limited to the following:

    a. Manufacturer standard O&M manuals for all equipment and software furnished.

    b. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.

    c. The manuals shall contain all illustrations, detailed drawings, wiring diagrams and instructions necessary for installing, operating and maintaining the equipment.

    d. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable.

    e. A functional description of the entire system, with references to drawings and instructions.

    f. A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.

    g. Copies of well annotated “As Built” program listings of all application software provided and developed for this project

contract. Listings shall reflect any modifications made during testing of the installed control system.

h. ISA calibration data sheets which includes specific instrument parameter information entered and used to set up the device.

i. A complete list of the equipment supplied, including serial numbers, ranges, configuration parameters and other pertinent data.

j. Full specifications on each item.

k. Detailed service, maintenance and operation instructions for each item supplied.

l. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

m. Complete parts lists with stock numbers and name, address and telephone number of the local supplier.

n. References to manufacturers' standard literature where applicable.

o. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

p. The operating instructions shall clearly describe the step by step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.

q. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.

r. Testing documentation with Owner / Engineer acceptance signatures shall be provided.

1.7 MEETINGS

A. The Contractor shall be required to give the Owner and their representatives, at least two weeks' notice prior to any scheduled meetings. The notice may be shortened by consent.

B. Preliminary Site Testing Meeting: A preliminary site testing meeting shall be conducted by the Contractor for the Owner and Engineer, to ensure site readiness, testing strategies and proper coordination between parties

related or involved in testing the ICS. The Contractor shall be responsible for arranging the on-site meeting after the Site Testing Plan has been approved and no earlier than 3 weeks prior to testing. The Engineer must be satisfied that the site is ready and that the testing will be performed to their satisfaction prior to any documented ICS testing being performed. The Contractor shall arrange for detailed meeting minutes to be recorded, approved, and distributed to meeting attendees. Additional meetings may be required at the discretion of the Owner and Engineer to resolve specific action items not addressed in the preliminary site testing meeting. Two weeks prior to the meeting the Contractor shall submit the following for approval.

1. A proposed list of meeting attendees including organization and phone number.
2. A proposed meeting agenda.
3. A list of personnel to be involved in the testing including their responsibilities, qualifications, and phone numbers.
4. A list of tasks requiring Owner, Engineer or outside party involvement in testing.
5. A testing schedule that coordinates the ICS testing with the operability of the specific equipment being tested.

C. Graphic Design and Review Meetings: The CSI shall conduct graphic design and review meetings with the Owner and Engineer at the Owner's location. The purpose of the first design meeting shall be to establish conventions, standards, formats, configurations, for screen development and for discussion of preliminary graphical displays. The CSI is encouraged to submit preliminary information in advance of this meeting to facilitate discussions. These graphic review meetings are for the CSI to present work completed, as a minimum, at the 30% level for comment by the Owner and Engineer and for any coordination and information requests. The intent is to achieve and acceptability of software prior to the factory demonstration testing in which all parties are confident of the end-product results. Acceptability of software implementation is at the Owner's discretion and must be achieved prior to scheduling the Factory Acceptance Test. A minimum of two graphic review meetings, four (4) hours per meeting, shall be conducted but of sufficient quantity to adequately address all issues and concerns of the Owner in developing a quality control system.

D. Additional meetings may be required at the discretion of the Owner and Engineer, to resolve specific action items not addressed in the preliminary design review or preliminary site testing meeting.

1.8 CONTROL SYSTEM INTEGRATOR

A. The Control System Integrator shall be regularly engaged in the detailed design, fabrication, installation and startup of instrumentation and control systems for water and wastewater treatment facilities in the state of the

project location. Any CSI that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five calendar years shall not be acceptable.

B. Where specific manufacturers and/or models of major hardware or software products (PLC, software, Network Equipment, Wireless Equipment, etc.) are specified to be used on this project, the CSI shall have completed at least three projects using that specified hardware or software and of a similar size and scope. As used herein, the term "completed" shall mean that a project has been brought to final completion and final payment has been made.

C. Control System Integrators shall meet the following minimum qualifications:

1. A minimum of 7 years' experience with at least 5 years performing water / wastewater projects

2. References for 3 completed projects of like size and application to the project specified herein

3. Project bonding capacity of $2 million

4. UL 508 certified panel shop

5. Electrical contractors license in the project site's state.

6. On staff licensed professional engineer registered in the project site's state, if required to perform engineering services as specified to implement this project.

D. The listing of acceptable Control System Integrators in this specification in no way relieves the Control System Integrator from meeting the qualifications specified herein. Acceptable Control System Integrators shall be as follows:

1. Revere Control Systems: 2240 Rocky Ridge Road, Birmingham, AL, 35216; (205) 824-0004; www.reverecontrol.com

2. Commerce Controls: 8875 Hidden River Parkway, Suite 340 Tampa, Florida 33637; (941) 347-4483

3. Or Approved Equal. (Will require written submission of background/qualification information for Owner/Engineer review. Approval must be granted, in writing, prior to submission of bids.)

E. The Owner shall have the right of access to the CSI's facilities and the facilities of their equipment suppliers to inspect materials and parts, witness inspections, tests, and work in progress, and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The CSI and their equipment suppliers shall furnish office space, supplies and services required for these surveillance activities. The Owner reserves the right to choose the integrator based on their own criteria if necessary.

1.9 QUALITY ASSURANCE

A. The listing of specific products in this specification in no way relieves the Contractor of furnishing equipment which shall meet the performance and quality criteria specified herein.

B. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.

C. For uniformity, only one manufacturer will be accepted for each type of product.

D. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.

E. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble free service.

F. Electronic equipment shall be suitable for the specified environmental conditions.

G. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these specifications and drawings, shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All materials, equipment, and devices shall, as a minimum, meet the requirements of UL, where UL Standards are established for those items, and the requirements of NFPA-70. All control panels shall comply with the requirements of UL 508A for Industrial Control Panels. All items shall be new and unused unless specified or indicated otherwise.

B. Prior to shipment of field panels, equipment, and instruments provide corrosive inhibitive vapor capsules in shipping containers as recommended by the manufacturer or distributor.

C. Properly store, adequately protect, and carefully handle equipment and materials to prevent damage before and during installation. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations. Replace damaged or defective items.

D. All equipment shall be the latest and proven design. Specifications and drawings call attention to certain features, but do not purport to cover all details entering into design of the instrumentation system. The completed system shall be compatible with functions required and the equipment furnished by the Contractor.

E. All electrical components of the system shall operate on 120 volt, single phase, 60 Hz power source, except as otherwise noted in the Specifications. Drawings and specifications indicate the energy sources that will be provided. Any other devices necessary to obtain proper operation of the instrumentation and control system from these energy sources shall be furnished with the system.

F. All necessary fuses or switches required by the instrumentation manufacturer for equipment shall be provided with the equipment. All instruments requiring internal power supply shall have internal on-off switches.

G. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The CSI shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the ICS. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.

H. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.

I. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

J. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.

K. Field equipment, including instrumentation and panels, may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient

temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets and interconnecting hardware shall be aluminum, 316 stainless steel, or as shown on the installation detail drawings.

2.2 TOOLS, SUPPLIES, AND SPARE PARTS

A. The CSI shall provide supplies as needed or as required by the Owner during the specified warranty period. All fuses consumed during installation, testing, start-up, the system availability demonstration, and the warranty period shall be replaced by the Contractor.

B. Provide spare parts for items of ICS equipment as recommended by the manufacturer and in accordance with the Contract Documents.

C. Furnish all spares in moisture-proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.

D. Refer to individual product specifications for additional requirements specific to those devices.

2.3 SIGNAL TRANSMISSION

A. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the ICS equipment.

B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers and subcontractors.

C. The CSI shall provide 24 VDC power supplies for signals and instruments where applicable and as required inside panels, controls, etc. Where two-wire instruments transmit directly to the instrumentation and control system, the CSI shall provide power supplies at the PLC-equipped control panels for those instruments. Where four-wire instruments with on-board loop power supplies transmit directly to the instrumentation and control system, the CSI shall provide necessary signal isolators or shall otherwise isolate the input from the ICS loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator or single loop controller with integral loop power supply is included in the loop.

D. Analog signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 mA and shall operate at 24 VDC. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. All cable shields shall be grounded at one end only, at the control panel, with

terminals bonded to the panel ground bus. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels and appurtenances.

E. Non-standard analog transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 mA signal.

F. All discrete inputs to equipment and PLC's, from field devices, starters, panels, etc., shall be dry contacts in the field device or equipment, powered from the PLCs, unless specified otherwise. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC.

G. All discrete outputs from local control panels and Control and Information System PLCs, to field devices, starters, panels, etc., shall be 120 VAC / 28 VDC 5A dry contacts. Output contacts may be powered from the field equipment, or powered from 24 VDC / 120 VAC sourced from PLCs cabinet power system, as required to interface with field equipment. Outputs to solenoid valves, horns, and strobe lights shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

H. Discrete signals between starters, panels, etc. where 120 VAC is utilized shall be clearly identified in the starter, panel, etc. as being powered from a different power supply, than other starter/panel components. Where applicable, warning signs shall be affixed inside the starter, panel, etc., stating that the panel is energized from multiple sources. Output contacts in the starter, panel, etc. which are powered from other locations shall be provided with special tags and/or color coding. Disconnecting terminal strips shall be provided for such contacts. The above requirements shall apply to all starters and panels, regardless of supplier.

## 2.4 NAMEPLATES

A. All items of equipment listed in the instrument schedule, control panels, and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the Engineer's approval.

B. Nameplates shall be made of 1/16 inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16 inch high on a black background.

C. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above

methods, it shall be drilled and attached to the associated device by means of stainless steel wire.

D. Nameplates for field instruments shall be 316 stainless steel, minimum of 1”H x 4”W and attached with stainless steel wire.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The CSI shall provide the Contractor and Engineer a periodic written report detailing progress of start-up. This report shall include specific tabulations of devices on which start-up has been completed.

B. Equipment shall be located so that it is accessible for operation and maintenance. The CSI shall examine the Contract Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of ICS equipment.

C. Top penetrations of cabinets are not permitted, No exceptions. All conduit penetrations shall be located at bottom of panel. Hole seals or plugs will not be permitted. Contractor is responsible for replacing cabinets in the event a top penetration is made to any cabinet.

D. Instrumentation and Control System equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

E. The CSI shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the CSI shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The CSI shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel, to assure proper space and access (front, rear, side).

F. Two complete sets of approved shop drawings shall be kept at the job site during all on-site construction. Both sets shall be identically marked up to reflect any modifications made during field installation or start-up. All markings shall be verified and initialed by the Engineer or his designated representative. Following completion of installation and the operational readiness test, one set of the marked up drawings shall be provided to the Engineer, the other retained by the CSI for incorporation of the mark-ups into final as-built documentation.

G. All work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising there from.

H. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

I. The Contractor shall take steps to keep electrical and control enclosures clean and free of contaminants throughout installation. Cleaning after installation is not acceptable. Under no circumstances are electrical and control enclosures to be cleaned using compressed air to blow out dust, causing contaminants to be forced into sensitive electronics.

J. Provisions shall be made to completely capture filings (metal, etc.) when drilling into enclosures, to prevent contamination of electrical equipment.

K. Upon completion of the instrumentation and control work, the Contractor shall thoroughly clean all soiled surfaces of installed equipment and materials and remove all surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

3.2 WIRING AND GROUNDING

A. The following wiring practice guidelines shall be used in order to minimize ground loops, to minimize electromagnetic interference/radio frequency interference (EMI/RFI) to this equipment, and to provide maximum practical immunity from damage resulting from lightning-induced transients.

B. Common wires or conductors shall not be utilized (either within panels or external to panels or for grounding of field devices) for both signal shield or signal grounding and for safety grounds.

C. Exposed wire lengths extending from within shielded signal cables shall be minimized to reduce pick-up of EMI/RFI by signal circuits. Exposed lengths of less than one inch are preferred, and a maximum exposed length of two inches may be permitted where necessary. No splicing of signal wires is permitted.

D. All signal wiring shall be shielded, both within panels and external to panels. Unless otherwise specified, all signal wiring shall be No. 18 AWG stranded tinned two-conductor twisted pair, with 100 percent coverage aluminized Mylar or aluminized polyester shield and tinned copper drain wire.

E. Signal wiring within outdoor or indoor field device enclosures shall conform to the same requirements as panel wiring.

F. The shield on each process instrumentation cable shall be continuous from source to destination and grounded at one end only. In general, grounding of signal cable shields shall be done at the control panel end. The signal

cable for no signal shall share a common cable shield grounding wire with the signal cable shield for any other signal and shall not share a common grounding wire with any other circuit. The length of no signal cable shield grounding wire shall not exceed two inches, with less than one-inch maximum length preferred.

G. All indoor and outdoor instruments and panel enclosures shall be properly grounded by a good earth grounding rod or grid using the practice defined in Section 800.40 of the National Electric Code. Ground jumper wire to a signal ground wire, within a control panel or instrument 4-wire surge protection enclosure, is unacceptable. Ground testing shall result in a reading of less than 5 ohms.

3.3 TESTING, GENERAL REQUIREMENTS

A. The CSI shall test all equipment hardware and software at the factory prior to shipment. As a minimum, testing shall include the following:

1. Unwitnessed Factory Testing (UFT)

2. Factory Acceptance Testing (FAT)

3. Operational Readiness Testing (ORT).

4. System Acceptance Testing (SAT).

B. Each test shall be in the cause-and-effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

C. All tests shall be conducted in accordance with prior Engineer approved procedures, forms, and check lists. Each specific test to be performed shall be described and a space provided after it for sign off by the appropriate party after its satisfactory completion.

D. Copies of these sign off test procedures, forms, and check lists will constitute the required test documentation.

E. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data; provide suitable means of simulation. Define these simulation techniques in the test procedures.

F. The Contractor shall require the CSI to coordinate all of his testing with him, all affected Subcontractors, and the Owner.

G. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved test procedures.

H. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

I. The CSI shall furnish the services of servicemen, all special calibration and test equipment, and labor to perform the field tests.

3.4 UNWITNESSED FACTORY TESTING (UFT)

A. Prior to the performance of a Witnessed Factory Acceptance Test, the CSI shall perform an Unwitnessed Factory Test.

B. The purpose of this test is to inspect and test the system to ensure it is operational and ready for the Factory Acceptance Test.

C. This test includes all of the components of the Witnessed Testing and the CSI shall provide documentation of the completion of this testing as part of the request to perform the Witnessed Testing.

D. The CSI shall submit the Unwitnessed Test results for review and approval, by the Owner and Engineer, prior to the Factory Acceptance Test.

3.5 FACTORY ACCEPTANCE TESTING (FAT)

A. The entire system except for primary elements, final control elements, and field mounted transmitters, shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions by installing a test PLC program, provided by the CSI, which tests all I/O. The CSI shall make provisions to view and manipulate this I/O, by all participants, during the factory testing.

B. PLC configuration settings shall be submitted to the Engineer for approval. The test PLC program and configuration settings from the CSI, described above, shall be forward the Engineer at least two weeks prior to the FAT, for review of configuration setting, control logic, and I/O addressing.

C. All panels and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, specifications, and Contract Drawings.

D. Factory acceptance testing shall take place over a contiguous time period after all factory fabrication has been completed, after completion of UFT and after acceptance.

E. The test shall verify the functionality, performance, and stability of the hardware and configuration. The system must operate continually for 24 hours without failure before the test shall be judged successful. All deficiencies identified during testing shall be corrected and retested prior to the beginning this continuous operation test.

F. Any malfunction during the tests shall be analyzed, and corrections made by the CSI at a later time. Engineer and / or Owner will not wait for corrections to be made to retest. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

G. Owner and / or Engineer reserve the right to terminate FAT or if excessive malfunctions or similar occurrences indicate more UFT is required.

H. The FAT process will restart from the beginning of testing no earlier than 14 days from previous termination if retesting is required due to excessive malfunctions or similar occurrences. Owner and / or Engineer is not responsible for the delays this may cause even if the project delays result in liquidated damages.

I. Upon completion of the FAT using the test PLC programming provided by the CSI as described above, each control panel PLC shall be made available to the SSP for Final Application Program Installation (FAPI). The final application programming has been prepared and will be installed by the SSP.

J. The CSI shall provide a suitable environment at the factory facility for storage and testing including all power sources, convenient access, networking and communications cables, desk space, and shall assist the engineer in the execution of the FAPI.

K. Successful completion of this test, as determined by the Engineer, shall be the basis for approval of the system to be shipped to the site. No equipment shall be shipped until the Engineer has reviewed all test results, and approved the system as ready for shipment.

L. The Engineer and the Owner reserve the right to attend the factory acceptance testing in its entirety. Two weeks' notice shall be given prior to the start of testing.

M. All costs associated with the Factory Testing, including travel, lodging, rental car, air travel (if required), and meals, for one of the Owner's representatives, shall be the responsibility of the CSI and shall be included in the contract price unless within 100 miles from Owner's location. Cost associated with air travel, for the Owner's representative, shall be included for originating and terminating at the Owner's facility location. If the Owner does not attend the FAT, credit should be given back to the Owner in the value that was used as part of the bid. The amount shall be verified by the Engineer.

3.6 OPERATIONAL READINESS TESTING (ORT)

A. The entire system shall be certified (inspected, calibrated, tested, and documented) that it is ready for operation. Each specified function shall be verified on a paragraph-by-paragraph, loop-by-loop and site-by-site basis.

B. The Owner and/or Engineer reserves the right to witness any test, inspection, calibration, or start-up activity. Acceptance by the Engineer of any plan, report, or documentation relating to any testing or commissioning activity specified herein, shall not relieve the Contractor of his responsibility for meeting all specified requirements.

C. The CSI shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

D. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Institute for Standards and Technology (NIST) and shall be certified.

E. The CSI shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

F. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

G. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to over-voltage, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

H. After completion of instrumentation installation and calibration, the CSI shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be

signed by all representatives involved for each loop test. Software trimming of analog I/O will not be permitted such as SCP functions.

I. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and the Contract Documents.

1. The Loop/Component Inspections and Tests shall be implemented using Engineer approved forms and check lists.

2. The Contractor shall require the CSI to maintain the Loop Status Reports and Components Calibration sheets at the job-site and make them available to the Engineer/Owner at any time.

3. These inspections and tests do not require witnessing. However, the Engineer will review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Tests. Any deficiencies found shall be corrected.

3.7 SYSTEM ACCEPTANCE TEST (SAT)

A. Successful completion of the operational readiness test, as determined by the Owner and/or Engineer, shall be the basis for starting the witnessed system acceptance test. The Engineer shall approve the ORT test results and the Engineer and Owner shall be given two weeks' notice prior to the start of the System Acceptance Test.

B. The system acceptance test shall repeat loop and functional testing done during the operational readiness test in order to demonstrate to the Owner and Engineer that the system has been started up, is operating, and is in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop and site-by-site basis.

C. The SCADA system and PLC programming will be tested by the SSP for the new control system during the system acceptance testing. The CSI shall be available for testing services, as necessary, to ensure the complete system is fully capable of providing all specified functions, whether provided or programmed by the CSI or by the SSP. The CSI shall include (7) days minimum for testing and startup service with the SSP.

D. The following documentation shall be made available to the Engineer during the test:

1. All Contract Drawings and Specifications, addenda, and change orders.

2. Provide I/O Test Documentation

3. One copy of all O&M Manuals shall be made available to the Engineer at the job-site both before and during testing.

E. Any malfunction during the tests shall be analyzed, and corrections made by the CSI. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

F. Owner and / or Engineer reserve the right to terminate SAT or if excessive malfunctions or similar occurrences indicate more ORT is required.

G. The SAT process will restart from the beginning of testing no earlier than 14 days from previous termination if retesting is required due to excessive malfunctions or similar occurrences. Owner and / or Engineer is not responsible for the delays this may cause even if the project delays result in liquidated damages.

H. After all functions have been tested and all corrections made, the system shall operate continuously for 30 days without failure before this test will be considered successful and is dependent on processes.

I. The total availability of the system shall be greater than 99.5 percent during this test period. Availability shall be defined as "Avail. = (Total Time-Down Time,) / Total Time x 100%". Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided, shall not contribute to the availability test times above.

3.8 TRAINING

A. The CSI shall provide project specific classroom training at the Owners site or designated location. Training shall be provided for the operation and maintenance of all equipment provided, as well as site specific installation configuration training for the system as a whole.

B. Each student shall be provided with training materials. All training materials shall be provided in hardcopy as well as on a training CD, with all materials in Microsoft Office or Adobe pdf file format. All training CD's shall be updated with final configuration information and resubmitted for approval. Final CD media shall be archival quality.

C. The Owner reserves the right to video tape any and all training sessions for the purposes of future or refresher training.

D. To facilitate the Owner's operations staff scheduling, training shall be conducted in two (2) four-hour sessions, a morning session and an afternoon session. Morning and afternoon sessions will cover the same material on a given day. The training shall consist of one (1) day minimum with (2) sessions per day.

E. Maintenance training shall be provided to designated maintenance personnel, so that each component may be maintained without the assistance of outside organizations. The training shall be extensive so that

after training, personnel shall be able to identify component malfunctions and repair components to the board/module replacement level. Training shall cover the entire system including controls and field equipment.

F. Maintenance training shall be conducted in one (1) session, with a minimum of 8 hours of instruction.

G. Under the scope of this project, the CSI will not be responsible for providing PLC and HMI control programming and logic. Specific training should therefore include, but not be limited to the following: System architecture and interconnection, wiring, field instrumentation, and PLC hardware including maintenance and trouble-shooting.

H. Refer to related specification sections for additional training requirements.

I. Training sessions shall be carried out to the satisfaction of the Owner before final acceptance will be provided.

3.7 WARRANTY

A. The warranty for the ICS shall be provided as specified in Section 01 60 00 – Product Requirements, and as specified herein. The warranty period for this system shall be for one year and shall begin upon acceptance of the complete system by the Owner. During this warranty period, the CSI shall provide, at no additional cost to the Owner, the services of a trained, competent, field service engineer who shall arrive on site within 36 hours of notification by the Owner or Engineer, to repair and/or replace any faulty device or equipment supplied by the system supplier as part of this Instrumentation and Control System. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed, and list materials used. A copy of all service reports shall be delivered to the Owner on or before the next business day.

B. The CSI shall be capable of providing, after the warranty period for this system expires, a 1-year renewable service contract whereby a trained, competent field service engineer shall arrive on site within 36 hours of notification by the Owner. Information relative to charges for such service and availability of such service shall be submitted to the Owner and the Engineer.

C. Components shall be furnished to the manufacturer's standard for service intended, unless otherwise indicated in the Specifications or on the Contract Drawings.

3.8 MAINTENANCE SERVICE AGREEMENT

A. Prior to substantial completion, the CSI shall prepare and submit to the Owner a maintenance agreement which includes the following as part of the bid price:

1. Duration of two (2) years following a successful and complete System Acceptance Test (SAT).
2. CSI experienced field personnel provide services on the ICS to be maintained.
3. Maintenance service agreement includes all equipment, software, programming, instruments, and devices furnished under this project.
4. All materials and labor required for preventative maintenance which includes the CSI's site visits (Total of 3 per year).
5. Repair and/or replace all components or software found to be faulty or defective. Provide Owner a list of items repaired or replaced as specified below.
6. Perform routine computer system software diagnostics and housekeeping.
7. Software Updates and New Releases:
    a. Provide Owner with a list of available PLC, HMI, server, and network hardware updates released since last visit. Updates include patches and maintenance releases, which do not include major new releases unless Owner has purchased these updates from the vendor's software package. CSI field personnel shall implement these updates if Owner requires them.
    b. Install selected updates in accordance with manufacturer's instructions. Verify updates are working properly and not producing unintended consequences. Restore older versions when unintended consequences or other unacceptable performance is discovered or suspected.
    c. Update network security devices to provide protection for newly discovered vulnerabilities and ensure proper configuration of devices is still intact and has not been corrupted.
    d. CSI shall complete these updates in a timely manner, as early in the visit as possible, coordinating with system operators and incorporating any documentation associated with the upgrades into the O&M manuals and software documentation.

B. Submit a site visit report which includes records of inspection, maintenance, calibration, repair, and replacement within one (1) week after each site visit.

C. At the end of the maintenance agreement term, the CSI shall submit a report documenting the status of the equipment and any additional spare parts recommended.

D. Telephone support provided by the CSI shall be up to 200 hours within the two (2) years.

E. Software subscriptions along with additional tasks and work items, specified for specific needs of the ICS, shall be included in the maintenance service agreement. These items and scope of services shall be identified and listed in the bid contract.

F. All onsite visits shall be scheduled during normal plant operating hours unless otherwise required, coordinated, and approved by the Owner.

END OF SECTION

# SECTION 40 62 00

# PROCESS CONTROL SYSTEMS – COMPUTER SYSTEM HARDWARE

## PART 1 - GENERAL

### 1.1 THE REQUIREMENT

A. The Control Systems Integrator (CSI) shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation the Computer Hardware.

B. The Controls System Integrator shall provide all software, operating systems, network interface, special drivers and network integrations required and shall perform all configuration, commissioning, troubleshooting, and diagnostics required for a complete and functional system.

C. The equipment specifications included herein define a level of performance based on current technology to establish a basis of bid. However, it is recognized that computer technology changes rapidly and that this technology level, while leading edge today, will be surpassed by the time equipment will be purchased. It is therefore expected that a comparable, leading edge, value in computer technology will be provided at the time of purchase.

D. The intent of this section is to provide the components to implement a fully functional SCADA monitoring and control system with an Ethernet-based network, linking all of the plant control equipment and providing for complete monitoring, control and data analysis for the plant operations and process control.

E. Cable systems shall be provided for various requirements, including but not limited to data network, fiber optic, printer, power cables, and others as required. Cables shall be routed in suitable conduits, cable ducts, channel and wire ducts to provide a clean, safe, non-obtrusive and workmanlike installation.

F. All software licenses and support contracts shall be registered to Charlotte County Utilities. The particular contact person and address shall be coordinated with the Owner prior to purchasing of any equipment or software. The CSI shall provide documentation within the SCADA System Hardware and Control Panel Submittal which states that all software provided and purchased under this contract will be registered in the Owner's name and that this coordination has been done. Proof of this ownership shall be provided prior to Substantial Completion.

B. Related Sections:

LIST ANY SECTIONS RELATED

### 1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. A description of how the unit can be configured to address other equipment; including, but not limited to:
         1) Operator Workstation Computers
         2) Control Panel Computers
         3) Other network components.

PART 2 - PRODUCTS

2.1 SCADA CLIENT OPERATOR WORKSTATION COMPUTER

A. General
   1. Provide equipment to operate on 115 VAC, single phase, 60-hertz electrical service.
   2. Provide all necessary items for installation, including mounting brackets, interconnecting cables, hardware, and appurtenances.
   3. The requirements are depending on the VTScada configured tag count or expected tag count, the minimum requirement may differ from the specified requirements. Refer to VTScada's recommended computer and server specifications.

B. Workstation
   4. The computer shall be a minimum 3.6 GHz, 8 Core Intel i7-11700K based processor with 16 GB DDR4 UDIMM memory and dual 2 GB SATA Solid State Drives configured in a RAID 1 configuration and Intel Integrated graphics.
   5. The computer shall be provided with 6 USB 3.0 ports, 2 Gigabit Ethernet LAN ports, audio speakers, wireless mouse/keyboard, in a tower configuration.
   6. The computer shall include Windows 10 Professional operating system with Microsoft Office Professional, latest edition.
   7. Network Card: 1000Base-T PCI Network interface. Computer shall have two (2) Network interfaces. One (1) for Control network and one (1) for the SCADA Network.
   8. The computer displays shall be 27-inch 4K flat-panel wide screen displays (2) with adjustable stands, Dell, HP or approved equal.
   9. Graphics Accelerator card: Intel UHD Graphics 630, two (2) Display Ports for multiple monitor configuration
   10. Provide all documentation, manuals, and licenses.
   11. Environmental conditions of a Control room environment. (Refer to Division 1, General Requirements, for environmental requirements).
   12. Safety/Regulatory: UL, FCC B, approved.

C. Products and Manufacturers:
   1. Dell or HP, or latest version in class or approved equal.

## 2.2 SCADA CLIENT CONTROL PANEL COMPUTER

A. General
   1. A Control Panel Computer shall be provided that is capable of monitoring and control of VTScada process parameters as specified herein.
   2. The requirements are depending on the VTScada configured tag count or expected tag count, the minimum requirement may differ from the specified requirements. Refer to VTScada's recommended computer and server specifications.

B. Computer
   1. The computer shall be a minimum 2.3 GHz, Intel -i3-6100U processor with 16 GB, DDR4 SDRAM memory and dual 1TB SSD SATA Hard Drives configured in a RAID 1 configuration.
   2. The computer shall be provided with 2 USB 2.0 ports, 2 USB 3.0 ports, 3 Ethernet LAN ports, 1 RS-232 port, and 1 RS-485 port.
   3. Graphics Accelerator card: Intel UHD Graphics 630, two (2) Display Ports for multiple monitor configuration.
   4. The computer displays shall be 27-inch 4K flat-panel wide screen displays (2) with adjustable stands, Dell, HP or approved equal.
   5. Network Card: 1000Base-T PCI Network interface
   6. The computer shall include Windows 10 Professional operating system with Microsoft Office Professional, latest edition.
   7. The computer display shall be a 21.5-inch flat-panel wide screen display with panel front door mounting and IP66 rated.
   8. Minimum screen resolution shall be 1920 x 1080.

C. Products and Manufacturers:
   1. Advantech TPC-5000 series or latest version in class or approved equal.

## 2.3 NETWORK EQUIPMENT

A. General
   1. The fiber optic network switches, utilized for single-mode fiber optic network systems, shall be supplied by the same manufacturer for all types to ensure compatibility and the functionality of the specified networks.
   2. The network switches furnished shall provide the capability to configure the plant wide fiber optic network in a full redundant ring topology.

B. Fiber Optic Ethernet Managed Rack Switch
   1. Provide a 28-port industrial Ethernet managed switch in the Network Communication Cabinets configurable for media conversion from copper network cable to fiber optic for communications and connection of all connected SCADA components.
   2. The switch shall be an Ethernet industrial switch with full management capability, minimum of qty-12 GB Ethernet RJ45 ports, and qty-12 GB SFP fiber ports.
   3. Unit shall include enough ports to support current and future requirements with a minimum of two (2) spare copper and two (2) spare fiber optic ports whenever possible based on the manufacturer series limitations.
   4. Unit shall be capable of supporting fiber optic ports with small form LC style connections for single-mode cable.

5. The unit shall be capable of web-based management, TELNET console interface, Spanning Tree Protocol with auto learning capability and auto-negotiation on all Ethernet 100/1000 ports.
6. Provide with dual power supply option.
7. Rack mount switches shall be Stratix 5410 series.

C. Fiber Optic Media Converter
   1. Provide an industrial media converter in each Network Communications Cabinet and Generator. Media converter shall connect to RJ45 Ethernet ports between these two devices. A single mode LC fiber jumper shall be used to connect the media convertors to each other. A second LC fiber jumper shall be installed as a spare.
   2. The media convertor shall be manufactured by Blackbox, model number LIC024A-R2 or approved equal.

D. Network Communications Cable
   1. Network communications cable shall be provided as indicated on the design drawings and as needed to complete network communications links.
   2. Cable shall be certified for operation in an industrial environment and compliant with Enhanced Category 6 specifications and indicate compliance with the specifications for Ethernet I/P communications.
   3. Cable shall be 24 AWG unshielded twisted pair and feature four (4) pairs of cable.
   4. Cable shall be terminated using RJ-45 type connectors.
   5. All cables shall be installed and tested in compliance with the requirements of Section 40 61 13, Process Control System General Provisions.

E. Network Communications Cabinet
   1. A network component rack shall be provided to accommodate all equipment as noted on the system Connection Diagram.
   2. The cabinet shall be 84” H x 24” W x 36” D and suitable for 19-inch rail mounting of equipment and classified as a minimum 42U.
   3. Cabinet shall include three (3) sets of mounting rails capable of moving in one-inch increments.
   4. Cabinet shall be constructed of 16 AWG cold rolled steel with a black fine powder coat textured finish. Provide with mesh front and back doors and flush mount removable side panels, all key lockable.
   5. Provide with a 3-fan top mounted air circulation system, casters, leg levelers and anti-tip legs and 16-outlet power strip.
   6. All equipment shall be designed for and mounted on slide out rails. Where equipment does not support this configuration, equipment shall be mounted on a rack mounted subpanel complete with all wiring.
   7. Shall be equal to Black Box RM3002A, Dell 4220 PowerEdge, or approved equal.

F. Network Communications Cabinet UPS
   1. The UPS shall be rack mountable and provide power to all network rack components with a twenty percent spare capacity.
   2. Unit shall be line interactive with 120 VAC sine wave output and auto voltage regulation.
   3. Built-in interface shall provide detailed data on UPS and power conditions as well as enable UPS setup and configuration.

4. Provide network interface for network management support and power management.
5. Unit shall include field replaceable, hot-swappable battery modules.
6. Unit shall provide minimum 20-minute battery backup on location power failure. Loading calculations shall be submitted to confirm UPS sizing.
7. UPS, as a minimum, shall be equal to Tripp Lite SmartPro Series or approved equal.
8. Provide with 5-year manufacturer warranty.

G. Network Cabinet Fiber Optic Patch Panel
   1. Fiber optic patch panels shall be provided in the network component cabinets to terminate all fiber optic cabling within the building.
   2. Each patch panel shall be designed for a rack mount installation and have capacity for up to 144 connections (LC type connections).
   3. Provide both the patch panel and inserts for fiber termination.
   4. Fiber patch panel shall be Black Box Corporation JPM406A-R5 or approved equal.

## 2.4 TOOLS AND SPARE PARTS

A. Provide the following spare parts:
   1. Workstation:
      a. Provide one workstation for every ten workstations
      b. Two display monitors for every ten workstations or portion thereof to be provided.
      b. One keyboard and mouse of each type for every five stations, or portion thereof.

B. Provide special tools necessary for normal operation, maintenance, and diagnostic aids. Provide a laptop computer and software, if required, for maintenance and troubleshooting.

C. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

## PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 40 63 43

PROGRAMMABLE LOGIC CONTROLERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment required to provide a complete and operable Programmable Logic Controller (PLC) system, as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.

B. PLCs and components no longer supported or being removed from support within two years by PLC manufacturer shall not be acceptable.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. In addition to the requirements specified in this section, the requirements of specification Section 40 67 17 - Process Control Panels and Enclosures, 40 61 13 - Process Control Systems General Provisions and the sections referenced therein shall be applied.

1.3 DEFINITIONS AND ABBREVIATIONS

A. The following definitions and abbreviations are used throughout the specifications and drawings when referring to instrumentation and control equipment, functions, and service. Definitions and abbreviations are not listed for those used in common industry practice except where to provide explicit meaning. Refer to ISA, IEEE, and other industry standard references for those not listed herein.
CSI……Control System Integrator
ICS……Instrumentation and Control System
OIT……Operator Interface Terminal
OWS…… Operator WorkStation
PID……Proportional-Integral-Derivative Control
SCADA…… Supervisory Control and Data Acquisition
SSP…… SCADA System Programmer
SPD…… Surge Protective Device
RTU…… Remote Telemetry Unit
PLC…… Programmable Logic Controller

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall provide, through the services of a single Control Systems Integrator (CSI), all components, system installation services, as well as all required and specified ancillary services, in connection with the Instrumentation and Control System (ICS). The CSI shall demonstrate a minimum of five years' experience providing PLC systems and be able to show evidence of at least five installations of equal or greater size to the one being specified.

1.5 WARRANTY

A. The warranty for the ICS shall be provided as specified in Section 01 60 00 – Product Requirements, and as specified herein. The warranty period for this system shall be for one year and shall begin upon acceptance of the complete system by the Owner. During this warranty period, the CONTRACTOR shall provide, at no additional cost to the Owner, the services of a trained, competent, field service engineer who shall arrive on site within 36 hours of notification by the Owner or Engineer, to repair and/or replace any faulty device or equipment supplied by the system supplier as part of this Instrumentation and Control System. All preventive and corrective activities shall be documented with service reports which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed, and list materials used. A copy of all service reports shall be delivered to the Owner on or before the next business day.

B. The CSI shall be capable of providing, after the warranty period for this system expires, a 1-year renewable service contract whereby a trained, competent field service engineer shall arrive on site within 36 hours of notification by the Owner. Information relative to charges for such service and availability of such service shall be submitted to the Owner and the Engineer.

C. Components shall be furnished to the manufacturer's standard for service intended, unless otherwise indicated in the Specifications or on the Contract Drawings.

1.6 MAINTENANCE

A. The CSI shall provide recommended preventive maintenance tasks, schedules and instructions for hardware supplied. The PM documentation must be clear, applicable to hardware provided, concise and accurate.

1.7 TROUBLESHOOTING

A. The CSI shall provide trouble-shooting procedures for hardware supplied. The procedures shall be accurate, easy to understand and follow, current, and comprehensive in scope. If links to vendor website or technical support is necessary, the vendor shall provide up-to-date phone numbers and links. The CSI shall supply this documentation prior to awarding of Contract.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLERS (PLC), GENERAL

A. The Control System Integrator shall furnish programmable controllers (PLCs) as specified herein and as shown on the Drawings. PLCs shall be provided complete with rack, power supply, Input/Output (I/O) modules, special function cards, instructions, memory, input/output capacity and appurtenances to provide all features and functions as described herein. PLC I/O cards may be supplied by third party vendors if approved by the PLC manufacturer and the Owner. No substitutions

will be permitted.

B. All components of the PLC system shall be of the same manufacturer who shall have fully tested units similar to those being furnished, in an industrial environment, with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein, based on the program stored in memory and the status of the inputs and outputs.

C. The programmable controller shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of five to ninety-five percent (5% - 95%), non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz, or 24 VDC if provided with a battery backup system. Overcurrent and undervoltage protection shall be provided on the PLC power supply.

D. System configuration shall be as shown on the Contract Drawings. PLC types shall be designated on the system block diagram and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLCs of a designated type. Memory, processor, and PLC type shall be adequate for all control functions specified. Memory backup shall be provided during loss of power for the configuration, logic program, and current operating parameters/addresses.

E. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. Memory shall consist of SD card and internal energy-storage solution, which shall retain the control program.

F. All PLC processors shall be provided with the latest manufactured firmware revision level installed.

G. The instruction set for the PLC shall include the following, as a minimum.

1. Relay type instructions
2. Counter and timer instructions
3. Comparison instructions (equal, greater than, limit tests, etc.)
4. Integer, long integer, and floating-point mathematical instructions
5. Advanced math and trigonometric functions
6. Matrix and array instructions
7. Logical instructions (and, not, or, etc.)

8. Bit modification, moving and shift instructions

9. Diagnostic instructions

10. Sequencer instructions

11. Program control instructions (jump, goto, subroutine, etc.)

12. PID control loops

13. Block read and write capability

14. Primary and secondary communications capabilities

15. Immediate I/O and communications update instructions

16. Real-time clock and date

H. In addition to a port for communications as shown on the Contract Documents, additional communication ports shall be provided for any other devices as required (i.e., operator interface unit, connection to a notebook computer for programming and configuration.)

2.2 PLC – IN-PLANT TYPE

A. PLCs as specified or shown in the Contract Documents shall meet but not be limited to the following requirements:

1. Two (2) 10/100 Mbps Ethernet IP Port, one (1) USB serial port

2. I/O Module Expansion Capacity: Up to thirty (30) 1769 modules, not to include processor or power supply.

3. One power supply for each I/O module bank.

4. I/O modules shall be of a dedicated type, i.e. AI, AO, DI, DO. No mixed I/O modules shall be acceptable.

5. Three (3) MB of Memory with 1GB SD memory card for memory backup.

B. The PLC input/output hardware shall be modular DIN-rail mounted units mechanically locked together with a tongue and groove design. Modules shall include an integral communications bus that is connected from module to module with a moveable bus connector. Additional I/O module banks shall be connected with an expansion cable in a horizontal or vertical configuration, up to three banks, one local bank which includes the controller and two additional banks.

C. Modules shall be placed to ensure adequate power supply voltage to all modules with a maximum of three (3) modules on the left of the power supply and eight (8) on the right side of the power supply, for the bank with the controller, and maximum of eight (8) modules on both sides of the power supply for additional

I/O module banks.

D. Power supply shall be compatible with the Allen-Bradley CompactLogix PLC. Input shall be 120VAC and shall supply power to the PLC, Communication, and I/O Modules. Shall be Allen-Bradley 1769-PA4.

E. PLCs shall be Allen Bradley CompactLogix 5370 L3 Controller, (1769-L36ERM).

2.3 PLC – REMOTE STATION TYPE

A. Remote Station PLCs as specified or shown in the Contract Documents, shall meet the general requirements for PLCs, and shall meet but not be limited to the following requirements:

1. Two (2) 10/100 Mbps Ethernet IP Port, one (1) USB serial port.

2. I/O Module Expansion Capacity: Up to four (4) local expansion Point I/O modules.

3. Embedded 24VDC power supply

4. Embedded I/O: 16 Digital inputs, 16 digital outputs, 4 analog inputs, and 2 analog outputs.

5. I/O module shall be of a dedicated type, i.e., AI, AO, DI, DO. No mixed I/O modules shall be acceptable.

6. One (1) MB of Memory with 1 GB compact flash card for memory backup.

B. PLC shall be Allen Bradley CompactLogix 5370 L2 Controller, (1769-L27ERM).

2.4 PLC INPUT/OUTPUTS

A. Input/output hardware shall be either plug-in modules in associated I/O rack assemblies or add-on modules for remote station type PLCs. Each PLC within an enclosure shall handle the required number of process inputs and outputs, plus a minimum of ten percent (10%) pre-wired spares for each I/O type furnished except discrete inputs which shall have a minimum of twenty percent (20%) pre-wired spares, plus a minimum of twenty percent (20%) spare I/O rack expansion space for the addition of future circuit cards or modules.

B. PLC input/output systems and processing modules shall be of the same model series. No third-party manufacturer models will be accepted.

C. Discrete inputs (DI) shall be 16-point module, 24 VDC developed from dry field contacts, for CompactLogix – 1769-IQ16 (24VDC Input module) or 1769-IA16 (120VAC Input module).

D. Discrete outputs (DO) shall be 16-point, 120 VAC / 28 VDC 5A relay contact modules, for the PLC. Output contacts may be powered from the field equipment

or powered from 24 VDC / 120 VAC sourced from PLC control panel's power system, as required to interface with field equipment. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise. Provide interposing relays as specified in Section 17130 as required to meet dry contact rating. CompactLogix – 1769-OW16.

E. Analog input (AI) circuits shall be isolated, 12-bit (minimum) resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Each input circuit shall have optical isolation to protect the equipment against high voltage transients. CompactLogix – 1769-IF4I.

F. Analog outputs (AO) shall be coordinated with the receivers but shall generally be isolated 24 VDC, 4-20mA outputs powered from the PLC. Each output circuit shall have optical isolation to protect the equipment against high voltage transients. CompactLogix – 1769-OF4CI.

G. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms which can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. #22...#12 AWG (0.2...4 mm2) wire.

H. Output failure mode shall be selectable so that upon station or communication system failure, all outputs shall be placed in the non-conducting mode or remain as they were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

I. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one half (½) of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one (1) loop or piece of equipment.

J. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements, plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm to the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein.

K. Control circuits and signals entering hazardous areas shall be provided with intrinsically safe barriers meeting the requirements of the NEC and UL698A.

PART 3 - EXECUTION

## 3.1 ENVIRONMENTAL CONDITIONS

A. The complete monitoring and control system and associated input/output wiring will be used in a water and / or wastewater treatment facility environment where there will be high energy AC fields, DC control pulses, and varying ground potentials between the transducers or input contact locations and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.

B. The PLC components shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:
   1. Temperature range: 32 to 122°F continuous.
   2. Relative humidity: 5 through 95 percent (non-condensing).

C. The Control rooms or electrical rooms will normally be air-conditioned to achieve environmental conditions outlined above. No positive control of relative humidity is provided or contemplated. However, in the event of a failure of the air conditioning system, the entire monitoring and control system shall be capable of operating continuously and satisfactorily with ambient temperatures between 32 and 104°F and with relative humidity to 95 percent (non-condensing).

END OF SECTION

# SECTION 40 66 33

# PROCESS CONTROL FIBER OPTIC COMMUNICATIONS SYSTEM

## PART 1 – GENERAL

### 1.01 GENERAL

A. The Control System Integrator (CSI) shall provide fiber optic communications system for the transmission of SCADA related and other network communications through the facility and off-site well field. The CSI shall provide an approved professional Fiber Optic Cable System Installer to have total system responsibility for all installation, termination, testing, and commissioning of the fiber optic systems as indicated in the contract drawings and described herein.

B. As an alternative, the CSI shall request the self-performance of the fiber optic system provided that the requirements of training, certification and compliance with the specifications can be demonstrated.

### 1.02 RELATED SECTIONS

A. The CSI shall coordinate the work of this section as it relates to other sections of the specification. Particularly:

1. Section 40 61 13 - Process Control Systems General Provisions

### 1.03 SUBMITTALS

A. The Fiber Optic Communication Submittal shall be in accordance with Division 1 and as specified in Section 40 61 13 - Process Control Systems General Provisions.

### 1.04 DESCRIPTION OF WORK

A. The CSI shall provide all equipment, materials, labor, installation, troubleshooting, testing and training, required to provide for all fiber optic communications links as shown in the contract drawings and as described herein.

B. Installed cable shall follow routes as shown on Contract Drawings and shall be terminated as directed.

### 1.05 QUALITY ASSURANCE

A. The CSI shall select and oversee the services of an appropriate, well established, contracting firm, which is experienced in all facets of fiber-optic cable installation.

B. This subcontractor, designated herein as the Fiber Optic Installer, shall provide installation technicians who are trained, experienced, qualified, and who shall provide all of the appropriate installation, termination, testing, and maintenance of the fiber optic communications medium and appurtenances. These technicians

shall install the cable and related equipment in accordance with the best-recommended standards and practices of the manufacturer and the fiber-optic cable industry.

PART 2 – PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The fiber optic cable system as specified herein, as specified in related sections and as shown on the Contract Drawings depicts overall system configuration requirements. Adjustments shall be made as needed to support the installation requirements and provide a fully functional fiber optic communications system.

B. The Contractor shall provide all cable, hardware, hand holes, vaults, patch panels, etc. with the approval of the Owner and Engineer. Approval of equipment and locations shall be obtained prior to purchasing or installation of any equipment.

2.02 FIBER OPTIC CABLE – MULTIMODE

A. Multimode shall only be used where the existing fiber optic network utilizes multimode and is not being replaced as part of the project. Coordinate with Engineer and Owner to determine the cable to be used.

B. Fiber optic cable shall be heavy-duty, flame-retardant, UV-resistance, gel-free, multi-fiber, tight-buffer, distribution style cable designed for high tensile strength and durability. Cable shall be designed for installation in buried duct and outdoor environments.

C. Cable shall be suitable for installation with a rated pull strength capability in excess of 340 lbs. The CSI shall use procedures, measurements, and precautions so that no more than 50% of the maximum rated pull strength capability of the cable is ever applied during any point in the installation procedure.

D. Cable shall be suitable for installation with a minimum bend radius of 1.5 inches for a maximum fiber count of 6. The Contractor shall use procedures, measurements, and precautions so that the cable is never exposed to a bend radius of less than 1.5 inches during any point in the installation procedure.

E. Jacketing shall be PVC, providing high abrasion and cut-through resistance. Outer jacket shall be flame-retardant, UV-resistant stabilized for outdoor use and overall ruggedness. Jackets shall have low friction resistance and high strength so that long pulls will not cause damage.

F. Cable shall be rated and approved for building interior and plenum installations.

G. Fibers shall have a 62.5-micron core, with a 0.275 numerical aperture. Multimode fiber shall utilize low loss core, with a typical maximum attenuation of 3.0 dB/km @850/1300 nm.

H. Fibers shall have a glass core, surrounded by a layer of glass cladding. Core and cladding shall be buffered to 900-microns.

I. Cable shall have Kevlar ripcord, inner and outer jacket, with gel-free water-blocking materials that swell to absorb water to protect against water penetration.

J. All cable elements shall be helically stranded, with a lay length not to exceed 30 times the finished cable diameter.

K. All strands of each cable shall be individually color-coded.

L. Cables shall have a minimum of six (6) fibers or as shown on contract drawings.

M. Fiber-optic cable shall be as supplied by Corning FREEDM LST cables, Optical Cable Corporation, or approved equal.

2.03 FIBER OPTIC CABLE – SINGLE-MODE

A. Fiber optic cable shall be rugged, rodent and UV-resistance, loose tube, gel-free, single-armored, multi-fiber, distribution style cable designed for high tensile strength and durability. Cable shall be designed for installation in an outdoor environment, direct-buried application.

B. Cable shall be suitable for installation with a rated pull strength capability in excess of 200 lbf (long-term). The CSI shall use procedures, measurements, and precautions so that no more than 50% of the maximum rated pull strength capability of the cable is ever applied during any point in the installation procedure.

C. Cable shall be suitable for installation with a minimum bend radius of 7 inches for a maximum fiber count of 24. The Contractor shall use procedures, measurements, and precautions so that the cable is never exposed to a bend radius of less than 7 inches during any point in the installation procedure.

D. Jacketing shall be Polyethylene, with single armored construction providing additional crush and rodent protection, suitable for direct-buried installations. Outer jacket shall be fungus, abrasion, and UV-resistant stabilized for outdoor use and overall ruggedness. Jackets shall have low friction resistance and high strength so that long pulls will not cause damage.

E. Cable shall be rated and approved for outdoor direct-buried installations according to NEC Article 770.

F. Fibers shall have an 8.2-micron core, G.652 compliant. Single-mode fiber shall utilize low loss core, with a typical maximum attenuation of 0.3 dB/km @1550 nm.

G. Fibers shall have a glass core, surrounded by a layer of glass cladding. Core and cladding shall be buffered to 900-microns.

H. Cable shall have high-strength ripcord with gel-free water-blocking materials that swell to absorb water to protect against water penetration.

I. All cable elements shall be helically stranded, with a lay length not to exceed 30 times the finished cable diameter.

J. All strands of each cable shall be individually color-coded.

K. Cables shall have a minimum of twelve (12) or forty-eight (48) fibers as shown on contract drawings.

L. Fiber-optic cable shall be as supplied by Corning ALTOS Lite Single-mode cables, Optical Cable Corporation, or approved equal.

2.04 FIBER OPTIC PATCH PANELS, CONTROL PANELS

A. Each Patch Panel supplied shall consist of the following:

1. Patch panel shall have termination plates installed, with sufficient termination connectors, to terminate all strands of all fibers. Termination plates shall have SC-style connectors. Connectors are to remain individually booted until used.
2. Fiber optic patch panels shall be Corning. Type 1 – WCH-02P, Type 2 – WCH-04P, and Type 3 – WCH-08P with appropriate LC termination plates, Corning, CCH-CP12-A9, or approved equal.

B. Cable and Termination Labeling.

1. Provide documentation listing: termination number, cable number, fiber strand color, and destination description.
2. Documentation sheet shall be laminated in clear plastic.
3. Documentation sheet shall be securely attached using appropriate adhesive, no screws shall be allowed.

    a. For building/structure interior installations, documentation sheet shall be secured to patch panel interior door.

2.05 FIBER OPTIC CABLE VAULTS

A. Each Cable Vault supplied shall consist of the following:

1. Fiber optic cable vaults shall be used as required for splicing and routing the fiber optic cable and for the connection to the Owner’s existing fiber optic network system.
2. All fiber optic vaults shall provide a mean of applying electrical connectivity to the sheath for the purpose of locating and tracing the fiber. A minimum of 100 feet of cable shall be left in each vault or building for splicing purpose.
3. The enclosure size shall be a minimum of 24 inches wide by 36 inches in length by 30 inches in depth. Fiber optic cable vaults shall be D.O.T. approved, 45,000LB. rated, CDR or approved equal.

B. Cable and Termination Labeling:

1. Provide documentation listing: termination number, cable number, fiber strand color, and destination description.
2. Documentation sheet shall be laminated in clear plastic.

3. Documentation sheet shall be securely attached using appropriate adhesive, no screws shall be allowed.
   a. For building/structure interior installations, documentation sheet shall be secured to patch panel interior door.
   b. For PLC enclosure interior installations, documentation sheet shall be installed in enclosure print pocket, or securely attached to interior of enclosure door.

2.06 FIBER OPTIC NETWORK SWITCHES

1. The fiber optic network switches, utilized for single-mode fiber optic network systems, shall be supplied by the same manufacturer for all types furnished under this contract to ensure compatibility and the functionality of the specified networks.

2. Refer to specification section 33 09 33 for the single-mode fiber optic Ethernet switch specifications.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

A. The Contractor shall provide all labor, materials, equipment, and expertise required to carry out the installation, calibration, termination, testing and start-up of all cables, connectors, patch panels and related equipment, in a manner in keeping with the best standard practices available and in accordance with the manufacturer's recommendations.

B. Where cable must be routed above ground, install cable in conduit. Conduit shall be as specified in the electrical sections of these specifications.

C. Where cable must pass under existing slab or paving to gain access to structures, install cable in conduit. Conduit shall extend a minimum of three (3) feet beyond the existing slab or paving and shall be terminated in an appropriate pull box.

D. Existing slab or paving may be cut to facilitate the installation of conduit and cable. However, all modifications to existing slab or paving and structures shall be patched and repaired in accordance with the other sections of this specification.

E. Careful attention should be paid to provide installations at each location, which are both functional and aesthetically acceptable.

F. Provide pre-manufactured fiber optic patch cords at each fiber optic patch panel, as specified on the Contract Drawings or a minimum of three (3) per patch panel.

Patch cords shall be compatible with the installed fiber optic cable, dual channel, and terminated with SC-style connectors. Length shall be a minimum of six (6) feet.

G. All strands of each cable installed shall be terminated unless shown otherwise on contract drawings.

H. All splicing shall be fusion method. All spicing enclosures shall meet or exceed the Corning canister closure, SCF series.

I. All plowed cables shall be placed at a depth of 36 inches along D.O.T. roadways and 24 inches on private property. All road and driveway bores shall be a depth of 36 inches and will have 2 inch interduct placed within.

J. Buried route marker posts shall be placed a minimum of every 1,500 feet. A warning tape shall be placed 12 inches above the buried cable.

K. All highway shoulders, school yards, and ditch lines will be compacted and restored to satisfactory condition.

L. All fiber optic patch panel connectors and patch cord termination connectors that are not used shall be booted and secured to prevent contamination or damage.

M. All work shall be scheduled in accordance with the Owner's staff, to minimize down time of any system. All modifications to existing and proposed wiring systems shall be carefully documented and included in the as-built documentation to be delivered at the end of the project.

3.02 CABLE ROUTE AND CONTINUITY

A. Fiber optic cable shall be installed un-broken and un-spliced for the entire distance from one designated termination point to the next, unless otherwise noted. The designated termination points shall be as shown on the Contract Drawings and/or listed in these specifications.

1. Where the cable run length exceeds the maximum continuous on-roll length available from the cable manufacturer, the installed cable may be spliced. In this circumstance, the Contractor shall notify the Engineer, in writing, before proceeding with the installation of the run.
2. All cables, including spliced cables, shall be fully tested after installation, and the cable system loss shall not exceed the theoretically calculated optical budget.

B. Each installed cable shall be terminated in a fiber optic patch panel. Every strand of each cable entering a patch panel shall be terminated.

3.03 FIBER AND TERMINATION TESTING

A. Terminations shall be made in a manner in keeping with the recommended practices of the fiber optic cable manufacturer.

B. All terminations shall be neatly and properly made, tested, and immediately booted, or placed in their final termination, so that they are fully protected from damage. Each fiber, including those designated as spares, shall be terminated, and tested.

C. All cables entering patch panel, and all patch panel termination connectors, shall be clearly marked to indicate their respective routing.

D. The technician(s) who are designated to perform the termination and testing, shall be fully familiar, trained, and qualified to service the items which are being provided.

E. Accurate and appropriate test equipment, and industry standard test procedures shall be used to demonstrate that the cabling and associated equipment operate within the expected tolerance of accuracy. The operation shall be verified at various points throughout the designed operating range. Fiber testing shall be in accordance with TIA 568 B, minimum.

F. All finished cables shall be fully tested under actual loading conditions, utilizing a light source and calibrated power meter, or OTDR. The theoretical power loss for the cable system, including all terminating connectors, shall be calculated, and compared to the actual field measurements. Any significant visual defects or any power loss in excess of 2 dB over the theoretical calculation shall be reason to fail the test.

G. Failed terminators shall be cut off and re-terminated. If any fiber of a cable fails, the entire cable shall be replaced in its full length, to the next termination point.

H. The Owner's Project Representative shall be given the opportunity to witness the testing. The notice shall be in writing and shall be delivered a minimum of three (3) days in advance of the testing.

I. A written, dated, report shall be prepared by the technician for each fiber test, troubleshooting, or maintenance event, which identifies the fiber serviced, defines procedures, describes the results of the testing including measured values, identifies witnesses, and provides conclusions. The report shall contain OTDR Trace Report which includes a graph of the signal over a distance for each fiber run. Each test report, as a minimum, shall include a table which includes columns each with the following information:

1. Test Date
2. Cable ID
3. Fiber Number
4. Wavelength (nm)
5. Quantity of Connectors
6. Beginning of Fiber Testing Location
7. End of Fiber Testing Location
8. A-B Distance (Meters)
9. Actual A-B Loss (dB)

10. Max Attenuation (dB/km) @ 850/1300 nm
11. Calculated A-B Loss
12. Splice Loss
13. Pass or Fail

The report shall also include the serial number and calibration number, for all equipment used in performing the testing.

J. All reports shall be distributed to the Owner's Project Representative and a copy shall be kept on-site for the duration of the project for reference. Copies of all reports shall be included in the final O&M manual.

K. Final signed test reports, indicating successful testing, for each fiber, of every cable, shall be delivered to the ENGINEER and OWNER for review, before final completion will be approved.

3.04 TRAINING AND MAINTENANCE EQUIPMENT

A. TRAINING: The Fiber Optic Installer shall provide training, to the Owner's designated maintenance staff, on the installation, operation, maintenance, and troubleshooting, of the fiber optic system.

1. The classes shall include but not be limited to the following:

   a. Installing LC connectors on fibers.
   b. Testing fibers cable strands.
   c. Installation techniques.
   d. Maintenance and troubleshooting.
   e. Field splicing and emergency repairs.

2. Course format shall be hands-on and shall include special emphasis on information and techniques particularly applicable to the respective project.
3. Training shall be performed using the test and repair equipment which is to be provided to the Owner as part of the project.
4. Training location shall be at the discretion of the Owner and shall be coordinated through the Owner's Project Representative.
5. Courses shall be formally prepared, scheduled, and tailored to the appropriate personnel. Provide one (1) session, 4 hour duration.

B. FIBER OPTIC TEST/MAINTENANCE KIT

1. Provide a test kit with optical light source and handheld digital power meter for testing of fiber terminations, suitable for use in testing and troubleshooting the installed system. The equipment shall be portable and include rechargeable batteries, carrying case, instruction manuals, adapters, and related accessories. Test kit shall be manufactured by Fluke or approved equal.

3.05 WARRANTY

A. The CSI / Fiber Optic Installer shall provide a one (1) year warranty minimum. Warranty shall cover, at a minimum, all parts, components, installations, and system performance.

END OF SECTION

# SECTION 40 67 17

# PROCESS CONTROL PANELS AND HARDWARE

## PART 1 - GENERAL

### 1.1 THE REQUIREMENT

A. The Contractor shall provide, through the services of a single Control Systems Integrator (CSI), shall furnish, modify, test, install and place into satisfactory operation all control enclosures (i.e. Field panels, control panels, PLC panels, RTU panels, cabinets, consoles, boxes, etc.) required to provide a complete and operable Instrumentation and Control System (ICS) as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.

B. The Contractor shall also be responsible to provide modifications to existing control panels as described herein or as indicated in the PLC Input/Output Schedule Attachment. Modifications to existing control panels shall also conform to the requirements of these specifications.

C. New control enclosures and/or subpanels shall be assembled, wired, and tested in the CSI's own facilities, unless specified otherwise.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

1. Section 40 61 13, Process Control System General Provisions.
2. Section 40 61 21, Process Control System Factory Testing.
3. Section 40 61 23, Process Control System Startup and Field Testing.
4. Section 40 61 96, Process Control Descriptions
5. Section 40 78 00, Panel-Mounted Instruments and Devices.

### 1.3 QUALITY ASSURANCE

A. Standards, Codes and Regulations:
   1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
      a. National Fire Protection Association 79, Annex "D" Standards, (NFPA).
      b. National Electrical Code, (NEC).
      c. National Electrical Manufacturer's Association Standards, (NEMA).
      d. American Society for Testing and Materials, (ASTM).
      e. Operational Safety and Health Administration Regulations, (OSHA).
      f. Underwriters' Laboratory, Inc., (UL).
      g. State and Local code requirements.
      h. Where any conflict arises between codes or standards, the more stringent requirement shall apply.

2. All materials and equipment shall be new and all panels shall be built in an Underwriters' Laboratory, Inc. (UL) approved panel shop and bear the UL label.

B. General Design Requirements:
   1. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.
   2. Comply with the control descriptions of Section 40 61 96, Process Control Descriptions.

C. Factory Assembly and Testing:
   1. Comply with the requirements of Section 40 61 21, Process Control System Factory Testing.

1.4 SUBMITTALS

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions. In addition, the following specific submittal items shall be provided.

   1. Cabinet sizing in relation to heat dissipation and cooling/heating system sizing calculations shall be submitted for all cabinets containing Radio equipment, PLCs, and UPSs and, at the request of the Engineer, for all cabinets containing sensitive electronic equipment or chemicals.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All enclosures shall fit within the allocated space shown on the Drawings. The Contractor shall examine plans and/or field inspect new and existing structures as required to determine installation requirements and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (Incidental, accidental, or unavoidable).

B. A minimum estimated size is shown on the Drawings. The Contractor shall furnish enclosures of the size and quantity required to house the manufacturers' equipment supplied and all other electrical components installed in the enclosure. In addition, provide useful space and power supply capacity as spare for future expandability to a minimum of one (1) item per item type installed or twenty percent (20%) of quantity of each type of item installed, whichever yields the greater spare space.

C. Enclosures (cabinets, panels, boxes, etc.) shall be formed or welded construction, reinforced with Unistrut, Powerstrut or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the supplier's equipment. Doors shall be removable. Enclosures with any dimension thirty-six (36) inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. No screws or bolts shall protrude through from the interior enclosure.

D. All steel enclosures shall be free from dirt, grease, and burrs, and shall be treated with a phosphatizing metal conditioner (phosphate conversion coating) before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six (6) color samples provided. All stainless-steel enclosures shall be polished to a No. 4 finish.

E. Enclosures shall be prefabricated cabinets and panels equal to Hoffman, Saginaw or Rittal. The Contractor may optionally provide enclosures custom fabricated by a reputable panel fabrication shop acceptable to the Engineer.

F. Each panel shall incorporate a removable back panel on which control components shall be mounted. Back panels shall be secured to the enclosures with collar studs. All components shall be of the highest industrial quality and securely mounted to the removable back panels with screw and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.

G. All enclosures with any dimensions of (24) inches or larger shall be provided with drawing pockets for as-built panel drawings. One (1) laminated copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

H. All enclosures shall be protected from internal corrosion-inhibiting vapor capsules as manufactured by Northern Instruments Model Zerust VC, Hoffman Engineering, Model A-HCL, or equal.

I. All metallic enclosures with door mounted equipment shall have the door grounded by means of flexible ground strap.

J. The enclosure and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Panel mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Contract drawings.

K. Enclosures shall provide mounting for UPS, power supplies, control equipment, input /output subsystems, panel mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling. Enclosures

shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. Louvered openings fitted with dust filters near the bottom and top of the cabinet shall be provided for NEMA 12 enclosures. If required, cabinets shall be provided with filtered fans, heat exchangers or air conditioners. Only closed loop cooling systems shall be provided for NEMA 4X cabinets. Cooling systems shall be by the cabinet fabricator or equal to McLean Midwest, Noren Products, or approved equal.

L. Enclosures shall be provided with a minimum of one (1) 120-volt duplex convenience GFCI receptacle for service equipment and programming. One (1) simplex receptacle shall be provided for an enclosure with an uninterruptable power supply (UPS) or equipment which requires 120VAC service. Service lights, LED type, shall be provided for sufficient light coverage inside the panel. Service lights shall be provided with On/Off switch incorporated into light and/or a door switch to activate light when panel door is opened. Service lights shall be manufactured by Hoffman Panelite, Phoenix Contact PLD enclosure lights, or approved equal. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker. Circuit breakers shall be provided for the following internal branch circuits distributed within the panel:

1. Receptacles and power strips.
2. Panel Lighting
3. UPS
4. HVAC Equipment
5. PLC power supply
6. OIT power supply
7. Power Supplies (24VDC)

M. Loads not requiring surge protection devices (i.e., receptacles, lighting, HVAC, branch circuits to remote equipment, etc.) shall be connected ahead of the enclosure surge protective device.

N. Locate equipment, devices, hardware, power supplies, instrumentation and controls, electrical equipment and wiring to be installed inside the enclosures and/or as facial features on the enclosures, so that connections can be easily made and so that there is ample room for servicing each item. Every component in and on the enclosures shall be able to be removed individually without affecting the other components and without the need to move other components. Support and restrain all internally, as well as panel mounted components to prevent any movement.

O. All cabinets and/or enclosures shall be NEMA rated for the environment in which it is to be installed and as noted in the Drawings.

P. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

Q. Panel enclosures (All PLC and Network SCADA panels/enclosures) shall be provided with a security door switch mounted at the top of the enclosure as shown on the drawings. The door switch shall be general duty, Reed switch type operation with a

straight plunger. Maximum voltage rating shall be 240 VAC and 125 VDC with 1pole, double throw, one position momentary signal switch unit. Door switch shall be Square D, 9007MS01S0300 or approved equal.

R. Control panels shall be built in accordance with UL508A Industrial Control Panels and NEC Article 409 Industrial Control Panels. Control panels for areas classified as Hazardous shall be built in accordance with UL698 Industrial Control Equipment for Use in Hazardous Locations. Control panels shall be UL508A and/or UL698 labeled and marked as defined in NEC 409.110 with the following:

1. Manufacturer's name and contact information (i.e. address, phone, website, email, etc.).
2. Supply voltage, phase, frequency, and full-load current.
3. Short-circuit current rating or the industrial panel based on one of the following:
    a. Short-circuit current rating of a listed and labeled assembly.
    b. Short-circuit current rating established utilizing an approved method.
    c. Electrical wiring diagram numbers or the index sheet to the electrical wiring diagrams.
    d. The enclosure type number (i.e., NEMA 1A, 3R, 12, 4X, 9, 9, etc.).
4. If the industrial control panel is intended as service equipment, it shall be marked to identify it as being suitable for use as service equipment.

S. All work shall be performed in a professional manner and in consideration of allowing ease of future troubleshooting and maintenance. All equipment should be mounted so as to minimize crowding within the panel. All devices shall be mounted and wired in a neat and workmanlike manner. Each component shall be prominently identified with the use of permanent engraved legend plates.

T. Grounding: All suppressors shall be grounded per the suppressor manufacturer's recommendations. Furnish control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation. Provide single point connection of all grounds to grounding bus using the shortest possible path. Each grounded object shall have a separate connection to the ground bus. Do not connect cable shields to suppressor ground terminal or daisy chain ground connections. Provide 12-port copper ground bus as a minimum. Panels shall include a Burndy #KCKF23 NEMA 4X bulkhead ground connector for exterior connection of #2 copper grounding conductor from site grounding loop or system. Inside the panel, the bulkhead connector will be directly connected to a Burndy KA2U terminal lug utilizing an insulated #2 AWG conductor.

U. All panels shall have a Hoffman H2Omit vent drain installed on the bottom of the

panel to drain panel and reduce corrosion. Stainless steel for metallic panels polyester for non-metallic panels. Free standing panels without legs and panels located in a climate-controlled building are exempt from this requirement.

2.2 PANEL ENCLOSURE MATERIAL AND CONSTRUCTION

A. Outdoor Enclosures

1. All outdoor enclosures shall be rated NEMA 4X, constructed of 316 stainless steel with a white powder epoxy coating finish unless specified otherwise. Outdoor enclosures shall have a hinged and gasketed door. Door latches shall be all stainless steel, 3-point latch with handle for all enclosures with a dimension of 24 inches or larger, or otherwise shall be fast operating clamp assemblies which do not require bolts or screws to secure. Gaskets shall be polyurethane.

2. Outdoor panels shall be fitted with pad-lockable latch kits.

3. Outdoor enclosures with internal digital electronics, exterior indicators, or exterior indicator lights shall have external sun shields or sunshades, constructed of the same materials as the associated enclosure, unless otherwise specified.

4. Outdoor enclosures shall be designed for ambient conditions of -15 to 50°C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Outdoor enclosures shall be provided with thermostatically controlled space heaters to provide condensation protection.

B. Indoor Enclosures

1. Indoor enclosures located in the same area (i.e., room, etc.) as open process tanks, open process channels, closed process piping or process equipment containing wet liquids or possible airborne powders, shall be rated NEMA 4X, constructed of 316 stainless steel, fiberglass, fiberglass reinforced polyester, or polycarbonate, unless specified otherwise. Enclosures shall have a hinged and gasketed door. Door latches shall be all stainless steel, fast operating clamp assemblies (quick release) which do not require bolts or screws to secure. Gaskets shall be polyurethane.

2. Indoor enclosures located in a dry or environmentally controlled area (i.e., electrical room, etc.) shall be NEMA 12 steel, unless specified otherwise. Enclosures shall have a hinged and gasketed door. Door latches shall be 3-point door latch with handle for all enclosures with a dimension of 24 inches or larger, or otherwise shall be fast operating clamp assemblies which do not require bolts or screws to secure. Gaskets shall be polyurethane.

3. Indoor enclosures in a non-air conditioned space shall be designed for ambient conditions of 0 to 40°C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Indoor enclosures in an air conditioned space shall be designed for ambient conditions of 20 to 30°C and twenty to eight-five percent (20%-85%) relative humidity, unless otherwise specified.

C. Terminals

1. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails, securely bolted using drill and tap method to the cabinet sub-panel No self-tapping screws allowed. Terminals shall be of the screw down pressure plate type equal to that manufactured by Allen Bradley, Phoenix Contact, Wieland, Square D, or equal. Power terminal blocks shall be single tier with a minimum rating of 600 volts, 30 amps. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

2. Fused terminal blocks or miniature thermal circuit breaker terminal blocks shall be supplied for protection and isolation of enclosed equipment, or as specified in the Contract documents. Blown fuse indicators shall be provided and/or tripped breaker status shall be clearly visible. Fused or miniature thermal circuit breaker terminal blocks shall be provided for, but not limited to each of the following:

   a. Each PLC module requiring external power

   b. Each piece of equipment provided with a power supply (integral, internal or external) with the exception of devices with internal fusing plugged into a receptacle.

3. Terminals shall be marked with a black waterproof, permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

4. All analog input and output signals entering or leaving the control panel shall be protected by a resettable thermomagnetic device circuit breaker. Manufactured by Phoenix Contact - catalog number 0916603 or approved equal.

D. Wiring

1. All wiring shall be bundled and run open or enclosed in vented plastic wireway, as required. All conductors run open shall be bundled and bound with nylon cable ties, at regular intervals, with intervals not to exceed 12 inches. Adequately support and

restrain all wiring runs to prevent sagging or other movement. Care shall be taken to separate communication, network, electronic signal, AC discrete signal, DC discrete signal and power wiring. Wiring to equipment mounted on doors or where movement of the equipment will take place, shall be installed in nylon spiral wrapping sheaths.

2. Wires shall be color coded as follows:

   a. Equipment Ground – GREEN

   b. 120 VAC Power Distribution – BLACK

   c. 120 VAC Power Neutral – WHITE

   d. 120 VAC Control (Internally Powered) – RED

   e. 120 VAC Control (Externally Powered) – YELLOW

   f. 24 VAC Control – ORANGE

   g. DC Power (+) – BLUE

   h. DC Power (-) – BLUE/WHITE

   i. DC Control – BLUE

   j. Analog Signal (+) – BLACK

   k. Analog Signal (-) – WHITE

3. All wiring shall comply with accepted standard instrumentation and electrical practices. Field wiring for power, control and signal wires shall comply with Division 16 of the specifications. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

4. Internal panel wiring shall be as follows:

   a. AC power wiring: 14 AWG minimum, stranded copper conductors, MTW wire rated for 600 volts and 90 °C. For wiring carrying more than 15 amps, use sizes required by NEC.

   b. AC control and dc power and control wiring: 16 AWG minimum, stranded copper conductors, MTW wire rated for 600 volts and 90 °C.

   c. Instrument signal wiring: 18 AWG stranded conductors, tinned copper, twisted pair or triad, overall one hundred percent (100%) aluminum foil shield with 20 AWG stranded

drain wire, plenum rated 300V 60°C FEP insulated wire with FEP jacket, equal to Belden 88760.

d. All stranded wire shall have a minimum of sixteen (16) strands, except for drain wires.

E. Identification

1. Provide a laminated black nameplate with beveled edges and ½ inch white letters to identify each console, panel, or cabinet on the front of the enclosure.

2. Provide laminated, beveled edge, plastic legend plates and nameplates, with 1/4-inch letters, for each front panel mounted device as shown on the Drawings. Legend plates and nameplates shall be the size as shown on the Drawings. Color shall be black lettering on white background except caution/warning nameplates which shall be white lettering on a red background. Attach front panel nameplates with both a permanent adhesive and stainless steel machine screws into tapped holes.

3. Tag all interior instruments and other components with engraved, laminated plastic nameplates with 1/8 inch, minimum, lettering. Legends shall be consistent with wiring and layout drawings. Nameplates shall be attached with permanent adhesive to the panel, near the device or on the device itself or as otherwise approved by the Engineer.

4. Number and label each wire in the systems. Every unique wiring node shall have its own individual unique number. Numbers shall be shown on all submitted drawings. All wires shall be labeled at each termination and junction of the wire and at 30-inch intervals along the wire. All multi-conductor cables shall be labeled at each end and at 30-inch intervals with CBL-XXX and also label each conductor at both ends. Labeling shall be self-laminating white/transparent self-extinguishing vinyl strips (equal to Brady DAT 7 292) with clear heat shrink tubing over the markers. Length shall be sufficient to provide at least two and one-half (2 ½) wraps. All labels shall be machine-printed with wire and /or cable numbers.

F. Accessories

1. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be equal to Allen Bradley 800H, Square D Company Type SK or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.

2. Pushbuttons and selector switches shall be non-illuminated,

spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Pilot lights shall be of the proper control voltage, LED type (indoor) and lamp type (outdoor).

3. Control operators shall have legend plates as specified herein, indicated on the Contract Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, white field (background) with black lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.

4. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Contract Drawings. Modifications to existing panels using control operators and indicators of the same type and manufacturer shall be allowed with Engineer's approval.

5. Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be miniature type with DPDT contacts rated a minimum 10 amp @ 120 VAC, push-to-test button, and status indicator. Relay coils shall be 120/240 VAC or 24 VDC as required. Relays shall be equal to Idec, Square D, Omron, Allen-Bradley or approved equal.

6. Where required to interface with equipment and instruments which are located in a NFPA classified hazardous area, intrinsically safe barrier relays shall be provided. Intrinsically safe barrier relays shall be FM approved and shall be manufactured by Phoenix Contact, Square D, Crouse-Hinds, or approved equal.

7. Time delay relays shall be general purpose, plug-in, electronic type with 120VAC coils. Time delay relays shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts as required for application. Time delay relays shall be DPDT contacts rated a minimum of 10 Amp @ 120VAC. Time delay relays shall be manufactured by Square D, Type JCK, Allen Bradley, or approved equal.

8. Digital Indicators shall be provided to indicate rates and readings in digital format and true engineering units. Indicators shall accept a 4-20 mA input signal and shall be programmable through the front panel to provide scaling, calibration, options and accessories. Units shall be 4 digit minimum with red LED indication, 120 VAC power. Digital Indicators shall be equal to Precision Digital, Red Lion or approved equal.

9. Digital Flow Indicator/Totalizers shall be provided to indicate flow rates and totalized flows in digital format and true engineering units. Indicator shall accept a 4-20 mA input flow signal and shall be programmable through the front panel to provide scaling, calibration, options, and accessories. Power supply to unit shall be 24VDC. A selectable non-resettable totalized flow and a resettable totalized flow shall be indicated and displayed along with the flow rate. Units shall be provided with a dual-line display, 6 digits for flow rate with a 9 digit totalizer. Front-panel housing shall be NEMA 4X, IP65, with UV resistant sunlight readable display for outdoor installations. Digital Flow Indicator/Totalizers shall be Precision Digital, PD6000 series, Red Lion Controls, or approved equal.

10. Signal isolators/boosters/converters shall be solid state electronic type with RFI protection. Signal isolators/boosters/converters shall accept a current, voltage, frequency, temperature, or resistance and provide current or voltage dual outputs as shown on the drawings and specified herein. Signal isolators/boosters/converters shall have complete isolation between input circuitry, output circuitry, and power supply, and with provisions for din-rail mount inside the control panel enclosure. Signal isolators/boosters/converters shall be Phoenix Contact, Acromag, or approved equal.

11. Circuit Breakers

    a. Circuit Breakers shall be provided for the circuits discussed in the General Section and as required to provide isolation for all component group power feeds. Units shall be rated as recommended by the equipment manufacturer for maximum equipment protection.

    b. Component Circuit Breakers shall be rated for 120 VAC, 10,000 ampere interrupting capability and UL approved. Units shall be thermal magnetic type with DIN rail mounting.

    c. Unit shall be Allen Bradley 1492 Series, General Electric V-Line Series, Schneider Electric or approved equal.

G. Power Supplies

1. Each control panel shall be provided with a minimum of two redundant 24 VDC power supplies. Power supplies shall be enclosed and sized per the guidelines of UL508 and UL508A. Power supplies shall have fail-safe normally open dry contacts that close upon power normal status.

2. Power supplies shall be equal to Phoenix Contact, Model Quint-

PS-X, Allen Bradley 1606, or approved equal.

H. Surge Protective Devices (SPDs)

1. Surge Protective Devices shall be provided at the following minimum locations:

   a. At any connections between AC power and electrical and electronic equipment, including panels, assemblies, and field mounted instruments.

   b. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building and/or control panel.

   c. At the control panel of all discrete signal circuits that have any portion of the circuit extending outside of a protecting building and/or control panel.

   d. At both ends of all copper-based communications cables that extend outside of a building.

   e. At all specified spare analog inputs and outputs and spare discrete signal inputs in PLCs and RTUs.

2. All SPDs shall be listed/recognized by UL1449 and UL497B certification approval, appropriate for the Surge Protective Device.

3. These protective devices shall be external to and installed in addition to any protective devices built into the equipment. Power and signal protection shall be installed in either in a NEMA 4X enclosure or in the enclosure that houses the equipment to be protected.

4. All surge protective devices shall be mounted and wired per the manufacturer's recommendations including local grounding for surge energy dissipation. For surge suppressors use No. 8 cable for ground connection or install suppressor directly on ground bus using grounding screw. Provide 1-inch wide by 1/8-inch thick copper ground bus as a minimum.

5. Panel-mounted power circuit protectors shall be provided in all enclosures powered by 120 VAC. The SPD shall be a 3-stage hybrid, solid-state power line protector with noise filtering, common mode and normal mode suppression and nanosecond reaction time, and remote status signaling. The unit shall include a replaceable fuse to remove the load (protected equipment) from the line if the unit is either overloaded or the internal protection fails. SPDs shall be Phoenix Contact PLT-SEC-T3-120-FM-UT or

approved equal.

6. Panel-mounted signal circuit protectors shall be made for mounting on a terminal block rail. Each SPD shall include a moveable grounding link to allow each signal cable shield to be individually grounded to the panel via the mounting rail through the SPD for that cable without the use of any additional grounding wire or to be isolated from ground at the SPD. Each mounting rail shall be grounded to the panel by the use of rail mounting screws at approximately one-foot intervals. Protection shall be from line to line and from each line to ground. Protection shall also be from shield to ground where the shield is not grounded at the protector. Each SPD shall have the ability to protect against surge currents greater than 10,000 amperes. Each SPD shall add no more than 22 ohms per signal wire to the total signal loop resistance of the analog signal loop in which it is installed. SPDs shall not introduce error-producing ground loop currents into the instrumentation signal circuits. SPD shall be equal to Phoenix Contract PlugTrab series.

| Phoenix Contact SPD Type/Description | Model No. (Part Type) | Part Number |
|---|---|---|
| Plug-in Module with Base, Digital, 120VAC, for incoming power, with remote status signaling | PLT-SEC-T3-120-FM-UT | 2907918 |
| Plug-in Module, Digital, 120VAC, Dual Channel | PT 2X1VA-120AC-ST | 2839185 |
| Base, Digital, 120VAC | PT-BE/FM | 2839282 |
| Plug-in Module, Digital, 24VDC, Dual Channel | PT 2X1-24DC-ST | 2856087 |
| Base, Digital, 24VDC | PT 2X1-BE | 2856139 |
| Plug-in Module with Base, Analog, 24VDC, Single Channel | PT-IQ-1X2-24DC-UT | 2800976 |

7. Signal circuit SPD for 2-wire field instruments shall be a conduit connected/pipe nipple type and shall have characteristics equal to the panel mounted devices. Units shall be mounted to a transmitter conduit entry point where available. When not available or practical, then these devices shall be mounted in NEMA 4X enclosures located at the field devices. SPD devices shall be equal to Phoenix Contact SURGETRAB, S-PT-EX-24VDC (2800035), or approved equal.

8. Signal circuit SPD for 4-wire field instruments shall be a separate enclosure unit capable of providing protection on both the power and signal side. The unit shall contain the characteristics of the line power protector and signal circuit protectors discussed above. Units shall be enclosed in a manufacturer assembled NEMA 4X polycarbonate enclosure with a clear polycarbonate cover. SPD devices shall be equal to Phoenix Contact BoxTrab, BXT-N4X 4-Wire (5603514) or approved equal.

9. SPD devices antenna cable signal protection shall be an in-line

panel mount type unit rated for 50 Ohms and with dc blocking. Unit shall be rated for the appropriate frequency range and have an insertion loss of 0.1 dB, maximum. SPD shall be equal to Polyphaser, Phoenix Contact CoaxTrab (CN-UB-70DC) or approved equal.

10. SPD devices for CAT 5 or 6 Ethernet cable data signal protection shall be DIN-rail mount type with RJ45 plug connection to the device it is protecting. Surge suppressor type shall be gas-filled surge arrester and diodes with a total surge current of 10kA. SPD shall be Phoenix Contact, DT-LAN-CAT.6+ (281007) or approved equal.

11. SPD devices for RS-485 cable connection data signal protection shall be DIN-rail mount type with 9-position D-SUB connector to the device it is protecting. Surge suppressor type shall be gas-filled surge arrester and diodes with a total surge current of 10kA. SPD shall be Phoenix Contact, DT-UFB-485/BS (2920612) or approved equal.

12. SPD specifications and ratings for signal or communication types not defined herein shall be as specified elsewhere or of a type recommended by the manufacturer of the device being protected. SPD devices shall be equal to Phoenix Contact or approved equal.

13. SPD devices for Marshalling Cabinets in electrical rooms shall be Phoenix Contact 2906858 with signaling units 2907811.

I. PLC Cabinet Managed Ethernet Switch, Fiber Optic (Local and Field Control Panels)

1. Unless otherwise noted, provide an industrial fiber optic Ethernet managed switch at each PLC cabinet for communications over the Ethernet data highway.

2. The switch shall provide a minimum of eight (8) Ethernet 10/100/1000 RJ-45 network ports and two (2) SFP fiber optic ports.

3. SFP transceivers used for fiber optic communication shall utilize type LC fiber connection ports.

4. The switch shall include automatic port detection for speed (10/100/1000 Mbps), duplex (full/half), and connection (mdi/mdix).

5. Input voltage shall be 10-30 VDC.

6. Switch shall be Rockwell Automation Stratix 5800 series. Stratix 5800 expansion modules shall be utilized when more communication ports are required.

J. Uninterruptible Power Supplies (UPS), Control Panel

1. UPS units shall be line interactive units provided for new PLC control panels as specified herein or shown elsewhere within the Contract Documents.

2. UPS units for locations without Automatic Transfer Switch (ATS) and generators shall be sized to provide a minimum of two (2) hours backup time for all connected equipment. At sites with ATS and generators, UPS units shall be sized for a minimum of twenty (20) minute backup for all connected equipment. Each UPS shall consist of a UPS module and battery modules as required to meet backup run time requirements.

3. UPS units provided for PLC cabinets shall be provided with dry contact outputs to alarm on: UPS trouble or failure, UPS on battery, and UPS low battery. These fail outputs shall be wired into the PLC I/O to represent the UPS status conditions.

4. Where located in a control or PLC enclosure, the UPS shall be located at the bottom of the enclosure but mounted on a raised shelf or platform.

5. Provide network interface for network management support and power management.

6. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories plus twenty (20) percent spare capacity. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.

7. Each UPS shall meet the following requirements:

   a. Input voltage shall be 120 VAC, single phase, 60 Hz.

   b. Operating temperature range shall be 0 to 40 degrees C.

   c. Voltage regulation shall be plus or minus five percent (+/-5%) for line and load changes.

   d. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz (+/-0.5%) when on battery operation.

   e. The batteries shall be of the sealed, lead acid or lead calcium

gelled electrolyte type, suitable for high temperatures.

f. Sound absorbing enclosure.

g. EMI/RF noise filtering.

h. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.

i. Adjustment allowed to prevent UPS from going offline when on a standby generator supplied power source.

j. Three separate relay output contacts indicating UPS fail, UPS on battery, and UPS low battery conditions.

8. UPS systems shall be equal to APC Smart-UPS SMT series (with AP9613 smart card) or approved equal.

2.3 TOOLS, SUPPLIES, AND SPARE PARTS

A. Tools, supplies, and spare parts shall be provided as specified in Section 40 61 13, Process Control System General Provisions and as specified for each equipment item. In addition, the following items shall be provided.

1. One (1) of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract.

2. One (1) 24VDC power supply and redundancy module.

3. Three (3) of each type of interposing relay provided under this Contract.

4. One (1) of each type of power surge protective device used

5. Six (6) of each type of signal surge protective device used

6. Two (2) of each type of communication surge protective device used

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. In addition to the requirements specified in this section, refer to Section 40 61 13, Process Control System General Provisions.

B. Floor mounted enclosures shall be installed on 1/4-inch thick rubber type pads. These pads shall completely cover the area of the base that is against the floor.

C. Keep enclosures clean at all times. Keep enclosures doors closed except when actually working in the enclosure. Protect all equipment during

installation, including hole punching for conduit connection. Remove all filings and thread cuttings from enclosures. Careful attention must be paid to provide installations which are both functional and esthetically acceptable.

D. All conduits used in conjunction with control panels or instrumentation of any kind shall be sealed using a suitable duct-sealing compound to minimize the possible damage caused by vapors or wetness. No top penetrations allowed at any time. It shall be the responsibility of the CSI to verify that this is accomplished early in the project, so that corrosion damage does not occur during the time of construction.

E. The Contractor shall provide the Engineer a periodic written report detailing construction progress. This report shall include specific tabulations of equipment on which construction/installation has been completed.

F. Equipment shall be located so that it is accessible for operation and maintenance. The CSI shall examine the Contract Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole and shall supervise the installation of all equipment.

3.2 WIRING AND GROUNDING

A. The following wiring practice guidelines shall be used in order to minimize ground loops, minimize the effects of electromagnetic interference/radio frequency interference (EMI/RFI) and to provide maximum practical immunity from damage resulting from lightning-induced transients.

B. Common wires or conductors shall not be utilized (either within panels or external to panels, or for grounding of field devices) for signal shielding, signal grounding, or safety grounds.

C. Exposed wire lengths extending from within shielded signal cables shall be minimized to reduce pick-up of EMI/RFI by signal circuits. Exposed lengths of less than one inch are preferred with a maximum exposed length of two inches only permitted where necessary. No splicing of signal wires shall be permitted.

D. All signal wiring shall be shielded, both within panels and external to panels. Unless otherwise specified, all signal wiring shall be No. 16 AWG stranded tinned two-conductor twisted pair with 100 percent coverage of aluminized Mylar or aluminized polyester shield and tinned copper drain wire.

E. The shield on each process instrumentation cable shall be continuous from source to destination and grounded at one end only. In general, grounding of signal cable shields shall be done at the control panel end. No signal cable shall share a common cable shield grounding wire with

any other signal cable or other circuit. The exposed length of cable shield grounding wires shall not exceed two inches prior to termination with less than one-inch maximum length preferred.

F. All outdoor instruments and all outdoor enclosures shall be grounded using the practice defined in Section 800.40 of the National Electric Code.

3.3 TESTING AND ADJUSTMENTS

A. Perform system testing and make any adjustments necessary in accordance with this Section, Section 40 61 13, Process Control System General Provisions, Section 40 61 21, Process Control System Factory Testing, and Section 40 61 23, Process Control System Startup and Field Testing.

B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

END OF SECTION

SECTION 40 68 13

PROCESS CONTROL (HMI) SOFTWARE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The CSI shall load, configure, develop, test, document, and place in satisfactory operation all software associated with the Programmable Logic Controller (PLC) and all its ancillary devices, as described herein, required by other Sections, as shown, and as required to provide a properly operating and integrated system.

B. The installing, configuring, developing, testing, documenting, and placing in satisfactory operation all software associated with the Programmable Logic Controller (PLC) will be provided outside this contract.

1.2 SYSTEM CONFIGURATION

A. The system configuration shall be as specified herein and as described in Section 40 61 96, Process Control Descriptions. Some variations in the configuration will be considered provided functional constraints as intended for the various components of the system are met.

B. The Contract Document illustrate and describe the overall PLC System functional and operational requirements. The PLC Supplier is responsible for tagging, integrating, and verifying the functionality of all system components.

C. All process and monitoring software shall be designed and manufactured specifically for the demanding requirements of real-time process management and control on a continuous basis.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. SCADA software shall be commercially available off-the shelf and shall be non-proprietary, such that independent systems integrators are able to provide configuration and maintenance services as required. Software shall be Trihedral VTScada to match the existing installation and the software shall meet the requirements specified herein.

B. Software shall be a Client/Server architecture. No Microsoft Client Access Licenses (CAL) or Terminal Services shall be required for full installation (thick) or browser-based (thin) clients.

C. Software shall offer options for unlimited, concurrent Thin Client connections for connectivity of common mobile device operating systems.

D. Software shall support running as a Microsoft Windows® service.

E. Software shall support development from a thin client.

F. Software shall support running in a virtualized server environment.

G. Software shall support installation on a Storage Area Network (SAN) or Network-Attached Storage (NAS).

H. Software shall support IPv6 addressing and be able to run on networks that support IPv4, IPv6 or both.

I. Software licenses shall be upgradable for an annual fee such that the client is able to download and install the current version of the product.

J. Software shall be tag-based and have an integrated development environment for creation of all aspects of the application.

K. Software shall be compatible with commercially available, off-the shelf PC hardware running Microsoft Windows client and server operating systems currently available at the time of installation.

L. Software shall not require dedicated server-level PC hardware for any individual system components.

M. Software shall support any computer running a thick copy of the software performing as both an application server and a user interface. Software shall support automatic server failover to an unlimited number of servers.

N. Software shall include the following integrated components available as standard components or for an optional add-on price. These components shall not require 3rd party software. However, the system shall allow 3rd party components to be used if required.

1. Online application development environment with version control.
2. I/O drivers for a wide selection of communication protocols.
3. Alarms management and alarms/events history.
4. Fully integrated historian.
5. Real-time and historical data trending and tabular views.
6. Report generation.
7. Security management.
8. Unlimited operator logbooks.
9. Support for networked applications.
10. Support for server redundancy.
11. Native High Performance / HMI widgets.
12. Support for master applications, which are able to monitor multiple independent subordinate applications.
13. An object-oriented scripting language with debugging tools.
14. Browser-based thin clients for PCs and Mobile devices.

15. Alarm notification to off-site operators (email, text message and voice.)
16. Interfaces for 3rd party software programs to access data and alarms from the SCADA software via ODBC/SQL via a REST interface, OPC, SNMP.
17. Drivers to read MQTT, JSON, SQL and XML data sources.
18. Support for translating the user interface into any language.

O. Software shall automatically compensate for deploying the same application simultaneously on a variety of monitor resolutions, while maintaining the aspect ratios of all displays.

P. Software shall protect against file corruption in the event of an unexpected loss of power or hardware failure. Software shall support an automatic, orderly shutdown when power levels drop to a user defined setpoint.

Q. Software shall support automatic startup upon computer restart, to full operation without user intervention.

R. Software shall provide a mechanism to backup and restore the entire application configuration.

S. Software shall include an integrated security system supporting an unlimited number of user accounts, roles and privileges. System users with appropriate account privileges shall be capable of changing the application configuration without requiring the software supplier's assistance. No lockout mechanisms or passwords shall be withheld from the final customer.

T. Integrated software help manuals shall be provided to assist operators and maintenance personnel with operational and configuration tasks.

2.2 Server Redundancy and Load Balancing

A. Redundancy

1. A minimum of two levels of redundancy for all application services shall be supported. Software shall support automatic failover from primary server to backup server(s). No manual intervention shall be required. This functionality shall be supported in both standard and virtual server environments.
2. Software must not require each redundant server to use a second network card to monitor the availability status of the primary server.
3. All servers shall be aware of which server is in control of each software process. No two servers shall perform the same function at the same time (e.g. I/O communications to a specific device, incrementing a totalizer.)

B. Load balancing

1. Software shall support the assignment of specific services (e.g. driver connections, alarms management, alarm notification) to specific computers.
2. Software shall support the use of named server lists, to which drivers can be assigned rather than requiring that a separate list be created for each driver.
3. Software shall support distribution of historical data storage to an unlimited number of computers.
4. Software shall support management of alarm and event history separately from I/O process history.
5. Software shall allow each workstation to hold a complete and automatically synchronized copy of alarm and event history so that alarms can be managed locally on any workstation if the workstation's connection to the rest of the network is lost.
6. Software shall automatically redirect incoming thin client connections to the server with the lowest number of active thin client connections.
7. Software shall support redundant networks and shall be able to use these for load distribution when both are available.

## 2.3 Thick (full installation) Client User Interface

A. Software licensing shall not limit the number of application display pages allowed.

B. Software shall support the following navigation methods:

1. A menu for navigating from one display to another. Menu shall be configurable to allow logical grouping of displays.
2. Tiled view of any number of displays concurrently, all tiles showing real-time data or pictures of displays (user-selectable). Selecting one of the tiles will switch to the full-screen view of that display.
3. Mouse-over selectable hot box for navigating to a specific display.
4. Button for navigating to a specific display.
5. Browser-like forward and reverse buttons to scroll through previously viewed displays.
6. A list of previously viewed displays with the option to navigate to a selection from the list.
7. A mapped view of assets with the option to navigate to an application display by selecting any asset from the map.

C. Application displays shall be event-driven, in that data will be delivered to client computers by the server immediately upon receipt. Client computers will not poll the server for new data.

D. Means shall be provided to allow the operator to print graphical displays.

E. Software shall support flagging tags as ‘questionable data’ (i.e. not commissioned or value is in question.) These values will continue to display the incoming values. These flags shall be removable by users with sufficient privileges.

## 2.4 Thin (browser-based) Clients

A. Software shall offer an optional zero-footprint thin client for use with HTML5-compatible browsers running on operating system variants, including

1. Windows
2. Linux
3. Apple
4. Android

B. Server for thin clients shall be an integral feature of the SCADA software. Use of the thin client shall not require a 3rd party Internet server software (e.g. Microsoft IIS, Apache).

C. System shall support two levels of server redundancy for thin client connectivity, with automatic failover and client load sharing.

D. System shall support cyber security measures including Firewalls, Virtual Private Networks (VPN) and Secure Socket Layer (SSL.)

E. OpenID Connect shall be supported for secure thin client logons.

F. Thin client connections shall be concurrent. Tools shall be provided to monitor client connectivity and to disconnect users or switch them to alternate servers on demand.

G. The thin client shall share the same security accounts as the rest of the SCADA Software. A separate privilege shall be required for browser client access. Revocation of this privilege will immediately terminate the user's client connection.

H. Thin Client displays shall be generated automatically, requiring no additional configuration.

I. On-line configuration changes shall be deployed immediately to all thin client interfaces without requiring the client interface to be restarted or refreshed.

J. An authorized user on a thin client connection shall be able to perform configuration changes.

K. The Thin Client user interface shall be offered in two variants, the choice of which to use being user selectable.

1. Graphical (preferred for large user interfaces) – A user experience mirroring (graphically and operationally) that of the Thick Client.
2. Text-based (preferred for mobile phone interfaces) – Simplified lists of monitored values, with support for control actions, alarms management, trending and mapped asset view.

## 2.5 Historian

A. Historian shall support logging of all the SCADA system data, including real-time, historical, transactions, and alarms and events, regardless of the number of tags in the system. For example, a 25,000-tag system shall support historical data storage for 25,000 tags, plus alarms and events.

B. Software shall include an integrated Historian and historical data storage at no additional cost but may optionally use Microsoft SQL Server as the database.

C. The Historian and its historical data storage shall not require dedicated server computers; however, dedicated servers may be used if preferred by the customer.

D. Historian shall be capable of logging up to 4,000 values per second.

E. A synchronization scheme shall be included such that a copy of all historical data storage resides on all designated computers. Data shall be synchronized in real-time.

F. Any historical database that has been offline must be automatically resynchronized with the historian holding the most recent data. Software shall be capable of synchronizing 100,000+ values per second between databases. This process shall occur in parallel with runtime SCADA processes and shall be designed to minimize interference.

G. Distributed Historian architecture shall be supported. For example, two plants (A and B) may be responsible for historical storage for locally collected data, while a central facility (C) may be responsible for redundant historical storage for both A's and B's data. This architecture shall be scalable to support the addition of future plants.

H. Historian shall support SQL queries of logged historical data. Queries of historical data may be for raw data or summary (value at beginning, average, max, min, delta) over a period.

I. Historian shall be able to import collected data that was not available to be logged in real-time.

## 2.6 Transaction Data

A. System shall provide a means to reliably collect and log (to historical data storage) transaction data from a field device. Transaction data is defined as a data set of related values stored with the same timestamp.

B. The transaction data capture process must include error checking.

## 2.7 Historical Data Display (trend plots and tabular)

A. Software shall display historical and real-time data in both plot and tabular format.

B. Software shall allow users to generate ad-hoc plots of historical data by clicking on each of the values to be trended. Selected groups shall be recordable for future recall.

C. Software shall support ad-hoc and preconfigured trend plots of real-time and historical data as integrated elements of graphical process displays. Historical and real-time plotted values shall be shown in a continuous, uninterrupted, scrolling fashion. The display shall support:

1. An unlimited number of pens (i.e. tag values), including both analog and digital values. Name and description of each tag shall be provided.
2. Analog pens as either layered or as stacked individual plots.
3. Time frame selectable from one second to five years.
4. Scaling for each pen as high/low values or graduated divisions.
5. Value of each tag at the date/time of the mouse location.
6. Statistical data, including average, minimum and maximum values, for each plot.
7. Annotating trends
8. Stop/pause scrolling.
9. Zoom in/out on the time (x) and value (y) axes.
10. Pan/Scroll along the time axis or select a date to display.
11. Move analog tag plots vertically (in the value (y) axis), either individually or as a group.
12. Print displayed plot data.
13. Annotate a moment in time on the plot.
14. Display alarm setpoints that are associated with the tag(s) as continuous marker lines across the plot.
15. Export plotted data to comma separated value (.csv) file or directly to a database, for use by 3rd party data analysis software.
16. Display plot data on a dedicated page, or as a component of a process display page.
17. Allow configuration of the plot display characteristics.

D. For tabular data, means shall be provided for the following:

1. An unlimited number of pens (i.e. tag values), including both analog and digital values. Name and description of each tag shall be provided.
2. Time frame selectable from one second to five years.
3. Stop/pause scrolling.
4. Show raw data.
5. Show summary data for a duration sampled at consistent periods (e.g. average, minimum or maximum value every 15 min for past 8 hrs.).
6. Export plotted data to comma separated value (.csv) file or directly to a database, for use by 3rd party data analysis software.

2.8 Alarms and Events Management

A. Software shall include alarms and events management tools consist with implementation of the ANSI/ISA 18.2-2009 Management of Alarm Systems for the Process Industries standard.

B. Software shall include a predefined alarms and events management interface. The interface shall provide the following operational tools.

1. Lists of Current, Unacknowledged, Disabled, Active, Configured Historical and Shelved alarms and events.
2. Tools for searching and filtering lists.
3. Add a blog-style note to any alarm.
4. Notes may not be edited after saving, but comments may be added.
5. Day and night view toggle.
6. Acknowledgement of individual alarms or all visible alarms.
7. Option to require confirmation before acknowledging all alarms in the list.
8. Option to require that a note be created when alarms are acknowledged.
9. Font size adjustment for visually impaired users.
10. Representation of alarm priorities using shape, color and numeric priority level for enhanced operational awareness.
11. Option to plot data associated with an alarm.
12. Option to open a process display where the alarm is currently shown.
13. Option to have a relevant process display open automatically if there is no operator action for a defined period of time following the triggering of that alarm.
14. Alarm mute and silence.
15. Alarm shelving options for a defined period or indefinitely. Shelved alarms shall still be recorded to the alarms history but shall not annunciate or require acknowledgement.
16. Option to include or exclude shelved alarms in the list of Current, Unacknowledged, and Active alarms. Shelved alarms to be visible at all times in lists of Historical alarms and events, Configured alarms and Shelved alarms.

C. Alarm acknowledgement shall immediately be propagated to all networked stations.

D. A full redundant copy of alarm and event history shall be stored on every workstation, allowing that workstation to continue to process local alarms if it becomes isolated from the network. History to be automatically synchronized when the workstation is reconnected to other servers.

E. Software shall allow alarms to be associated with functional areas, such that a user only has to deal with alarms in his/her functional area(s).

F. Alarm occurrence, acknowledgement, clear, disable and shelve actions shall be recorded.

G. Alarm disabling to be provided only as a configuration option, not as an operational action.

H. Software shall provide user-configurable settings for dead band on analog alarms and delay on analog and digital alarms.

I. Alarms and events records shall include:

1. Time/Date stamp.
2. The name and description of the alarm tag.
3. Priority.
4. Status of Alarm (i.e. Active, Acknowledged, Cleared). Alarm Acknowledgement records shall include the name of the user who acknowledged the alarm.
5. The value of the associated tag at the time of alarm occurrence.
6. The value of the alarm setpoint at the time of alarm occurrence.

J. Software shall support an unlimited number of alarm priorities and shall allow unique annunciation sounds, shapes, and colors for each.

K. Alarm annunciation shall be configurable to use alarm tones, text to speech descriptions, sound files or popup displays.

L. Users must be notified, both visibly and audibly, of the occurrence of an alarm, regardless which display is presently being viewed.

2.9 Alarm System Auditing and Reporting

A. Software shall support printing of alarms/events created over a range of dates/times.

B. Software shall provide a means to identify frequently occurring alarms (e.g. nuisance alarms.

C. Software shall provide a means to identify and analyze alarm flood conditions.

D. Software shall provide a summary of alarm percentages by priority, for comparison with generally accepted percentages as defined in the ANSI/ISA 18.2-2009 Management of Alarm Systems for the Process Industries standard.

2.10 Alarm Notification System (for remote users)

A. The Alarm Notification System shall support alarm notification via dial-out over voice modem (using text-to-speech), an Internet service such as Twilio®, SMS text message, email and alphanumeric pager. Alarm acknowledgement shall be supported during voice calls and via email and text message.

B. The Alarm Notification System shall allow status retrieval and alarm acknowledgement via dial-in over voice modem (using text-to-speech.)

C. The Alarm Notification System shall be an integrated feature of the SCADA systems and shall not require a separate tag database and security system.

D. Email messages shall support outgoing mail with transport layer security (e.g. corporate email server.)

E. The Alarm Notification System shall be capable of annunciating alarms to rosters of users with up to 30 contacts per roster. An unlimited number of rosters shall be supported. The system shall support associating rosters with functional areas, such that alarms in these functional areas will activate notification to the appropriate contacts.

2.11 Site Lists and Mapping

A. Software shall allow for the creation of "sites" which are collections of I/O tags, with an optional location that can be represented using Latitude and longitude coordinates.

B. Sites shall be user-definable to store and provide a configuration interface for any user-specified data.

C. Sites shall be user-configurable to control whether and how they are to be displayed in Site Lists.

D. Sites shall be user-configurable to control whether they will open a pre-defined screen showing the associated collection of I/O tag data, or open a user-selected display screen.

E. Software shall include an integrated map display with zoom and pan features such that remote assets can be automatically mapped based on latitude and longitude coordinates.

F. Software shall support user-selection of the map style to use, including night-time and day-time modes.

G. Software shall allow for user creation and selection of the icons used to represent sites on the map.

H. Software shall allow users to navigate the map including zoom and pan features.

I. Icons used to represent sites on the map shall be capable of displaying information about the site including current connection status and presence or absence of active alarms within the site.

J. Icons used to represent sites on the map shall include a built-in navigational link to either an automatically generated page displaying all I/O tags within the site, or to a user-selected page.

K. Software shall provide a means to define and display pipes or other connections between sites.

L. Pipes or other connections between sites shall be user-configurable to include any relevant information about the connection.

2.12 Security Management

A. Software shall include a security system with privilege and role-based user accounts. Level-based access shall not be acceptable.

B. All output controls shall be locked automatically when no user is signed in.

C. Security system shall support an unlimited number of user accounts and roles. System shall allow creation of an unlimited number of additional security privileges where necessary.

D. User passwords must be configurable to require a minimum length, contain a combination of letters, numbers and special characters, and expire after a pre-set period. User passwords shall be stored in an encrypted format.

E. System shall allow changes to user accounts, and roles and privileges while the application is running. Changes shall become effective immediately.

F. User sign-in and sign-out activity shall be recorded in the application event log. Disabling accounts after X failed attempts within Y seconds shall be supported where X and Y are configurable options.

G. System shall provide a mechanism to limit client access to specific IP addresses.

H. System shall support authentication of user accounts via a Windows domain and authorizing SCADA user roles from domain security groups.

I. System shall support the use of proximity cards/readers.

J. The integrated version control system shall allow the option of including or excluding security-related changes if returning the application to an earlier configuration state.

2.13 Report Generation

A. Authenticated operators shall, in the runtime environment, be able to produce reports including any analog, digital or calculated tag data from the historical database.

B. Data format options shall be as follows:

1. To screen.
2. To a comma separated value (.csv) file.
3. To a text file.
4. To an ODBC-compliant database.
5. To any direct-connected or networked printer.
6. To a 3rd party software (e.g. Microsoft Excel) template for advanced data analysis and formatting.
7. To e-mail, if an external email server is provided.

C. Reports may be created for one-time use or saved for reuse.

D. The following reports should be included:

1. Analog Summary Report

2. Daily Snapshot Report
3. Daily Total Report
4. Derived Flow Report
5. Detail Report
6. Driver Communication Error Detail Report
7. Driver Communication Summary Report
8. Hourly Snapshot Report
9. Hourly Total Report
10. Rainfall Report
11. Pump Activity Report
12. Pump Discrepancy Report
13. Standard (raw data) Report

E. Report generation shall be invoked either on demand, by a monitored event, or on a scheduled basis.

F. For reports that are created on a scheduled basis, a mechanism shall be provided to allow operators to re-create the last scheduled report.

G. A data-query add-in tool be available for addition to Microsoft Excel®, thereby allowing reports to be generated in that program.

2.14 Electronic Operator Notebooks

A. System shall support operator logbooks for recording ad-hoc notes or predefined notes as threads, in that notes can have associated comments.

B. Notebooks shall be searchable by keyword, user account and time/date.

C. Notebooks shall be color-coded for easy identification.

D. System shall support creation of an unlimited number of notebooks for association with system elements, such as equipment and trended pen groups.

E. All notes shall be encrypted and include the name of the user's account and the time/date of creation. All notes entered into the notebook shall be immediately viewable from all clients and servers.

F. System shall not allow editing or deleting notes once created, to prevent tampering.

G. System shall support the addition of comments to existing notes.

H. System shall support the option of requiring operator authentication as part of the note creation process.

I. System shall support printing of notes by range of dates/times.

J. System shall support the export of notes for a selected range of dates, to a format that can be easily viewed / printed from any workstation without the need for a (HTML)

2.15 Integrated Development Environment

A. An intuitive graphical development environment with drag and drop tools shall be used for configuration of application displays. A ribbon bar along the top of the display, as common to Microsoft office tools, is preferred.

B. Displays shall support zoom and pan actions.

C. A large library of static and animated graphics including High Performance / HMI tools shall be provided with the software. Software shall support dragging and dropping additional graphics into the library.

D. Standard features shall be included for the following:

1. Analog and digital inputs and outputs.
2. Retentive counters. Values will persist if power is lost and subsequently restored or if failing over to a backup server.
3. Retentive totalizers. Values will persist if power is lost and subsequently restored or if failing over to a backup server.
4. Historical calculations (e.g. average flow over last hour.)

E. Software shall include pre-built displays for standard user interfaces. The following pre-built displays shall be provided as a minimum:

1. Alarm display that can be filtered by name and includes current, unacknowledged, disabled, shelved and history.
2. Trending and tabular viewing of historical data.
3. Report creator.
4. Operator notebook.
5. Site map.
6. Site list.

F. Software shall allow calculations to be associated with each graphic object to facilitate movement, visibility, sizing, and rotation.

G. Software shall allow multiple objects to be saved as a template graphic. The following template capabilities shall be supported:

1. A template may be associated with a tag structure.
2. Each new instance of the template will inherit the properties of the template, such that changes to the template will automatically update all instances created from it.
3. The template may have any number of parameters, including tags and text values, which can be used to animate objects within the template. Each new object created from the template may include different parameters.
4. Templates may be imported from other projects.
5. Copy/paste/rename/delete for any template.
6. Ungrouping of any instance of the template.

H. Software shall support the creation of template displays. The following capabilities shall be supported:

1. A template display may be associated with a tag structure.
2. Each new instance of the template will inherit the properties of the template, such that changes to the template will automatically update all instances created from it.
3. The template may have any number of parameters, including tags and text values, which can be used to animate objects within the template. Each new object created from the template may include different parameters.
4. Templates may be imported from other projects.
5. Copy/paste/rename/delete for any template.

I. There shall be no limit to the number of animated graphics that can be used to represent the same tag value.

J. Software shall support background bitmaps on graphical pages.

K. Users shall be able to select all or a subset of the graphics on any display and see a list of the associated tags. The list of tags shall be modifiable individually or using search and replace tools.

2.16 I/O Drivers (Field Device Communications)

A. Software shall support an unlimited number of field devices and different I/O drivers in the same application.

B. Software shall include support for communications over Serial port, TCP/IP and UDP/IP

C. Software shall include, at no additional cost, I/O drivers for:

1. Protocols – As a minimum the following shall be included: Ethernet/IP (CIP), Allen Bradley DF1, Koyo/Automation Direct DirectNet, DNP3, Modbus ACSII, Embedded, TCP, RTU, SQL Data Query, MQTT data and JSON/XML data.
2. Manufacturers Rockwell/Allen Bradley, PLC Direct (Koyo), Schneider Electric, and Square D.
3. Other - API, OPC Client to support OPC Servers from 3rd party software providers.

D. Software shall support the development of additional I/O drivers where necessary.

E. Software shall support multiple communications protocols over a single communications port.

F. I/O drivers shall support redundant failover to one of more server computers. Software shall support redundant physical links to any field device, such as primary connectivity via Ethernet and redundant connectivity via serial port. Redundant links shall support similar or different protocols.

G. Software shall provide tools for polling telemetry devices (e.g. RTUs) directly. Software shall allow real-time tuning of each device's polling frequency without interrupting the polling cycle or restarting the application. To optimize I/O communications for telemetry applications, the polling order shall be configurable, and polling shall be asynchronous (if permitted by the remote telemetry unit.)

H. Software shall be capable of pooling modems connected to one or more servers, for use in I/O communications.

I. Tools shall include methods for monitoring communication statistics and reporting errors for each I/O driver. Software shall support radio diagnostics monitoring for radio modems (e.g. Dataradio/Calamp, MDS.)

J. Software shall support writing to multiple output tags via a single write request. This shall allow writing a set of default values to a set group of field device registers.

K. Software shall support rewriting the last written value to an output.

2.17 Tag Database

A. A browser shall be provided for tag creation, modification, and deletion. The tag browser shall include a summary of all tags' current addresses and values.

B. A tag export/import utility shall be provided to allow bulk tag changes using Microsoft Office tools.

C. Software shall support the creation of template tag structures to represent a typical piece of equipment (e.g. a pump, an engine.)

D. Tag configuration shall support the use of expressions that can set configuration parameters based on developer-defined rules.

E. Template tag structures shall be copied and pasted to create any number of equipment instances having similar structures but differing configuration.

2.18 Configuration Management

A. Software shall be capable of on-line configuration. That is, changes to most aspects of the application (e.g. tags, displays, calculations, reports, trends, server lists) can be deployed in real-time without recompiling or restarting the application or restarting computers.

B. Software shall be capable of offline configuration, such that changes to most aspects of the application can be imported and deployed without recompiling or restarting the application or restarting computers.

C. Software shall be capable of testing configuration changes to tags and displays in the runtime environment before changes are deployed.

D. Users shall be able to deploy a set of changes either automatically or manually, with the option to select and deploy specific changes.

E. Software shall allow multiple users to configure an application simultaneously.

F. Any shut down client shall automatically download newly deployed changes from the server when the client is restarted.

G. All application servers and clients shall automatically synchronize with the primary application server. No manual file duplication shall be required.

2.19 Application Version Control

A. The software shall have an integrated version control system that automatically logs application configuration changes to an encrypted repository. Versions shall be auto numbered. No manual changes to the repository shall be permitted.

B. A chronologically ordered summary of versions shall display the time and date when the version was created, the user who created the version and any comments entered by the user when deploying the version.

C. It shall be possible to determine which version is currently deployed on each client and server station.

D. The version history shall allow review of all changes applied within each version.

E. The version control system shall allow the following version management methods.

1. Switch (aka rollback) to a previous version of the application.
2. Reverse changes applied during a specific version.
3. Merge changes made local to a specific workstation.
4. Option to include or exclude security changes made between the current revision and the target revision when switching.

2.20 Multi-Plant Application Support

A. Software shall allow centralized configuration, security management and monitoring of multiple sub-applications by one master application. The sub-applications may be connected via either LAN or WAN.

B. Tags viewed in both the sub-application and the master application shall not be counted twice.

C. The master application shall be capable of monitoring all tags, pages, alarms, etc. in all sub-applications.

D. Data logging shall be managed by each sub-application, but the master application shall be able to generate reports using any sub-application’s data.

E. Each of the sub-applications must be capable of running autonomously in the event of network unavailability.

F. Software shall allow users to be authorized for access to information from one or more sub-applications, or all sub-applications, of the large application.

G. Software shall support limiting the sub-applications that can be accessed from a specific SCADA node.

## 2.21 Information Technology (IT) Tools

A. Software shall include server-to-server and server-to-client IP link monitoring for the SCADA network. Link failure shall generate an alarm.

B. Software shall include tools for monitoring of historical data storage.

C. Software shall include tools for monitoring of any modems and SMS appliances used for sending alarm notifications to remote operators.

D. Software shall include an SNMP Agent option for integrating with Network Monitoring Software.

E. Software shall include tools to monitor computer resources (e.g. CPU, virtual memory, drive space) with the ability to generate an alarm on an out of range condition.

## 2.22 Product Upgrades, Support and Training

A. Software must have a history of allowing applications that have been deployed on current technology (operating systems and PC hardware) to be upgradable to new technology with minimal change to the application.

B. Software must have a history of allowing applications that have been deployed on one version of the product to be upgradable to a new version with minimal change to the application.

C. Software manufacturer shall offer product support via phone, email, user forum and remote access methods (e.g. Remote Desktop.)

D. Software training shall be available from the manufacturer via classroom courses and self-directed study (e.g. workbooks and tutorials online.)

# PART 3 - EXECUTION

A. All software development of the VTScada must follow the Owner’s SCADA Standards Manual whether if the development is performed by the CSI or outside of the contract.

END OF SECTION

SECTION 40 68 23

REPORTING SOFTWARE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The CSI shall load, configure, develop, test, document, and place in satisfactory operation all software associated with reporting, as described herein, required by other Sections, as shown, and as required to provide a properly operating and integrated system.

B. The installing, configuring, developing, testing, documenting, and placing in satisfactory operation the reporting software will be provided outside this contract.

C. In general, the Owner has existing automated reports that execute each evening. These reports may need to be modified as part of the project scope. These reports may also be used a go-by to create new reports.

1.2 SUBMITTALS

A. Sample of each report specified or being provided as part of the project scope.

B. Submit the report configuration files or backup of the project using the tools within the software

1.3 REPORT TYPES

A. Daily Operating Report – this report provides the minimum, maximum, average and totals for a 24-hour period. The values are the required analytical values and recordable flows required by the regulatory agencies.

B. Weekly Operating Report – this report provides the minimum, maximum, average and totals for a 7-day period and generated on Monday of each week. The values are the required analytical values and recordable flows required by the regulatory agencies.

C. Monthly Operating Report – this report provides the minimum, maximum, average and totals for each day for the entire month. This report is generated each day or at the end of the month. The values are the required analytical values and recordable flows required by the regulatory agencies.

PART 2 - PRODUCTS

2.1 FUNCTIONALITY REQUIREMENTS

A. The reporting software shall be capable of running on the latest operating system (Windows 10 or later). The software shall be able to use Microsoft Excel or build reports within the software that mimics Microsoft Excel.

B. The software shall be able to connect to multiple databases which shall include Microsoft SQL and Trihedral VTScada by using OBDC and direct connection to the HMI software.

C. The software shall include an easily configurable tag group definition list. Tags can be split into groups to better organize the project configuration file.

D. The system shall include an easily configurable tag definition list. Tags in the HMI/SCADA system(s) and/or values contained in the SQL compliant Database(s) for which reporting is desired will have a corresponding tag in the reporting software tag definition list. The software shall allow users to abstract the reporting system tagname from the actual item name.

E. The system shall include a feature that allows users to make modifications to tag attributes and apply them to a group of tags simultaneously.

F. The current definitions for Databases, Tables, Tag Groups, and Tags shall be exported on demand to separate xlsx files. Each of these .xlsx files can be modified and imported to facilitate software configuration.

G. The software shall support automatic output to the following destinations:

1. Printer
2. Email
3. Excel Workbook (.xlsx) file

H. When outputting to an Excel Workbook file, the software shall be capable of generating unique files. The files shall be named according to the date that they were created, the facility and the type of report. The type of report shall be abbreviated such as:

1. MOR – Monthly Operating Report
2. DOR – Daily Operating Report

I. Reports shall be capable of being run automatically via the built-in task scheduler. Reports can be configured to run for any custom time frame or for the following time periods:
1. Today
2. Yesterday
3. This Week
4. Last Week
5. This Month

J. The report reporting generation software system shall be as manufactured by XLReporter as manufactured by Sytech.

PART 3 - EXECUTION

3.1 GENERAL

A. All software development of the XLReporter must follow the Owner's standards and use the existing Operator Workstation Nodes at each facility unless the project scope is to provide and install a new installation of the reporting software.

3.2 SUPPORT

A. If a new license is being provided as part of the project, software support which includes phone support with tech support for one (1) year shall be provided.

END OF SECTION

SECTION 40 70 00

PROCESS CONTROL FIELD INSTRUMENTATION

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment required to provide a complete and operable Instrumentation and Control System (ICS) as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.

B. The system shall Control System Integrator (CSI) shall provide full onsite supervision of all equipment provided under this section, where installation is provided by others.

C. Field equipment (i.e. primary elements, measuring devices, transmitters, field controllers, chart recorders, indicators, and other instrumentation and accessories) shall be provided with all components necessary for a fully functional device whether specifically mentioned in these specifications or not. This shall include, as applicable or recommended by the manufacturer: sample conditioning, sensors, sensor holder and mounting brackets, transmitter, all required cables, calibration equipment, chemicals, reagents, and spare parts.

D. Specialty cables between sensors/probes and their electronics/transmitters shall be furnished with each instrument. Cables shall be coordinated with the conduit installation and be of sufficient length to not require any splicing. Special cables include any type of cable not specified in Division 26 – Electrical.

E. Equipment shall be provided by the CSI unless shown with an asterisk on the PIDs designating equipment by others.

F. Panels will be designed with consideration given to routing of cables and piping, maintenance, and calibration. The panel designs will be submitted with the field measurement equipment for approval.

1.02 SUBMITTALS

A. All submittals shall be in accordance with Section 01 and as specified in Section 40 61 13 – Process Systems General Provisions. In addition, the following specific submittals items shall be provided:

1. An ISA specification sheet for each instrument furnished and/or calibrated shall be submitted with the field equipment submittals. The ISA data sheet shall be in accordance with ISA Standards ISA S20 “Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves” and ISA TR20.00.01 “Specification Forms for Process Measurement and Control Instruments”.
2. The CSI and the field equipment manufacturer shall review the proposed installation and configuration of all field equipment, prior to submittal for

approval, and shall identify any condition which shall require corrective measures. The following as a minimum shall be reviewed for the installation configuration of each instrument:

a. Listed features
b. Material of construction
c. Consideration of process fluid
d. Environmental conditions
e. Installation location
f. Process connections
g. Ability to perform maintenance

3. Submit in writing in the field equipment submittal, that each piece of equipment is suitable for the proposed installation. Any proposed deviations shall be reviewed by the Engineer prior to execution.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Unless otherwise specified, instruments shall be provided with enclosures to suit the specified environmental conditions. Field-mounted devices shall be rugged and mounted on walls, equipment racks, or pipe stanchions. Where the field equipment's integral enclosure for a specified instrument is not available with the specified environmental rating, the field equipment shall be provided in a control enclosure as specified in Specification Section 40 67 17 - Process Control Panels and Enclosures.

B. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted or shown on the Contract Drawings, installed adjacent or near to the sensor, in a readily accessible location. Special cables that are required for interconnection between sensors or probes and transmitters shall be furnished with the instrumentation devices by the associated equipment manufacturer. Special cables shall be of the required length for the equipment locations and conduit routing paths shown on the Contract Drawings. No splicing of cables will be accepted.

C. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture, and fungus. Ambient conditions shall be -15 to 50° C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid and corrosive service conditions.

D. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 120 VAC, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

E. All analog transmitter and controller outputs shall be isolated, 4-20 mA into a load of 0-750 ohms minimum, unless specifically noted otherwise.

F. Each field instrument receiving a power source of 120VAC shall be provided with a field mounted disconnect switch, as specified under Division 26, allowing the incoming power to the instrument be removed or turned off at any time. Instruments mounted adjacent or nearby other instruments shall each have their own individual disconnect switch, where multiple instruments on one disconnect switch is unacceptable.

G. Process taps for primary sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and taps for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

H. All instrumentation exposed to sunlight shall be provided with sunshields constructed from 316 stainless steel. Sunshields shall be designed to withstand regional wind and ice loads. Sunshield design shall be submitted for approval.

I. All outdoor external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation, and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating, and shall adjust its heat output to the temperature of the lines.

J. Each instrument shall include a stainless steel tag, with tag number and calibration data from the contract drawings, attached to the instrument. Where not physically connected to the instrument, the tag shall be attached with stainless steel wire.

## 2.02 TOOLS, SUPPLIES, AND SPARE PARTS

A. Tools, supplies, and spare parts shall be provided as specified in Section 40 61 13 – Process Control Systems General Provisions, and as specified for each equipment item. In addition, the following items shall be provided:

1. All instruments shall be supplied with one (1) years' worth of supplies, including chemicals and reagents, for the calibration, operation and maintenance of the device.
2. One (1) spare water quality analyzer/transmitter from same manufacturer for each type provided.

## 2.03 ACCESSORIES

A. Instrument tubing shall be 1/4 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with Type 316 - 37° stainless steel flared fittings, or equal to Swagelock or Parker-CPI flareless fittings.

B. Diaphragm seals shall be provided to systems as shown on the Contract Drawings, as specified herein and/or for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. Diaphragms shall be 316L

stainless steel for operating pressures at or above 15 psi, and elastomers for operating pressures below 15 psi. Diaphragm material shall be non-reactive with the process fluid. Refer to the Instrument Schedules for specific materials requirements. Seal shall have fill connection, 1/4-inch NPT valve flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements, and shall be provided with 316 stainless steel factory filled capillaries. Seals shall be equal to Helicoid Type 100 HA, Mansfield & Green, Ashcroft or approved equal.

C. Isolating ring seals shall be provided for sensing elements measuring pressure in solids bearing fluids. For heavy solids/slurry applications, wherever the associated pressure instrument is used for control purposes, or where shown on the Contract Drawings, the sensor body shall be full line size wafer design, with 316 stainless steel housing and assembly flanges, and Buna N flexible cylinder lining for in-line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Isolating ring seals shall be equal to RED Valve Series 40, Ronningen-Petter Iso-Ring, Moyno RKL Series W or approved equal.

D. For all other solids bearing fluids, pressure shall be sensed via a 1/2" diameter spool-type isolating ring seal, mounted on a 1/2" pipe nipple at 90 degrees from the process piping. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally. Isolating ring seals for normal solids service shall be equal to Red Valve Series 42, Peter Iso-Spool, or equal.

E. Isolation valves shall be 1/2-inch diameter ball valves with 316 stainless steel body, 316 stainless steel ball.

2.04 SURGE PROTECTIVE DEVICES (SPDs)

A. SPDs shall be supplied for all field equipment power, signal, and communications wires that have any portion extending outside of a building. Refer to Specification Section 40 67 17 – Process Control Panels and Enclosures for requirements.

2.05 LEVEL SWITCH, SUSPENDED FLOAT TYPE

A. Float switches shall be of the non-mercury displacement type, encapsulated in polyurethane or vinyl floats.

B. Units shall be waterproof, shockproof, explosion-proof and equipped with sufficient submersible cable to extend to the control panel or junction box without splicing.

C. Any required weights shall be provided. Switches shall be suspended on a suitable rack or rail of stainless steel construction.

D. Suspended type float switches shall be equal to Flygt ENM-10, Anchor Scientific Eco-Float or approved equal.

2.06 LEVEL/FLOW TRANSMITTER, ULTRASONIC TYPE

A. Ultrasonic transmitters shall be provided for measurement of tank, wet well, and pond levels or for flow measurement based on level over a weir or flume. Equipment shall be provided with features and accessories as described herein and suitable for the application.

B. Ultrasonic level/flow transmitters shall meet the following specifications as a minimum:

1. NEMA 4X enclosure
2. 120VAC, 60Hz input power
3. Process display with keypad for menu driven configuration
4. One (1) isolated 4-20 mA output.
5. One (1) alarm relay output
6. Non-volatile memory
7. Accuracy: 0.25 %

C. The CSI shall provide all mounting hardware and coordinate the details of the installation so that the instruments are installed in keeping with the best standard and recommended practices of the manufacturer and conforming to the requirements set forth by the Engineer.

D. Level/flow transmitters shall be fully programmable and configurable using a computer and keypad. The final 'As-Built' documentation shall be provided with a tabulation of the Programming Parameters used in each level/flow transmitter so that the initial calibration can be reproduced if a spare transmitter is installed.

E. Level/flow transmitters shall be provided with optional integral analog signal isolators, as part of the transmitter assembly. All conduit connections shall be sealed to prevent damage or corrosion due to vapors or wetness.

F. Ultrasonic Level/Flow Transmitters shall be Siemens Hydroranger 200 (An alternative model # is Siemens LUT-400, for level measurement, and LUT-430, for open channel flow measurement. The LUT has only one analog output, 3 relay outputs, and has a higher immunity to noise, and is HART communications.) with Echomax XPS-15 sensors. Refer to the Instrumentation Schedule Attachment for flange mounting requirements. Transmitters shall be installed using the appropriate transducer, suitable for the range and process connection of the installation. The cable provided with the transducer shall be ordered with sufficient length to provide installation without splicing the cable at any point.

G. The CSI shall provide mounting hardware components and appropriate mounting assistance to install and secure the transducers in a manner in keeping with the recommendations of the manufacturer of the equipment and in keeping with the general details provided in the drawings. All hardware shall be fabricated from corrosion resistant materials and shall utilize stainless steel hardware. The

mounting system shall be secure and permanent and shall allow easy access to the sensor for servicing. All cables shall be installed in suitable rigid conduit with only short lengths of flexible conduit allowed to complete the installation.

H. In cases where the transducer is used to monitor a covered wet well, the transducer shall be installed using a hinged protective enclosure. The enclosure shall be a special corrosion resistant instrument enclosure made of polyurethane, and stainless steel hardware. Enclosures shall be equal to model C-6, as provided by O'Brien Corp, St. Louis, Missouri. The case shall be secured to the slab using heavy anchors over an appropriately sized hole cored through the slab. The enclosure shall also have a hole in the bottom to match the hole in the slab so that the transducer can be easily installed from above. The transducer shall be installed on a heavy aluminum plate which would lie in the bottom of the enclosure and allow the transducer to extend into the cored hole.

I. In cases where the transducer is used to monitor a water storage tank or other type of location, the CSI shall provide a mounting design and mounting hardware to provide an installation which is appropriate for the operation of the device and easily maintained. For storage tanks, the transducer shall be mounted above the tank or a suitable bracket extending out far enough from the tank sides to receive a strong signal over the entire level range without reflections off the tank sides. The transmitter shall be mounted outside of the wall at a convenient ground-level working height.

J. In cases where the transducer is used on a chemical storage tank, the CSI shall provide a flange mounted arrangement to match the connection point on the storage tank. Flange sizes and type will be coordinated with that equipment supplier.

K. In cases where the transducer is used in a turbulent area, the sensor shall be flange mounted to a stilling well to minimize incorrect responses to wave action in the liquid. The stilling well shall be a six (6) inch PVC pipe which shall extend the entire depth of the measured range and to below the normal low liquid level. The stilling well shall have holes drilled periodically along the length sufficient to allow adequate response to changes in liquid level. The stilling well shall be supported in a manner which produces a rigid installation minimizing the movement due to the turbulent liquid.

L. Spare parts: Provide one (1) spare ultrasonic level transmitter of each type used and one (1) spare transducer of each type used, supplied with the longest cable utilized in the project.

2.07 FLOW SWITCH, VANE TYPE

A. General purpose flow switch for detection of low or no flow in process piping or pump discharge operation by utilizing a magnetically actuated switch.

B. One SPST snap switch contact for remote indication of flow, electrical rating of 5A at 125/250 VAC.

C. Sensor wetted materials and upper body shall be stainless steel.

D. Process connection shall be 1/2–inch NPT for 1/2-inch to 1-1/4 inch lines; 1-1/2-inch for line sizes of 1-1/2-inches or larger.

E. Sensors shall be side mounted in the process piping to prevent sensor interference from less than full piping and fluid particulate settling.

F. Switch shall be W.E. Anderson FLOTECT or approved equal.

2.08 FLOW TRANSMITTER, MAGNETIC

A. Magnetic flow meters shall consist of a flow tube with integral or remote-mounted signal converter/transmitter that is capable of converting and transmitting a signal from the flow tube. The flow tube shall utilize the characterized principle of electromagnetic induction and shall produce DC signals directly proportional to the flow rate

B. The flow meter accuracy shall be ≤±0.5% of reading from 2-100% meter capacity.

C. The flow meter shall include but not be limited to the following:

1. NEMA 6P / IP68 accidental submersion enclosure
2. Meter body shall be powder coated aluminum or carbon steel with an epoxy finish.
3. Electrical Housing shall be epoxy painted aluminum
4. ANSI Class 150 flanges (minimum)
5. EPDM, polyurethane or hard rubber liner to suit process requirements
6. Flush type or bullet type (slurry applications) electrodes compatible with process fluid.
7. Empty pipe detection.
8. SST bolts/nuts, centering device, Teflon gaskets.
9. Grounding rings when installed in non-metallic piping. Grounding rings shall be chemically resistant to process, 316SST minimum.
10. The cables for interconnecting the flow tube to the transmitter shall be furnished by the manufacturer and of sufficient length as to not require splicing.
11. All flow meters shall have a remote-mounted flow transmitter/converter with the exception of the well sites which will have an integral mounted flow transmitter/converter.

D. The transmitter shall include but not be limited to the following:

1. NEMA 4X enclosure
2. 120VAC, 60Hz input power
3. Process display with keypad for menu driven configuration
4. One (1) 4-20ma output
5. HART protocol
6. One (1) alarm relay output
7. Empty pipe detection
8. Reverse flow detection

9. Lo-flow cutoff
10. Damping
11. Flow Totalizer
12. Non-volatile memory

E. Magnetic Flowmeters shall be equal to Rosemount 8750W with 8700 series transmitter/converter, Sitrans F M Mag 5100W flow tube with Sitrans F M Mag 6000 signal converter/transmitter as provided by Siemens, Endress + Hauser, or approved equal.

2.09 PRESSURE GAUGE

A. General: Unless otherwise noted or specified, pressure and vacuum gauges shall conform to the following:

B. Mounting Type: Gauges shall be of the stem-mount type unless noted otherwise.

C. Construction: Gauges shall be of the bourdon tube or bellows type with 270 degrees clockwise pointer travel. Dials shall be white face with black numerals. Dial size shall be 4-1/2 inches. Connections for all gauges shall be male 1/2 NPT with square wrench flats. Wetted parts shall be corrosion-resistant to the process fluid shown and unless otherwise specified shall be the manufacturer's best quality standard. The case shall be filled with glycerin and shall be black phenolic. Accuracy shall be ±0.5 percent of span.

D. Chemical Sea: Where specified or shown in the drawings, the gauge, with optional locking device, shall be furnished with a diaphragm seal. The diaphragm seal shall have a 316 stainless steel (minimum) top and bottom housing and a 316 stainless steel diaphragm welded to the top housing. When the process fluid or pressure is not compatible with 316 stainless steel, the manufacturer shall provide a diaphragm seal compatible with the process fluid. The process connection shall be a 3/4-inch threaded connection with a flushing connection. The fill fluid shall be glycerin. A locking device shall be included from the factory on all fluid-filled instruments to prevent inadvertent loosening or removal from the seal.

E. RAS/WAS: Where specified or shown in the PID drawings, the gauges shall be furnished with a wafer type in-line diaphragm seal. The diaphragm seal shall be Wika or equal.

F. Where no seal is specified the gauge will be supplied with a pressure limiting snubber to protect against surges and pulsations.

G. Manufacturers: The gauges shall be equal to Ashcroft, McDaniels, U.S. Gauge or approved equal.

H. The diaphragm seals shall be field serviceable for oil filling and equal to Ashcroft, Mansfield and Green, FIT, Ametek or equal.

2.10 PRESSURE SWITCH

A. Pressure switches shall be of watertight enclosure type. The switch element shall be Narrow Deadband 15A, 125/25Vac type.

B. Units shall be waterproof, shockproof, and equipped with a single position dual throw switches 20 to 250 VAC, 50/60Hz.

C. Any required mounting parts shall be provided. Switches shall be connected to a stainless steel pipe treated, with isolation valve for easy replacement.

D. Pressure switches shall be equal to Ashcroft B4 or approved equal.

2.11 pH ANALYZER/TRANSMITTER

A. The online pH analyzer shall continuously measure pH in the range of 0-14 pH with an accuracy of +/- 0.1% of span.

B. The analyzer shall include but not be limited to the following:

1. Non-corrosive NEMA 4X enclosure
2. 120VAC 60Hz input power
3. Process display with keypad for menu driven configuration
4. Two (2) 4-20ma outputs (standard); up to five (5) outputs with module card
5. Two (2) alarm relay outputs

C. The sensor shall be a convertible style liquid crystal polymer differential sensor with integral preamplifier and glass electrode.

D. Sensor cable shall be provided with enough length to mount the analyzer and sensor as shown on the plans. Minimum length of 33’ to be provided.

E. Sensor shall be provided with a flow thru tee mounting assembly for insertion into the sample line when measuring from a process piping.

F. Sensor shall be provided with a fixed point installation mounting kit when measuring from a process tank.

G. A calibration kit as well as one (1) year supply of maintenance/operating parts and chemicals shall be provided.

H. Install the probe per the manufacturer’s instructions. The probe shall be installed to prevent air bubbles from interfering with the measurement accuracy.

I. Where shown on the drawings make provisions for monitoring process temperature. pH controller shall provide a separate 4-20mA signal representing temperature. Controller shall be provided with a module card, as required, for additional output signals.

J. pH Analyzers shall be equal to Hach DPD1P1 pH sensor with sc200 Controller or approved equal.

## 2.12 TURBIDITY ANALYZER

A. The online turbidity analyzer shall continuously measure turbidity in the range of 0-1000 NTU with an accuracy ≤±2% of reading between 0-40 NTU and ≤±5% above 40 NTU.

B. The analyzer shall include but not be limited to the following:

1. Non-corrosive NEMA 4X enclosure
2. 120VAC 60Hz input power
3. Process display with keypad for menu driven configuration
4. Two (2) selectable 4-20ma outputs
5. Two (2) alarm relay outputs

C. The sensor method of measuring turbidity shall be nephelometric by utilizing a pulse scattered light at a 90 degree angle. The sensor shall include but not be limited to the following:

1. The turbidity unit shall be a closed system design with a flow head bubble rejection system which eliminates the requirement for a separate bubble trap.
2. The sensor shall provide sample color-independent measurement.
3. Where applicable, the sensor cable shall be provided with enough length to mount the interface controller unit and sensor as shown on the plans.
4. Sample and drain line fittings shall be approximately 1/2-inch I.D. hose connection.

D. Interface unit shall allow control and configuration of the process sensor with a user-friendly, menu driven software. The unit shall include two (2) analog outputs and three (3) SPDT alarm contacts.

E. The interface unit shall be self-contained in a NEMA 4X industrial enclosure powered from 120 VAC, 60 Hz.

F. A complete calibration kit as well as one (1) year supply of maintenance/operating parts and chemicals shall be provided.

G. Turbidity Analyzers shall be equal to Hach 5300 Plus SC Sensor with sc200 Controller, or owner approved vendor list equal.

## 2.13 CHLORINE ANALZYER (FREE)

A. The online, reagentless, amperometric free chlorine analyzer shall measure concentrations of total chlorine residual in water in the range 0-10 ppm with an accuracy ≤±10% of reading.

B. The analyzer's accuracy shall not be affected by pH changes between 4-9 pH. The analyzer shall have a response time ≤1.7 minutes.

C. Where shown on the drawings, provide pH probe sensor and flow cell for pH monitoring.

D. The analyzer shall include but not be limited to the following:

1. Non-corrosive NEMA 4X enclosure
2. 120VAC 60Hz input power
3. Process display with keypad for menu driven configuration
4. Two (2) 4-20ma outputs
5. Two (2) user-selectable alarm relay outputs
6. Gateway Controller
7. Chlorine and pH sensor flow cells
8. Sample conditioning kit, components and accessories for a complete operational system
9. One (1) year supply of maintenance/operating parts and chemicals

E. Free Chlorine Analyzers shall be equal to Hach CLT10 with the SC200 controller, or approved equal.

## 2.14 CHECK VALVE LIMIT SWITCH

A. Limit switches shall be provided, where shown on the drawings, to sense the position of a pump discharge check valve to determine pump flow and operate a SPDT switch to actuate alarms or control circuits. Limit switches shall also be provided on building doors for intrusion alarms at locations shown on the drawings. The switch contacts shall be rated for up to 10-ampere maximum load at 120 VAC, 60 Hz. The limit switch shall consist of a lever sensor and operating head. The lever sensor shall be 316 stainless steel or other material suitable for the application.

B. The lever sensor shall be a roller type or pushpin arm to allow reaction to the movement of the check valve arm and as required based on the specific requirements of the installation. The operating head shall be housed in a NEMA 4 enclosure with an electrical conduit connection.

C. The switch shall be field adjusted for correct operation. Repeatability of sensing shall be within 1.0 percent (± 1.0%) of full switch range.

D. Lever type limit switches shall be equal to model 802T type as manufactured by Allen Bradley or approved equal.

## 2.15 FLOW REGULATING CONTROL VALVE

A. Flow regulating control valves shall be provided on water quality sample lines, where shown on drawings, or as recommended by the analyzer manufacturer. Flow regulating control valve shall have direct reading scales with a manual control knob for valve operation and position.

B. Accuracy of flow control valve shall be plus or minus 4% with a maximum pressure rating of 50 psi.

C. Flow regulating control valve body shall be molded transparent nylon with process connections of 5/16 OD

D. Flow regulating control valve shall be equal to Dwyer MMA Series Mini-Master or approved equal.

2.16 LEVEL TRANSMITTER, RADAR TYPE

A. Radar transmitters shall be provided for measurement of chemical tanks. Equipment shall be provided with features and accessories as described herein and suitable for the application.

B. Radar level transmitters shall meet the following specifications as a minimum:

1. NEMA 4X enclosure
2. Loop Powered 12 – 35 VDC
3. Wetted parts made of PVDF with FKM seal
4. W-band, 80 GHz operation
5. Process display with VEGA tools app, PACTware
6. One (1) 4-20 mA output.
7. Non-volatile memory
8. Accuracy: +/- 5 mm

C. The CSI shall provide all mounting hardware and coordinate the details of the installation so that the instruments are installed in keeping with the best standard and recommended practices of the manufacturer and conforming to the requirements set forth by the Engineer.

D. Radar level transmitters shall be fully programmable and configurable using a computer, keypad, and app. The final ‘As-Built’ documentation shall be provided with a tabulation of the Programming Parameters used in each level transmitter so that the initial calibration can be reproduced if a spare transmitter is installed.

E. Level transmitters shall be provided with analog signal surge protection. All conduit connections shall be sealed to prevent damage or corrosion due to vapors or wetness.

F. Radar Level Transmitters shall be Vega, VEGAPULS 11. Transmitters shall be flange mounted. Transmitters shall be installed using the appropriate transducer, suitable for the range and process connection of the installation.

G. The radar level transmitters are being installed in a corrosive area. The CSI shall provide mounting hardware components and appropriate mounting assistance to install and secure the transmitters in a manner in keeping with the recommendations of the manufacturer of the equipment and in keeping with the general details provided in the drawings. All hardware shall be fabricated from corrosion resistant materials and shall utilize polyurethane reinforced with glass fiber hardware. The mounting system shall be secure and permanent and shall allow easy access to the sensor for servicing. All cables shall be installed in suitable non-metallic rigid conduit with only short lengths of flexible non-metallic conduit allowed to complete the installation.

H. The transmitters are used on chemical storage tanks, the CSI shall provide a flange mounted arrangement to match the connection point on the storage tank. Flange sizes and type will be coordinated with that equipment supplier.

I. Spare parts: Provide one (1) spare radar level transmitter.

2.17 LEVEL TRANSMITTER, SUBMERSIBLE TYPE

A. A submersible transmitter shall be provided for measurement of the scum well. Equipment shall be provided with features and accessories as described herein and suitable for the application.

1. Submersible level transmitters shall meet the following specifications as a minimum:

a. NEMA 6P submersible rated enclosure
b. Loop Powered 9 – 28 VDC
c. Wetted parts made of 316 SS
d. UL Class 1, Div 1 Groups A through G
e. Vendor cable with length to reach control panel without splicing.
f. Full lightning protection option
g. One (1) 4-20 mA output.
h. Accuracy: +/- 0.25% FSO Static

1) The CSI shall provide all mounting hardware and coordinate the details of the installation so that the instruments are installed in keeping with the best standard and recommended practices of the manufacturer and conforming to the requirements set forth by the Engineer.
2) Level transmitters shall be provided with lightning protection. All conduit connections shall be sealed to prevent damage or corrosion due to vapors or wetness.
3) Submersible Level Transmitters shall be TE Connectivity KPSI 750. Transmitters shall be flange mounted. Transmitters shall be installed using the appropriate integral transducer, suitable for the range and process connection of the installation.
4) The submersible level transmitters are being installed in a hostile environment. The CSI shall provide mounting hardware components and appropriate mounting assistance to install and secure the transmitters in a manner in keeping with the recommendations of the manufacturer of the equipment and in keeping with the general details provided in the drawings. All hardware shall be fabricated from 316 SS materials and shall utilize 316 SS hardware. The mounting system shall be secure and permanent and shall allow easy access to the sensor for servicing. All cables shall be installed in suitable rigid conduit with only short lengths of flexible conduit allowed to complete the installation.

5) Spare parts: Provide one (1) spare submersible level transmitter.

## 2.18 PRESSURE TRANSMITTER, IN LINE GAUGE SCALEABLE TYPE

A. Pressure transmitters shall meet the following specifications as a minimum:

1. Classic Accuracy 0.035% span
2. 150:1 range down
3. 316 Stainless Steel isolating diaphragm
4. Integral Rosemount 306 manifold
5. One (1) 4-20 mA output
6. PlantWeb aluminum housing with LCD display
7. 2” stainless steel pipe mounting bracket
8. Loop Powered 10.5 – 42.4 VDC
9. UL Class 1, Div 1 or 2 option when required by site installation conditions

B. The CSI shall provide all mounting hardware and coordinate the details of the installation so that the instruments are installed in keeping with the best standard and recommended practices of the manufacturer and conforming to the requirements set forth by the Engineer.

C. Pressure Transmitters shall be Rosemount series 3051S. Transmitters shall be inline mounted with manifold. Transmitters shall be installed using the appropriate integral transducer, suitable for the range and process connection of the installation.

D. The CSI shall provide all mounting hardware and coordinate the details of the installation so that the instruments are installed in keeping with the best standard and recommended practices of the manufacturer and conforming to the requirements set forth by the Engineer.

E. Spare parts: Provide one (1) spare pressure transmitter

## 2.19 CHEMSCAN – NITRATE AND ORTHOPHOSPHATE

A. Chemscan shall meet the following specifications as a minimum:

1. Accuracy 2%-5% of range
2. Automated, continuous analysis
3. Reagent-Less and Reagent-Assisted, Multiple-Wavelength UV Absorbance Technology utilizing pattern recognition of spectral data
4. 8 parameters per sample line. One (1) sample line per train. Capacity for two (2) trains and expandable to six (6) trains in the future (all trains to include Nitrate and Ortho-Phosphate)
5. 4-20mA (8 outputs)
6. Ethernet IP communications
7. 120VAC power, 4 A maximum, hard wired

8. 7” TFT, LCD, Touch HMI panel

B. The CSI shall provide all mounting hardware and coordinate the details of the installation so that the instruments are installed in keeping with the best standard and recommended practices of the manufacturer and conforming to the requirements set forth by the Engineer.

C. Chemscan shall be In-Situ Chemscan UV-6201 with HMI or equal with electronic interface enclosure to provide Ethernet IP communications. Transmitters shall be inline mounted with manifold. Transmitters shall be installed using the appropriate integral transducer, suitable for the range and process connection of the installation.

2.20 SUNSHIELDS

A. All outdoor mounted transmitters shall be provided with a 316 stainless steel sunshield. Sunshields are to be sized so that the sunshield will extend a minimum of three (3) inches beyond the transmitter enclosure on all sides.

B. The sunshield shall be sized to include protection for the transmitter and the surge arresting device.

C. All sunshield and instrument mounting hardware shall be 316 stainless steel.

D. Orient Sunshield and transmitter so as to minimize exposure of display to direct sunlight.

E. Sunshield design shall be submitted for approval.

PART 3 - EXECUTION

3.01 REQUIREMENTS

A. In addition to the requirements specified in this section, refer to Section 40 61 13 - Process Control Systems General Provisions.

END OF SECTION