SECTION 40 10 00
PROCESS CONTROL & INSTRUMENTATION SYSTEM-GENERAL

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. General requirements applicable to all process control work.
2. The requirements of this Section apply to all components of the Software Systems unless indicated otherwise.
3. General requirements for programming submittals.

B. Related sections:

1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all sections to ensure a complete and coordinated project:
   a. Items involving electrical, control, and instrumentation construction may be shown on Drawings or referred to in Specifications that do not apply specifically to electrical, control and instrumentation systems.

C. The Programming Contractor shall program all PLC's and the SCADA system. The Programming Contractor shall provide all software as specified herein for programming the system. The Programming Contractor and the electrical contractor shall be responsible to test each device and loop to verify proper function of all equipment on the project, whether provided by the contractor or by the owner. They shall then work with the owner to test and commission the entire system as described herein. The programming contractor shall be present to test the I/O for each equipment subsystem. The I/O to the PLC systems shall be tested at this time. The programming contractor shall provide and install a simple testing routine in each PLC in order to verify all I/O is functioning properly. All I/O shall be tested from its respective field device to the software level in the PLC. If final PLC programming is complete at the time of testing, the final software programming shall be used to test each device

D. The Programming Contractor shall design the operator interface graphics, human machine interface (HMI) graphics, PLC logic, and control systems hardware as specified herein.

E. Contract Documents:

1. General:
   a. Contract documents consist of drawings, specifications, and other documents issued by the ENGINEER. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work, and requirements shown, written or reasonably inferred there from on one is considered as written, shown or implied in all. In the event work is called for in more than one place and there are conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.

b. Schematic Diagrams:
    1) All controls are shown de-energized.
        a) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
        b) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences found in the Drawings or Specifications. Combine all information and furnish a coordinated and fully functional control system program.

1.2 REFERENCES

A. Code Compliance:

1. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.
2. The following codes and standards are hereby incorporated into these Specifications:
    a. National Fire Protection Association (NFPA):
        1) NFPA 70 - National Electric Code (NEC).
        2) NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
        3) NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment, where applicable.
        4) NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
    b. Underwriters Laboratories, Inc. (UL):
        1) UL 508 - Industrial Control Equipment.
    c. American National Standards Institute (ANSI):
        1) ANSI B16.5 - Pipe Flanges and Flanged Fittings.
    d. American Petroleum Institute (API):
        1) API RP551 - Process Measurement Instrumentation.
        2) API RP552 - Transmission Systems.
        3) API RP553 - Refinery Control Valves.
        4) API RP554 - Process Instrumentation and Control.
        5) API RP555 - Process Analyzers.
        6) API RP556 - Fired Heaters & Steam Generators.
        7) API RP557 - Guide to Advanced Control Systems.
    e. American Society of Testing and Materials (ASTM):
        1) ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
    f. Instrumentation, Systems, and Automation Society (ISA):
        1) ISA-5.1 - Instrumentation Symbols and Identification.
        2) ISA-5.2 - Binary Logic Diagrams for Process Operations.
        3) ISA-5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
        4) ISA-5.4 - Instrument Loop Diagrams.
        5) ISA-5.5 - Graphic Symbols for Process Displays.
        6) ANSI/ISA-7.00.01 - Quality Standard for Instrument Air.
        7) ISA-RP - 12.4 - Pressurized Enclosures.
        8) ANSI/ISA-18.1 - Annunciator Sequences and Specifications.

9) ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
10) ISA-TR20.00.01 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
11) ANSI/ISA-50.00.01 - Compatibility of Analog Signals for Electric Industrial Process Instruments.
12) ISA-51.1 - Process Instrumentation Terminology.
13) ISA-RP60.3 - Human Engineering for Control Centers.
14) ISA-71.01 - Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.
15) ISA-71.02 - Environmental Conditions for Process Measurement and Control Systems: Power.
16) ISA-71.03 - Environmental Conditions for Process Measurement and Control Systems: Mechanical Influences.
17) ISA-71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

1.3 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth in the:

1. National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. Instrumentation, Systems, and Automation Society.
4. National Fire Protection Association.
5. National Electrical Testing Association.

B. Specific Definitions:

1. Control Circuit: Any circuit operating at 120 volts AC or DC or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
2. Panel: An instrument support system that may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term “panel” in these Contract Documents is interpreted as a general term, which includes flat surfaces, enclosures, cabinets and consoles.
3. Power Circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
4. Signal Circuit: Any circuit operating at less than 50 volts AC or DC, which conveys analog information or digital communications information.
5. Digital Bus: A communication network, such as Profibus, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions and diagnostic information.
6. 2-Wire Transmitter (Loop Powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Specification, two-wire transmitter refers to a transmitter that provides 4 to 20 mA current regulation of a signal in a series circuit with an external 24 VDC driving potential.

7. Field Bus Communications signal or both.
8. Powered Transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Specification, the produced signal may either be a 4 to 20 mA current signal, a Digital Bus communications signal or both.
9. Modifications: Changing, extending, interfacing to, removing or altering an existing circuit.

C. Acronym Definitions:

1. ES: Enterprise System: Computer based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
2. FAT: Factory Acceptance Test.
3. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode of control equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode of control equipment is started or stopped, valves are opened or closed through a control algorithm within the PLC software. In the Off mode the equipment is prohibited from responding from the PLC control.
4. HMI: Human Machine Interface: PLC based operator interface device consisting of an alphanumeric display and operator input devices. The HMI is typically a flat panel type of display with either a touch screen or tactile button interface.
5. HVAC Heating, Ventilation, & Air Conditioning.
6. ICSC: Instrumentation and Control System Contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
7. IJB: Instrument Junction boxes. A panel designed with cord sets to easily remove, replace or relocate instrument signals.
8. I/O: Input / Output.
9. LCP: Local Control Panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
10. LAN: Local Area Network: A control or communications network that is limited to the physical boundaries of the facility.
11. LOR: Local-Off-Remote control function. In the Remote mode equipment is started or stopped, valves are opened or closed through the PLC based upon the selection of the HOA. In Local control, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
12. OIT: Operator Interface Terminal. PC based interface device used for operator interface with the SCADA system.
13. P&ID: Process and Instrumentation Diagram.
14. PC: Personal Computer.
15. PCIS: Process Control and Instrumentation System, includes the entire instrumentation system, the entire control system, and all of the work specified in Division 17 and depicted on the Instrumentation Drawings.
16. PCM: Process Control Module: An enclosure containing any of the following devices: PLC, RIO.

17. PJB: Power Junction Box: An enclosure with terminal blocks that distribute power to multiple instruments.
18. PLC: Programmable Logic Controller.
19. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.
20. RTU: Remote Telemetry Unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
21. SCADA: Supervisory Control and Data Acquisition system consists of the computer-based software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software.
22. UPS Uninterruptible Power Supply.
23. VCP: Vendor Control Panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
24. WAN: Wide Area Network: A control or communications network that extends beyond the physical boundaries of the facility.

1.4 SYSTEM DESCRIPTION

A. General Requirements:

1. The Work includes everything necessary for and incidental to executing and completing the general requirements for programming the control system described in the Contract Drawings and Specifications and reasonably inferable there from including but not limited to:
   a. Procure all software.
   b. With the electrical contractor, perform post programming tests on panels.
   c. With the electrical contractor, oversee, document, and certify system pre-commissioning.
   d. With the electrical contractor, conduct the Performance Tests.
   e. Prepare Operation and Maintenance Manuals.
   f. Conduct training classes.
   g. Develop all requisite loop descriptions, functional narrative and instructions and record drawings associated with the programs provided under other Divisions of these Specifications.
2. It is the intent of these Specifications that the programmed system be complete and operable.
3. Furnish detailed, complete, and thorough operations and maintenance documentation, including, but not limited to: Operations Manuals, Maintenance Manuals, Training Manuals, As-Built Software Documentation, final as installed software configurations, and software disks including installed program disk.

1.5 SUBMITTALS

A. General:

1. Furnish Submittals that are fully developed for a given section of the work and fully indexed with a tabbed divider for every element and component.

2. Sequentially number the pages within the tabbed sections. Submittals and Operation and Maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
3. Edit all Submittals and Operation and Maintenance Manuals so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.
4. Submittal Requirements:
    a. Submit copies of shop drawings, and product data, in accordance with the requirements of this Section:
        1) Show information on software to be supplied, SCADA screens, reports, menus, operation, etc.
5. Exceptions to Specifications and Drawings:
    a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
    b. Any exceptions to the Specification and Drawings must be noted and the reason for the exception explained.
    c. If there is insufficient explanation for the deviation, the submittal will be returned requiring Revision and Re-submittal.
    d. Acceptance of any exception is at the sole discretion of the ENGINEER. Furnish all items (materials, features, functions, performance, etc.) that are not listed as exceptions strictly in accordance with the Specifications and Drawings.
    e. Replace all items that do not strictly meet the requirements of the Specifications, which were not previously accepted as exceptions, even if the Submittals contained information indicating the failure to meet the requirements.
6. Submittal Organization:
    a. First page:
        1) Specification Section reference.
        2) Name and telephone number of individual who reviewed submittal before delivery to ENGINEER.
        3) Name and telephone number of individual who is primarily responsible for the development of the submittal.
        4) Place for CONTRACTOR's review stamp and comments.
    b. Next pages:
        1) Provide confirmation of Specification compliance in a tabular form that individually lists each Specification section, paragraph, and sub-paragraphs and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.
        2) Include a response in writing to each of the ENGINEER’s comments or questions for submittal packages which are re-submitted:
    c. In the order that the comments or questions were presented throughout the submittal.
    d. Referenced by index section and page number on which the comment appeared.
    e. Acceptable responses to ENGINEER’s comments are either:

f. ENGINEER's comment or change is accepted and appropriate changes are made.
g. Explain why comment is not accepted or requested change is not made.
h. Explain how requirement will be satisfied in lieu of comment or change requested by ENGINEER.
i. Any re-submittal, which does not contain responses to the ENGINEER's previous comments, shall be returned for revision and re-submittal.
j. No further review by the ENGINEER will be performed until a response for previous comments has been received.
k. Remaining pages:
    1) Actual Submittal data:
        a) Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.
        b) For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is intended to be used.
l. Specific Submittal requirements:
    1) Furnish the submittals required by each Section or Division 17:
        a) Product Data.
        b) Shop Drawings.
m. Furnish submittals in the following general order, each in a separate bound set:
    1) Product Data.
    2) After approval of the Product Data, submit the Project Shop Drawing submittals
    3) Testing, Calibration and Start-up procedures.
    4) Operation and Maintenance Data.
    5) Training Submittals.
    6) Record Documents.

B. Product Data:
    1. General:
        a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
        b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
        c. Include:
            1) Catalog cuts.
            2) Bulletins.
            3) Brochures.
            4) Quality photocopies of applicable pages from these documents.
            5) Identify on the data sheets the project name, applicable specification section, and paragraph.
            6) Identify model number and options for the actual equipment being furnished.
        d. Neatly cross out options that do not apply or equipment not intended to be supplied.
    2. Software Data Sheets and Cut Sheets:

a. Provide fully completed data sheets , in hardcopy, for each software package. Including the following information on the data sheet:
    1) License limitations, points, screens available.
    2) Description of software compatibilities with hardware (PLC's, ethernet communications, P.C.'s, modems, HMI's, etc.)
    3) Description of software capabilities, function and use.

3. Software Program Submittal:
    a. Prepare a program submittal to demonstrate how the programs address the following:
        1) Alarm indication and notification.
        2) Alarm acknowledgement.
        3) Operational sequences.
        4) Communications.
        5) Recording and trending – show for each recorded or tended tag.
        6) Report generation with samples.
        7) Maintenance information and notes storage.
        8) Samples of each screen shot and report.

C. Operation and Maintenance Manuals:

1. Furnish the ENGINEER with a complete preliminary set of written Operation and Maintenance Manuals 2 weeks before start-up and/or testing.
2. Furnish in accordance with the following additional requirements.
3. Submit preliminary sets of these manuals to the ENGINEER for review of format and content:
    a. ENGINEER will return 1 set with comments.
    b. Revise and/or amended as required and submit the requisite number of copies to the ENGINEER 15 days before Pre-commissioning of the systems.
4. Incorporate changes that occur during startup and submit as part of the final manuals.
5. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
6. Organize the Operation and Maintenance Manuals for each process in the following manner:
    a. Section A-Description of operation.
    b. Section B- Screen shots.
    c. Section C- Report samples.
    d. Section D- Trending/recording operations.
    e. Section E- Software information with disks.
    f. Section F- Operational Manual.
    g. Section G- Spare Parts List.
7. Training Submittals:
    a. Develop and submit for review a General Training Plan. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).

b. The ENGINEER will review the General Training Plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the ENGINEER, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system provide more qualified instructors.
c. Training Course Plan submittals:
    1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson.
    2) Describe any student pre-requisites for the course or training activity.
    3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.
    4) Submit training materials.
d. Incorporate all submittal review comments into the course.
e. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.

D. Responsibilities

1. The Programming Contractor, shall be responsible to the OWNER for the implementation of the software and programmed systems.
2. Instrumentation & Control System Contractor (ICSC) Responsibilities:
    a. The Programming Contractor shall assume full responsibility to perform all engineering to select, furnish, install, test, calibrate, and place into operation all software for PLC's and SCADA P.C.'s.
    b. The Programming Contractor shall be responsible for coordination with OWNER to provide a complete, integrated and functional software system.
    c. As a minimum, the Programming Contractor shall perform the following work:
        1) Prepare software submittals.
        2) Design, develop, and implement controls, screens, reporting, recording, etc.
        3) Prepare the test plan, the training plan, and the spare parts submittals.
        4) Procure all software.
        5) Perform tests on PLC and SCADA software.
        6) Participate in system pre-commissioning.
        7) Participate in the performance tests.
        8) Prepare Technical Manuals.
        9) Conduct training classes.
3. Owner's Responsibilities:
    a. Assist the Programming Contractor in coordinating and integrating the system controls.
    b. The Programming Contractor shall not be responsible for providing or testing any hardware.
4. The Programming Contractor and the Instrumentation & Control System Contractor will be one and the same for this contract.

E. Programmer Qualifications:

1. The Qualification requirements specified in these paragraphs apply to the portions of the Process Control and Instrumentation System Work to be provided by the Programming Contractor.
2. The Programming Contractor shall meet the following minimum qualifications:

a. The Programming Contractor shall have completed at least five (5) successfully completed projects for a pumping system of similar scope and complexity in which the Programming Contractor used components the same as those intended for use on this project, performed system programming, documentation, including software configuration and documentation, field testing, calibration and start-up, operator instruction and maintenance training.
b. The Programming Contractor company shall be actively involved in the instrumentation, PLC based control systems, and SCADA systems business for a minimum of ten years and has adequate facilities, organization structure, manpower and technical and managerial expertise to properly perform the WORK under and in conformance with these Specifications.

1.6 SEQUENCING

A. General:
   1. Testing requirements are specified in Division 27.
   2. Work restrictions and other scheduling requirements are specified in the General specifications.

B. Pre-submittal Conferences:
   1. Before producing any submittals, schedule a pre-submittal Conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.

C. Training:
   1. Complete all training before the pre-commissioning phase of the project may start.
   2. Schedule the training sessions a minimum of 15 days prior to the start date of the courses.
   3. Submit training manuals to the ENGINEER a minimum of 10 days before starting the training session.
   4. Within 10 days after the completion of each session, submit the following:
      a. A list of all OWNER personnel that attended the session.
      b. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

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

1.7 WARRANTY

A. Warrant the Software and Programming in accordance with the General Conditions:
   1. Provide additional warranty as specified in the individual Division 17 Specifications.

1.8 SYSTEM STARTUP

A. Replace or modify software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:

1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the ENGINEER.

1.9 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 DEMONSTRATION AND TRAINING

A. Training:
   1. General:
      a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.
      b. Conduct all training at the Project Site unless another location is approved by the ENGINEER and OWNER.
         1) Include instruction on the use of all maintenance equipment and special tools provided under the contract.
      c. Tailor training classes to the specific needs of the class participants:
         1) The specific categories and number of personnel in each category are identified below.
         2) Furnish training courses that are a combination of classroom and hands-on training:
         3) Present the minimum number of sessions, specified in Table 1, for each course in order to satisfy class size restrictions and limitations scheduling OWNER staff.
         4) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.
         5) Schedule individual training classes with the OWNER at least 3 weeks before the start of the class.
         6) Schedule all training classes Monday - Friday between 7:30 AM and 3:30 PM.
         7) Each individual daily training session, travel time excluded:
            a) Minimum duration of 4 hours.
            b) Maximum duration of 7 hours.
            c) Breaks scheduled at least every 90 minutes and 1 hour for lunch.
         8) Complete training for maintenance personnel 90-days before Performance Testing.
         9) Complete operator training classes before startup of the SCADA system, or any part of it:
         10) Refer to Paragraph 1.09 of this Section.

11) Schedule follow-up training classes after SCADA startup on a schedule determined by the OWNER.
    a) Furnish highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:
    b) Provide completion reports in accordance with Paragraph 1.09 of this Section.

2. Training Manuals and Materials:
    a. Furnish training manuals and other materials for training courses.
    b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.
    c. The manuals are to serve as teaching aids during presentation of the training classes.
    d. Manuals are to serve as reference material after the training has been completed.

Table 1

Course Title	Minimum Course Length (days per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
SCADA, HMI, PLC Software	1	5	1

3. Training Course Requirements:
    a. Software Training:
        1) Furnish training on software and on related systems, including operation alarms, control, recording, reporting, etc.
        2) Furnish training on features, operation, troubleshooting, and maintenance.
    b. HMI Training:
        1) Provide the following:
            a) Overview of firmware, including starting, stopping, and PLC interface.
            b) Troubleshooting.
    c. Follow-up Training:
        1) Provide on-site follow-up training class beginning after startup of the SCADA system. The intent for these classes is to provide the OWNER's personnel the opportunity for a review and "refresher" of the training topics and material after they have had some experience using the system.
        2) Mutually schedule and develop the content of these classes with the OWNER no later than 1 month before the beginning of the first session:
            a) Schedule at the OWNER's discretion on non-consecutive days spaced out over the start-up and warranty period.

- END OF SECTION -

SECTION 40 11 00
PROGRAMMABLE LOGIC CONTROLLER (PLC)

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, material, equipment, appliances, and perform all operations in connection with providing a complete and operable programmable logic controller (PLC) system in accordance with this section of the specifications and applicable drawings and subject to the terms and conditions of the Contract.

B. The SUPPLIER shall furnish a PLC control system utilizing Allen Bradley MicroLogix family of hardware as specified herein. No like, equal, or equivalent products will be considered.

C. The SUPPLIER shall furnish PLC programming software.

D. The CONTRACTOR'S programmer shall work in conjunction with the contractor to train the owner on the PLC system. The contractor shall train the owner on all hardware. The programmer shall train on PLC programming, SCADA programming, operations, fault clearing, start-up and shutdown procedures, etc.

E. The SUPPLIER and the CONTRACTOR will be one and the same for this contract. There will not be a separate contract for PLC programming.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, alternates and Addenda, applicable drawings and the technical specification herein shall apply to work under this Section.

1.3 APPLICABLE REFERENCES

B. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI X3.64 (1979) Additional Controls for Use with American National Standard Code for Information Interchange

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA232-D (Jan. 1987) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

EIA RS-485 (1983) Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Multipoint System

FEDERAL COMMUNICATION COMMISSION (FCC)

FCC Part 68 (July 1986) Connection of Terminal Equipment to the Telephone Network

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE No. 100 (1988) IEEE Standard Dictionary of Electrical and Electronic Terms

IEEE C57.13 (1978) Instrument Transformers

IEEE C62.41 (1980) Surge Voltages in Low-Voltage AC Power Circuits

IEEE 802.3 Carrier Sense Multiple Access/Collision Detection (CSMA/CD)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1985; Incl. Rev. I and 2; ICS-6) Enclosures for Electrical Equipment

NEMA ICS 1 (1988) General Standards for Industrial Controls and Systems

UNDERWRITERS LABORATORIES, Inc. (UL)

UL 50 Enclosures for Electrical Equipment

UL 508 Industrial Control Equipment

1.4 SUBMITTALS

A. Provide complete submittal information for the PLC system as specified in Sections 01 34 00 and 26 05 00. Include manufacturer's data for each part, Bill of Materials, panel fabrication drawings including elevations and complete wiring diagrams with wire and terminal numbers for local and remote terminations. Remote terminations may be submitted with the operational and maintenance information in lieu of the initial equipment submittals.

B. Provide operational and maintenance information as specified in Section 26 05 00.

1.5 RELATED SECTIONS

A. Section 26 05 30 - Static Un-Interruptible Power Supply

B. Section 26 09 13 – Control Devices

C. Appendix A

PART 2 PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLER SYSTEM

The PLC system shall match the existing PLC brand or be Allen-Bradley

Note: Allen-Bradley systems to be installed per Allen Bradley recommended procedures and installation guidelines. Provide necessary hardware, accessories, fittings, cable, etc. for a complete and functioning system.

2.2 PLC ENCLOSURE AND ACCESSORIES

A. PLC Enclosure and Accessories: The PLC enclosure shall house the power supplies, PLC processor, analog input and output modules, discrete input and output modules, communication module, operator interface terminal (OIT), UPS, thermostatically controlled vent fan and louvers, heater with thermostat, light with integral door switch, relays, terminal blocks, and ancillary components. In addition, provide 25% spare back panel space and space for additional cards as indicated. The PLC shall be equipped with the following accessories, at a minimum:

1. Enclosure: The PLC shall be housed in a NEMA type12 enclosure with a lockable 3-point latch, and an interior swing out panel. The enclosure, swing out panel, vent fan, heater, and light shall be manufactured by Hoffman, or equal.
2. Redundant Power Supplies: Power supply hardware shall include a PLC power supply and redundant 24VDC power supplies as required for Inputs and Outputs (I/O). The redundant power supplies shall be 100 watt, minimum.
3. Fusing: Individual I/O loops shall be individually fused. Fuse holders shall be indicating type.
4. I/O Terminal Blocks: Field wiring DIN rail type terminal blocks. 25% spare terminal blocks shall be provided. Discrete and analog I/O terminals shall be segregated by I/O type.
5. Plastic Snap-On Cover Wire Management Systems: These shall be sized to accommodate all wiring with 25% spare capacity.
6. UPS System: A panel mounted UPS shall be included in each PLC cabinet. The UPS's shall be sized to provide at least 30 minutes of run time for the PLC and all system I/O. UPS systems shall be as specified elsewhere.
7. Transient Voltage Surge Suppression (TVSS): The TVSS system shall protect all power wiring within the PLC enclosure. The TVSS shall be a branch panel model as specified in Section 26 35 53.
8. Work Light and Outlet: A work light utilizing a 32 watt self ballasted compact fluorescent lamp or equal with an integral door operated switch shall be mounted within the enclosure. Enclosures over 4' wide shall include a light in each 4' section. A 20 amp, 120 volt duplex grounded power outlet shall be mounted within the PLC enclosure.
9. Ground Terminals: A screw type bonding terminal strip to which all ground bonding shall take place for all signal reference, TVSS, safety bonding etc. This grounding terminal shall accept a #6 copper ground bonding conductor. 25% spare terminals shall be provided.
10. Enclosure Labeling: The enclosure shall carry a phonetic label indicating the enclosure name, label all pilot devices on the swing out panel, and label all I/O termination modules, relays, power supplies, etc. Internal wiring shall be labeled at each terminal and each terminal shall be labeled, all labeling names and/or numbers shall be reflected on the panel fabrication drawings.
11. Separate Power Warning Signs: The enclosure shall receive power from external sources and shall be labeled with the source of where the external power is derived. Each circuit providing power to the cabinet shall be indicated.

B. Operator Interface Terminal (OIT/HMI): An OIT/HMI shall be mounted in the PLC enclosure swing-out panel. The OIT shall be 7" touchscreen or nearest available size compatible with Allen Bradley equipment, with keypad, 24VDC power, color graphics, and Ethernet communications operating from the terminal server with terminal services client software.

1. Provide OIT programming software to the OWNER, registered in OWNER's name.
2. Provide a programming cable for connection to a Personal Computer for the transfer of files.

2.3 INPUT/OUTPUT MODULES

A. Analog transmitters and receivers have 4 to 20 mA signals. Discrete (on/off) inputs (DI) originate from dry contacts. For discrete outputs (DO), provide interposing relays with dry contacts. Refer to the PLC Input / Output Point List, Appendix A, for required inputs and outputs.

B. The discrete input modules shall be 24 VDC.

C. The discrete output modules shall be isolated relay contacts suitable for operating interposing relays. Each discrete output module shall include fuses and fuse blown indicators.

D. The analog input (AI) modules shall be suitable for accepting 4 to 20 mA from 2, 3, or 4 wire transmitters. The input power shall be from an internal or external 24-volt dc power supply. The analog to digital converter shall have a 10-bit minimum resolution with an overall accuracy of + .5% at 60ºC.

E. The analog output (AO) modules shall be 4 to 20 mA signals suitable for driving into a 0 to 600 ohm load without load adjustments. The digital to analog converter shall have a 10 bit minimum resolution with an overall accuracy of + 2% to 60ºC. The output power shall be from an internal or external, 24 volt dc power supply provided by the SUPPLIER. If the PLC processor fails, the analog outputs shall retain their present value.

F. Discrete PLC I/O modules shall have individual LED status lights for each I/O point. All discrete and analog modules shall have terminal blocks for termination of the I/O wires. Individual I/O points shall be capable of withstanding low energy common mode transients to 1,500 volts.

2.4 PLC START-UP

A. Each PLC shall have start-up software that causes automatic commencement of operation without human intervention, including start-up of all connected I/O functions. A restart program based on detection of power failure shall be included in the software. Upon restoration of power, the program shall restart all equipment and restore all loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips. The start-up software shall initiate operation of self-test diagnostic routines. If the data base and application software are no longer resident or if the clock cannot be read, the PLC shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made. If the data base and application programs are resident, the PLC shall resume operation after an adjustable time delay of from 0 to 600 seconds. The start-up sequence for each device shall include a unique time delay setting when system operation is initiated.

B. Programming software for the PLC shall be provided by the contractor. The programming of the PLC shall be performed by the contractor. All loop testing and debugging shall be performed by the Contractor.

PART 3 EXECUTION

3.1 PANEL FABRICATION

A. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents.

B. The panel shall be fabricated and UL Listed as an assembly by a qualified panel shop.

3.2 FACTORY TESTING

A. A factory conducted test shall be preformed at the manufacturer’s facility upon the completed fabrication of the PLC system. The factory test shall demonstrate the successful operation of inputs and outputs from the field terminal blocks to the PLC. Provide signal generators and measuring devices as needed for a complete and through test.

B. Hardware and software components of the PLC System shall be thoroughly tested and “burned in” by the SUPPLIER. Inform the OWNER 10 working days prior to the testing of the equipment. The OWNER shall witness these tests before shipment to the site.

1. Panel fabrication drawings shall be updated based on the factory test and a current set of drawings shall be shipped with the panel.
2. The SUPPLIER shall be responsible for all transportation, meals, accommodation, and expenses for the OWNER’s representative witnessing the factory test.

3.3 OWNER TRAINING

A. Provide the services of a factory trained, manufacturer’s representative for instruction of the OWNER’s personnel. The training shall include basic PLC and OIT operation overview, I/O module normal and fault condition indications, and equipment maintenance, troubleshooting, and replacement.

B. The operation and maintenance manuals shall be included as a part of the instruction to the OWNER’s personnel. Refer to Section 01 34 00 for operation and maintenance data requirements.

C. Refer to Section 01 34 00 for additional training requirements.

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SECTION 40 15 06
PLC PROGRAMMING SOFTWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for application software to be used in conjunction with the specified PLC hardware.

B. General:

1. The control system logic program shall reside at the PLC level. Software shall be provided and by installed and programmable by this Programming Contractor.

C. Related Sections:

1. Contract documents are a single integrated document, and as such all Division and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all Sections to ensure al complete and coordinated project.

1.2 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 1700 and 17200.

B. Furnish complete product data, operating manuals, manufacturer's certifications, and other submittals as described.

C. Additional Requirements:

1. Product Data:
   a. Programming languages.
   b. Operating system requirements.
2. Control logic:
   a. Fully annotated copy of programmed PLC logic.
   b. Cross-referenced index of all PLC registers or points.

1.3 QUALITY ASSURANCE

A. System Compatibility.

1. The software must be the standard operating software system designed specifically for use with the PLC hardware.
2. The software must be furnished and developed by the manufacturer of the PLC hardware.

1.4 WARRANTY

A. Provide extended 2 year manufacturer's warranty support as follows:

1. Dedicated technical support department or handled by programming staff or distributor.
2. Telephone hours for support shall be 24 hours, 7 days per week.

3. Email and web support addresses.
4. Document download via website.
5. Field services.

1.5 MAINTENANCE

A. Provide system upgrades and maintenance fixes for a period of two years from substation completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Rockwell Programming Software: The following, not equal:
   1. Rockwell Software, Full edition with concurrent license.
   2. Or Software consistent with existing PLC on site matching the PLC to be installed if not Allen-Bradley.

2.2 MANUFACTURED UNIT

A. PLC Programming Software:
   1. The PLC based control system software package shall be able to monitor and/or control PLC's via the PLC data network.
      a. It shall contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
      b. It shall also monitor devices at each drop on the PLC data network for proper communications.
      c. It shall provide the ability to program all PLC on the PLC data network from the Engineer's Console.
   2. All PLC programming shall be accomplished using a standard software package developed for this purpose.
   3. The software package shall be installed on the hard disk of the portable PLC programming terminal, as well as the Engineers Console, EC.
   4. Operating System
      a. Microsoft Windows compatible with owner's latest edition.
   5. The PLC programming software shall be suitable for the PLCs furnished under Section 17720.
   6. All programming, monitoring, searching, and editing shall be accomplished using this PLC programming software.
      a. It shall be usable both online, while connected to the PLC, and offline .
      b. The PLC programming software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical functions blocks.
      c. The software shall be able to monitor the status of all inputs, outputs, timers, counters and coils.
      d. It shall have the capability to disable/force all inputs, outputs and coils to simulate the elements of the ladder logic by means of color change.
      e. It shall include a search capability to locate any address or element and its program location.
      f. PLC status information, such as error indication and amount of memory remaining shall be shown on the CRT screen.

7. The PLC programming software shall support the following programming languages:
   a. Ladder diagram
   b. Function block diagram
   c. Structured text
   d. Sequential function chart
8. The PLC programming software shall have the capability to generate a PLC program printout, which is fully documented.
   a. Fully documented program listings shall have appropriate rungs, address, and coils shown with comments to clarify to a reader what the segment of the program accomplishes.
   b. There shall be a comment for each and every rung of the program explaining the control function accomplished in said rung.
   c. Each contact, coil, etc shall have a mnemonic associated with it that describes its function
   d. The Tag and Loop identification as contained in the P&IDs shall be used whenever possible.
      1) If additional internal coils, timers, etc are used for a loop they shall contain the loop number.
   e. A fully documented listing shall also include a cross-reference report of program addresses.
9. Operating system software shall function automatically without operator intervention, except as required to establish file names and similar information.
   a. The real-time operating system software shall be the standard uncorrupted product of the PLC manufacturer and shall provide the following minimum functions:
      1) Respond to demands from a program request.
      2) Dynamic allocation of the resources available in the PLC. These resources shall include main memory usage, computation time, peripheral usage, and I/O channel usage.
      3) Allotment of system resources on the basis of task priority levels such that a logical allocation of resources and suitable response times are assured.
      4) Queuing of request in order of priority if one or more requested resources are unavailable.
      5) Resolution of contending requests for the same resources in accordance with priority.
      6) Service requests for execution of one program by another.
      7) Transfer data between programs as requested.
      8) Management of all information transfers to and from peripheral devices.
      9) Control and recovery from all program fault condition.
      10) Diagnose and report real-time hardware device errors.
10. Program Execution:
    a. Program execution shall be scheduled on a priority basis.
       1) A multilevel priority interrupt structure is required.

2) A program interrupted by a higher priority program shall be entered into a list of pending programs.

3) Its execution shall be resumed once it becomes the currently highest priority program.

4) The system shall allow periodic programs to be scheduled.

5) The allocation of resources to a time-scheduled program shall be based on its relative priority and the availability of resources.

6) Initiation of programs shall, as a minimum, be activated in the following ways:

a) In response to external interrupts.

b) At a scheduled time of the day.

c) On an elapsed time interval basis.

d) On request by another program

11. Start-up and Restart:
    a. Software shall be provided which initializes and brings a PLC or any microprocessor based hardware unit from an inactive condition to a state of operational readiness.
    b. Initialization shall include determination of system status prior to start -up of initializing operating system software and initializing application software.
    c. Initialization shall also include the loading of all memory-resident software,
    initializing timers, counters, and queues, and initialization of all dynamic database values.
12. Shutdown:
    a. The software shall provide an orderly shutdown capability for shutdowns resulting from equipment failure, including PLC processor failure, primary power failure, or a manually entered shutdown command.
    b. When the loss of primary power is sensed, a high -priority hardware interrupt shall initiate software for an immediate, orderly shutdown.
    c. When a shutdown occurs in response to a command or malfunction, the software shall control the affected hardware quickly and automatically to a secure state.
    d. The failure of the PLC shall be detected at the operator interface level.
13. Diagnostics:
    a. Diagnostic programs shall be furnished with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
    b. The manufacturer's standard diagnostic routines shall be used as much as possible.
    c. Diagnostic software and test programs shall be furnished for each significant component in the control system.
    d. Diagnostic routines shall test for power supply, central processing unit, memory, communications and I/O bus failures as a minimum.
14. Calendar/Time Program:

a. The calendar/time program shall update the second, minute, hour, day, month, and year in the operating system and transfer accurate time and date information to all system level and application software.
b. Variations in the number of days in each month and in leap years shall be handled automatically by the program.
c. The operator shall be able to set or correct the time and date from any operator interface, only at the highest security level.
d. The calendar/time program shall be year 2000 compliant.

15. Algorithms:
    a. PLC software shall support the implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
    b. Algorithms shall be capable of outputting positional or incremental control outputs or providing the product of calculations.
    c. Algorithms shall include alarm checks where appropriate.
    d. As a minimum, the following types of algorithms shall be provided:
        1) A calculator algorithm, which performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
        2) A switch algorithm, which reads the current, value from its input address and stores it as the value of its output address. Two types of switches shall be accommodated, two outputs with one input and one output with two inputs.
        3) A three -mode Proportional -Integral -Derivative, PID, controller
        4) algorithm, with each of the three modes independently adjustable.
        5) The algorithm shall support both direct and reverse acting modes.
        6) Algorithms for lead, lag, dead time, and ratio compensators.
        7) Algorithms to perform integration and totalization of analog process
        8) variables.
    e. All flow rates and run status inputs shall be totalized within the PLC/RTU registers.

B. Analog Database:

1. A comprehensive database shall be furnished for the analog inputs, calculated values, control modules, and outputs.
    a. In addition, spare database points shall be provided for future expansion.
2. One integrated database can be utilized for all types of analog points or separate databases for each type, in either case the database for each point shall include all specified aspects.
3. All portions of the database shall be available for use by the display, report, and other specified software modules.
4. All of the data fields and functions specified below shall be part of the point definition database at the operator interface. It shall be possible to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification shall include all of the features and functions defined below. The analog database software shall support the following functions and attributes.
    a. Analog Input Signal Types:

1) Software shall be provided at the RTUs and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.

b. Input Accuracy:
   1) Inputs shall be read with an accuracy of ±0.05 percent full scale or better.
   2) No data conversion errors shall exceed ±0.05 percent full scale.
   3) Pulse accumulation error shall not exceed :tone (1) count of actual input count at a scan rate of once a minute.
   4) The system accuracy stated above shall be maintained for a period of at least one year without adjustments.

c. Validity Checking:
   1) All analog inputs shall be checked to determine whether they are within a valid measurement range as determined by the zero and span limits of the input.
   2) If a signal is outside of its valid range, a flag shall be set to indicate an over/under range condition and the signal shall be clamped at its minimum or maximum value, as appropriate.
   3) The validity checking shall allow for up to 2 percent zero drift and automatically damp the signal at its maximum/minimum value if it is within this two percent range, adjustable, without setting the invalid signal flag.
   4) It shall be possible to clamp a signal to its zero value based on an external event, ie. drive a pump flow signal to zero when the pump is off.

d. Blocking:
   1) It shall be possible to inhibit or block the scanning and/or processing of any analog input through the operator interface.
   2) For any input so blocked, it shall be possible for the operator to manually enter a value to be used as the input value.

e. Filtering:
   1) Each analog input shall be provided with a first order lag digital filter with an adjustable filter factor.

f. Linearizing:
   1) Where analog inputs require square root extraction or other linearization, means shall be provided to condition the filtered data before the process of scaling and zero suppression take place.

g. Calculated Values:
   1) Means shall be provided to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated value, constants, etc.
   2) These values shall be handled the same as real inputs in terms of record keeping, alarming, etc.

h. Scaling and Zero Suppression:
   1) A conversion program shall be provided to convert input values into engineering units in a floating point format.
   2) Alarms:
   3) An alarm program shall be provided to check all analog variables against high-high, high, low, and low-low alarm limits.
   4) When an analog value exceeds a set limit, it shall be reported as an
   5) alarm based on individually set priority level for each alarm point

6) There shall be an adjustable hysteresis band in order to prevent
7) excessive alarms when a variable is hovering around an alarm limit.
8) Return to normal shall also be reported.
9) It shall be possible to inhibit alarms based on external events, ie. lock-out low pump flow alarm when the pump is off.

i. Averages:
   1) There shall be provided a program to calculate and store hourly, daily, and monthly averages of analog variables.
   2) Averages shall be continuously computed, ie. the average for the current period to the present point in time shall be stored in memory and available for use in displays, etc.
   3) Hourly averages shall be updated each minute or at the polling interval for the selected variable.
   4) Daily averages shall be updated at least once each hour and shall be calculated using the results of the hourly averages.
   5) Monthly averages shall be updated at least once each day and shall be calculated using the results of the daily averages.
   6) At the end of each averaging period, the average values for the period shall be stored on the hard disk for historical record keeping and the present period average register shall be reset to the present value of the variable.
   7) The active database shall include the present period average and previous period average for each variable and averaging period.

j. Totals:
   1) There shall be provided a program to calculate and store hourly, daily, and monthly totalization of analog variables.
   2) There shall be a scaling factor assignable to each variable to convert
   3) to the appropriate units based on a one-minute totalizing interval.
   4) A separate factor shall be assignable for each totalizing interval.
   5) Variables for which totalization is inappropriate shall have scaling
   6) factors of zero.
   7) At the end of each totalizing period, the totalized values for the period shall be stored on the hard disk for historical record keeping and the present period totalization register shall be reset to zero.
   8) 6) The active database shall include the present period total and previous period

k. Totals
   1) There shall be provided a program to determine and store the maximum and minimum values of analog variables and their time of occurrence during the hour, the day, and the month.
   2) At the end of each period, the maximum and minimum values for the period shall be stored on the hard disk for historical record keeping and the present period maximum and minimum registers shall be reset to the present value of the variables.
   3) The active database shall include the present period maximum and minimum values and the previous period maximum and minimum values for each variable and period.

l. Engineering Units:
   1) Software shall be provided to allow the system and the operator to convert all the measured analog variables to any desired engineering units.

2) The operator shall be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in GPM, MGD, CFS and Acre-Feet per day.
3) The conversion of the engineering units shall be preprogrammed, and if not pre-programmed, the operator shall be able to program new engineering unit conversions by using simple methods, ie. multiplication of the database attributes by a constant.
4) The programming method shall be at a level and compatible with the specified training of the operator and the OWNER'S personnel.
5) New conversions shall not require the services of a special programmer and/or special, high-level, programming training.

m. Control Modules:
1) For each control function configured, whether processed at the RTU, PLC, or operator interface, there shall be maintained a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.
2) Input and output assignments, setpoints, and constants shall be adjustable by the operator through the operator interface.
3) Control algorithms shall provide for manual control and output values shall be adjustable by the operator.

n. Analog Outputs:
1) Analog outputs shall be maintained as part of the database.
2) These outputs shall be adjustable manually by the operator through the operator interface or through automatic control algorithms.

5. Some of the above functions may be better accomplished in the Data Acquisition and Graphic Display Software package, it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

C. Digital Database:

1. A comprehensive database shall be furnished for the digital inputs, calculated points, control logic, and outputs.
a. In addition, spare database points shall be provided for future expansion to match the spare I/Os.
2. One integrated database can be utilized for all types of digital points or separate databases for each type, in either case the database for each point shall include all specified aspects.
3. All portions of the database shall be available for use by the display, report, and other specified software modules.
4. All of the data fields and functions specified below shall be part of the point definition database at the operator interface.
a. It shall be possible to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification shall include all of the features and functions defined below. A copy of those portions of the database that are necessary for execution at the RTU and/or PLC shall be maintained at the RTU and/or PLC. The digital database software shall support the following functions and attributes.
1) Digital Input Signal Types:

a) Software shall be provided to allow for single, two state, and dual, three state, inputs.

2) Noise Rejection:
   a) Input bounce filter shall be provided through software if not furnished with input hardware.
3) Blocking:
   a) It shall be possible to inhibit or block the scanning and/or processing of any digital input through the operator interface.
   b) For any input so blocked, it shall be possible for the operator to set the state of the input.
4) Calculated Points:
   a) Means shall be provided to allow for pseudo-inputs calculated from boolean expressions.
5) Status and Alarm:
   a) Each digital point shall be assigned a priority level for change of state reporting as an alarm.
6) Totals:
   a) There shall be provided a program to calculate and store daily and monthly run time, in hours and tenths, and number of start totals of digital inputs.
   b) At the end of each totalizing period, the totalized values for the period shall be stored on the hard disk for historical record keeping and the present period totalization register shall be reset to zero.
   c) The active database shall include the present period totals and the previous period totals for each input and totalizing period.
   d) There shall also be provided a non-resetting, lifetime, run time and number of start totalizer provided for each input.
7) Digital Outputs:
   a) Digital outputs shall be maintained as part of the database.
   b) Software shall be provided to allow for single, two state, and dual, three state, output types.
   c) Output change of state shall be reported as described for inputs.
   d) It shall be possible for outputs to be set manually by the operator through the operator interface or automatically through control logic and sequences.

5. Some of the above functions may be better accomplished in the Data Acquisition and Graphic Display Software package, it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

D. General Control Functions

1. 1.Analog Control Functions:
   a. PID, lead/lag, signal select, alarm, limit, delay, and time base.
   b. The control system shall be furnished complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR and NXOR functions.

c. All math utilities shall be linkable to process data points or manual inputs via control block configuration.
d. By linking control blocks to data points, the math library shall support system unit conversion and calculation requirements.

2. Discrete Control Functions:
   a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays and time base.
3. Software Support:
   a. All control and logic functions shall be retained in firmware at each RTU and PLC and in RAM at the operator interface.
   b. Each function shall be called as required by the configured controls to perform the intended function.
4. Control and Status Discrepancies:
   a. A discrepancy/fail alarm shall be generated for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.
   b. For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.
   c. Involuntary change in the device's status shall also generate an alarm.
      1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.
   d. Each command, status and alarm shall cause the color of the symbol to change.
   e. Because many discrete final control elements have a cycle time in excess of the scan interval, each control output shall have an associated delay period selected to be longer than the operating period of the control element.
      1) Delay periods for each final control element shall be adjustable at the operator interface.
      2) All time delays shall be listed in the final documentation.
5. Some of the above functions may be better accomplished in the Data Acquisition and Graphic Display Software package, it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

E. Control Configuration:

1. Software shall be provided to allow control strategies to be developed and their operation initiated through the operator interface.
2. Standardized control point displays shall allow for defining the control functions including the function type, input/output addresses, set points and tuning constants, etc.
3. In a similar manner, it shall be possible to link separate control functions together into an integrated control strategy.
4. It shall be possible to download operational/control set points developed at any operator interface to any PLC or RTU for operational implementation.
5. It shall also be possible to define and implement operational/control set points locally at the PLC or RTU and to upload them to the Operator interface for operational record keeping.

6. Control configurations shall be performed on-line at the operator interface, but the PLC or RTU may be taken off-line when being configured or downloaded.

2.3 SOURCE QUALITY CONTROL

A. As specified in Section 40 10 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. As specified in Section 40 10 00.

3.2 INSTALLATION

A. All tags used and/or assigned as part of the application programming work provided by the Programming Contractor shall use the Tag and Loop identifications found on the P&IDs.

3.3 TRAINING

A. The training shall be performed by pre-approved and qualified representatives of the Programming Contractor and or manufacturer of the local operator interface software. A representative of the Programming Contractor may perform the training only if the representative has completed the manufacturer's training course for the PLC programming software.

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SECTION 40 15 07
CONTROL SYSTEMS - NETWORK EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

A. Sections Includes

1. Materials and equipment used in process control and LAN networks including:
   a. Network switches.
   b. Other data network hardware.

B. Furnish a complete operating data network as indicated on the Drawings, as shown on the cable or system block diagrams; and as specified herein.

C. The process control LAN and the business office LAN shall be separate networks as shown on the Drawings. Some equipment required for the business office LAN shall be provided by the Owner at a future date.

D. Related Sections: The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. Refer to Section 40 10 00 and noted herein for a list of references.

B. TIA/EIA Standards:

1. TIA/EIA-568-B (Series), Commercial Building Telecommunications Standards.
2. TIA/EIA-569 (Series), “Commercial Building Standard for Telecommunications Pathways and Spaces”
3. IEEE Series 802 standards.

1.3 DEFINITIONS

A. Definitions of terms are specified in Section 40 10 00.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Section 40 10 00 and 40 20 00

B. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer’s certifications, Manufacturer’s Field Reports, and other submittals as specified in Section 40 10 00 and below.

C. Additional Requirements

1. Product Data:

a. Complete Manufacturer's brochures for each item of equipment. Mark up to clearly show options and components to be provided, and cross out any options or components that will not be provided.
b. Include information on all test equipment.
c. Manufacturer's operation and installation instructions.

2. Shop Drawings:
   a. Complete set of drawings including but not limited to:
      1) System block diagram showing relationship and connections between devices provided under this Contract. Include manufacturer and model information, and address settings.
      2) Network riser diagram.
      3) Network port diagram, which physically locates all ports, within the facility, and identifies their patch panel and switch port.
      4) Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, nameplates.
      5) Electrical connection diagrams.
      6) Complete grounding requirements.
3. Test Reports
   a. As noted herein.
   b. Signed test results as described in Part 3 of this Section.
   c. Test results shall include:
      1) Narrative describing the test procedures followed.
      2) Block diagram of test set up.
      3) Manufacturer's information on test equipment used.
      4) Detailed test results.
      5) A narrative summarizing the results of the testing and identifying any further action required.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store all network equipment in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer:

   1. Replace any network equipment components that are not stored in strict conformance with the manufacturer's recommendation.

1.6 PROJECT OR SITE CONDITIONS

A. Network equipment shall be suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, ambient temperature, and humidity conditions.

1.7 WARRANTY

A. As specified in Section 26 05 00.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Ethernet Switches: - Office Network -

1. Managed Enterprise Ethernet Switches:
    a. Manufacturers – One of the following:
        1) The part number shall match those existing in the treatment plant, or approved by OWNER.
2. Performance:
    a. Latency: Less than 10.2 microsecond.
    b. Switch fabric speed: 18.3 Gbps, minimum.
    c. Address Table Size: 8,000 entries, minimum.
    d. Gigabit throughput.
3. Environment:
    a. Operating Temperature Range: 32 to 131 Deg Fahrenheit.
    b. Humidity: 15 to 95 percent, non-condensing.
4. Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
    a. Port Monitoring.
    b. Remote switch management.
    c. Port Security.
    d. Switch Meshing.
    e. Rapid Spanning Tree protocol.
5. Capable of adding or swapping modules without interrupting the network.
6. Modules:
    a. 10/100 Base-TX:
        1) Protocl: IEEE 802.3 Type 10Base_T; 802.3u Type 100base-TX.
        2) Auto-sensing
        3) Connector: RJ-45 – CAT 6.
        4) 24 ports per module.
    b. Fiber optic 100-Base-FX.
        1) Protocl: IEEE 802.3u 100Base-FX.
        2) Full Duplex
        3) Metallic MT-RJ type connectors for use with 62.5 micron multimode optical fiber.
        4) 6 ports per module
    c. 100/100-Base-T:
        1) Protocol: IEEE 802.3u Type 100Base; 802.3ab Type 1000Base-T.
        2) Auto-sensing.
        3) Connector: RJ-45 CAT 6.
        4) 1 port per module.
    d. Fiber Gigabit-SX:
        1) Protocol: IEEE 802.3z Type 1000Base-SX.
        2) Full duplex.
        3) Metallic SC-type connectors for use with 62.5 micron multimode optical fiber.
    e. Provide modules required to provide network connections as indicated on the Drawings.
        1) As required to provide the number of connections required plus 20 percent spare ports of each type used.
7. Spare Parts:
    a. Provide the following spare components:
        1) One spare module of each type provided.
        2) One spare Ethernet switch backplane.
        3) One spare Ethernet switch power supply.

B. Ethernet Switches: - SCADA Network -

1. Process Floor Ethernet Switches:

a. Manufacturers – One of the following:

1) N-Tron 7014FX2.
2) Cisco 2950 Series.
3) No Equal.

b. Properties:

1) Hardware
a) Power Supply
(1) Provide redundant power supplies.
(2) 24VDC, 350 Watts/per power supply.

2) Performance
a) Switch fabrix speed: 8 GBPS, minimum

3) Environment:
a) Operating Temperature Range: 32 to 131 Degrees Fahrenheit.
b) Humidity: 15 to 95 percent, non-condensing.

4) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
a) Remote switch management.
b) Port security
c) Rapid spanning tree protocol.

5) Metallic SC-type connectors for use with 62.5 micron multimode optical fiber.
a) Provide modules required to provide network connections as indicated on the Drawings.
(1) As required to provide the number of connections required plus 20 percent spare ports of each type used.

6) RJ45 connectors for use with Cat 5e or Cat 6 cable.

7) Mounting:
a) DIN Rail.

2. Power Over Ethernet (POE)

a. Manufactures
1) The part number shall match those existing in the treatment plant, or approved by OWNER.

b. Properties:

1) Four pair of two RJ45 10/100BaseTX copper ports.
a) One RJ45 connects to an existing network.
b) Other RJ45 in the pair can send data and up to 15.4 Watts of power.

2) The data on all four pairs are isolated from each other.
3) Redundant power inputs.
4) 2 million hour MTBF.
5) -40ºC to 85ºC operating temperature range.
6) ESD protection.
7) RFI immunity.

C. Fiber Optic Panel

1. LIU – Light Interface Unit.
a. Manufactures:

1) The part number shall match those existing in the treatment plant, or approved by OWNER.

b. Properties:
   1) 2 CCH panels minimum.
   2) 24 fiber capacity minimum.
   3) Corning PWH-02P

2.2 ACCESSORIES

A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.

B. Uninterruptable Power Supply (UPS)

1. In accordance with Section 26 05 00.
2. Provide one UPS for each networking enclosure.
3. UPS shall power all components in networking enclosure and all workstations and servers.
4. As shown on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Upon delivery to the site, examine all cables and components for damage.

3.2 INSTALLATION

A. All racks shall be level and plumb.

B. Install Velcro wrap on all cable bundles within the network/enclosure.

C. All cables and equipment shall be installed in strict conformance with the manufacturer's recommendations.

1. Cables shall be installed avoiding sharp bends.
2. Install cable using lubricant designed for cable pulling.
3. Cable ties or other cable supports shall be installed without crimping the LAN cables.
4. Install LAN cables without splices.
5. Installed bend radii shall not exceed 4 times the cable diameter.
6. Terminate all pairs at the jack and the patch panel.

D. Install cables a minimum of 40 inches away from electrical motors and transformers.

E. Install cables a minimum of 12 inches away from fluorescent lighting.

F. Individual pairs will be untwisted less than 0.5" at termination points.

G. All cables and terminations shall be labeled with cable designations as described in the Division 26 specifications.

H. Each data port shall be individually labeled with its patch panel/switch port ID.

1. Labeling must be printed – no handwritten labels will be allowed.

I. At the completion of the wiring installation, the Engineer will be provided with the following documentation:

1. A plan-view of the premise(s) showing the jack numbering scheme.
2. A printed certification report for the entire wiring installation showing compliance with all ANSI/EIA/TIA specifications for data cable.
3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.

3.3 FIELD QUALITY CONTROL

A. LAN Cable Testing:

1. Testing scope: Test all installed LAN cables.
2. Test plan and witnessing: Obtain Engineer's approval for the test procedures as part of the submittal process. Arrange for the Engineer to witness all testing. Submit a request for witness 15 days (minimum) prior to the proposed test date.
3. Pre-testing:
   a. Test individual cables before installation.
      1) Prior to physical placement of the cable, the installer shall test each cable while on the spool with a LAN certification test device.
      2) Before the cable is installed the installer shall check that the cable conforms to the Manufacturer's attenuations specification and that no damage has been done to the cable during shipping or handling.
      3) The test shall be fully documented and the results submitted to the Engineer, including a hard copy of the all traces, prior to placement of the cable.
      4) The Engineer shall be notified if a cable fails to meet specification and the cable shall not he installed unless otherwise directed by the Engineer.
4. Test Equipment
   a. LAN Certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed level III accuracy.
   b. Tests performed shall include:
      1) Near end cross talk
      2) Attenuation
      3) Equal level far end cross talk
      4) Return loss
      5) Ambient noise
      6) Effective cable length
      7) Propagation delay
      8) Continuity/loop resistance
   c. LAN certification test equipment shall be able to store and produce plots of the test results.
   d. Manufacturers – One of the following:
      1) Agilent Technologies, WireScope 350.
      2) Or approved equal.

3.4 ADJUSTING

A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

3.5 PROTECTION

A. Protect all network equipment after installation and before commissioning. Replace any hardware damaged prior to commissioning.

   1. The Engineer shall be the sole party responsible for determining the corrective measures.

- END OF SECTION -

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SECTION 40 15 10
PROCESS CONTROL STRATEGIES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. This section includes the process control strategies for this Contract. Together with the process input/output schedule, the equipment specifications (including control strategies for local equipment control panels), and the Drawings, the process control strategies describe the required operation, monitoring, and control of the treatment facilities included in this Contract. The Contractor shall provide all equipment, and services necessary to implement all functions described herein.

B. The Contractor shall be responsible for furnishing functioning systems as described herein. The functional descriptions contain requirements for furnishing and installing labor and materials that may not appear elsewhere in the contract documents.

1.2 GENERAL DESIGN INFORMATION

A. Indicator lights on all MCCs, control panels, starter enclosures, interfaces, etc. shall conform to the following color convention:

Condition	Color
Running/Open	Red
Auto	White
Ready/Stopped/Off/Closed	Green
Fail	Amber
Alarm	Amber
Generic Status	Blue or White

B. Running status shall be provided from auxiliary contacts provided with the motor starter. Auto status shall be defined as HOA switch in Auto position. Ready status shall be defined as in remote or auto mode with all interlocks satisfied (no failure conditions present). Stopped and Off status shall be defined as all interlocks satisfied (no failure conditions present), except for no remote or auto mode. Failed status shall be defined as motor overload and/or any other shutdown mode such as over torque, over temperature, low oil pressure, high vibration, etc.

C. A discrepancy failure shall be indicated through the control system for any drive, motor, instrument, etc. that should be running or providing a reading but for which the PLC is not receiving a run status signal or valid reading. An example is a motor which is commanded to run by the control system but is not subsequently detected as running. An adjustable time delay shall be provided for each motor to allow time for the motor to start and satisfy all

interlocks.

D. Manual start/stop, open/close, speed/position adjustment, etc., from the Operator work stations shall be provided for all equipment controlled by the control system.

E. Where devices such as temperature, moisture, and/or vibration sensors, over- or under-pressure protection, space heaters, etc. are provided with process equipment and their associated motors under the various sections of Division 11, the Contractor shall provided all required interconnecting wiring between those devices and their associated MCCs, motor starters, VFDs, local control panels, etc.

F. Where setpoints, operating limits, and other control settings are provided by the process control strategies, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable, and based on actual operating conditions, the Contractor shall make all necessary adjustments to provide smooth, stable operation.

G. The control system shall be capable of receiving inputs of initial run-times for existing and proposed equipment. Initial run-time shall not automatically assumed to be zero.

H. All PLC-controlled equipment shall be provided with adjustable start and stop delays in the control logic. Unless otherwise specified, these delays shall be initially set at one minute. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in the MCCs and equipment control panels. All PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power either by generator or by utility.

I. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the integral and derivative functions to zero. All PLC-controlled variable speed equipment shall be provided with individual speed control PID modules in the PLC which shall be cascaded with the overall setpoint PID modules as required. All setpoints, sequence timers, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the Operator work stations.

J. All pumping systems which contain a wetwell shall be provided with a level sensor in the wetwell to automatically shut down the pumps on low level. The low level shutoff shall bypass PLC control (where applicable) and shall be hardwired directly to the pump starter, VFD, MCC or other control circuitry. The Contractor shall supply all required interposing relays and associated circuitry to multiplex the shutdown signal from the single float switch to all pumps at a given wetwell. The low level shutoff shall also be transmitted to the PLC for alarm logging.

K. All setpoints, alarms, etc. based upon an analog input signal or field variable shall be provided with time delays and dead bands to prevent nuisance tripping of controls and alarms.

L. Elapsed run time shall be determined through the run status input to the PLC.

1. Elapsed run time shall be displayed at the SCADA level for each and every motor controlled through the PLC system.
2. Individual elapsed run time accumulation may be reset by the operator after entering a password if the proper security level is associated with said password.
3. Elapsed run time shall be displayed as 99,999.9 hours after which the elapsed run time registers shall recycle to 0.0 hours.

4. Provisions shall be made to allow the operator to enter a start value for runtime accumulation.
5. Elapsed run time shall be accumulated and stored in PLC registers and not in the SCADA system.

M. PID control algorithms.

1. PID control algorithms shall have operator selectable slew rates for setpoints that will allow the setpoint to slowly ramp to its final value in order to minimize system disturbance.
   a. Individual setpoint slew rates shall be set at a local HMI if available as well as through the SCADA system.
2. Each PID control algorithm shall have a face plate associated with the individual PID control algorithm that shall be displayed at its associated HMI and at the SCADA terminal. Said face plate shall have the following functions:
   a. Display Output, CV.
   b. Display Setpoint, SP.
   c. Display Process Variable, PV.
   d. Allow for operator selection of Automatic or Manual control of Output.
   e. Under manual control of output allow the Operator to enter the desired output value.
   f. Allow for input of the three PID tuning parameters.

N. Programmable settling and proving timers shall be provided in all control sequences for starting and stopping of pumps, in order to let the process settle down before proceeding with any additional control functions.

1. These timers shall be imbedded in the PLC logic, tuned in the field, and listed separately as part of the software submittal and O & M manual.

O. Status indication:

1. All status indication shall match existing status indication in the treatment plant.

P. HMI development shall match existing HMI design requirements in the treatment plant.

Q. Control software and/or hardware shall be so configured and designed as to monitor for loss of analog signal (signal <4 mA), analog signal too large (signal > 20 mA), or rate of signal change too fast (individual rate parameter for each analog input signal to be imbedded in software), when any of these conditions are detected the control system shall alarm this condition, and close the appropriate valve and or stop the appropriate motor in order to prevent the process from running away.

R. The manual control mode shall be completely manual and under the operator control, there shall be no programmed interlocks requiring completion of a previous step before operating a device, unless specifically identified in the individual loop descriptions as occurring in the manual mode.

S. Number of starts shall be accumulated for each motor.

1. The number of starts for the current day shall be moved into a register and held as the previous day's number of starts at 0:01 hours each day.
2. The number of starts for the current day shall be moved entered into the historical data base time and date stamped at 0:01 hours each day.
3. The current day number of starts shall be reset at 0:01 hours each day.

T. Alarm/Fault Indication/Acknowledgement

1. All Alarm/Fault indication and acknowledgement shall match existing plant system.

U. Power failure.

1. The control system upon sensing a power failure including when switching to Generator shall store, within, the PLC memory the current status of all equipment, i.e. ON or OFF.
2. Upon restoration of power the control system shall then sequence ON all equipment that was running prior to the power failure condition following the same load step sequences as start-up.
3. For Pump Cycling algorithms, the selected stand-by pump shall not be cycled into operation, or an operating pump into stand-by, but shall keep the same cycle selection for all pumps.

V. PLC System Status

1. There shall be indication within the HMI of the PLC system and communications status. The indication and/or alarm shall match existing indication and/or alarm in the treatment plant.

W. Analog device calibration override.

1. Provide a SCADA screen for each and every analog input that allows the Operator to access said analog input to:
   a. Disable the analog input in the PLC control system.
   b. Enter a value for the analog input from the SCADA system to the PLC.
   c. Hold the last analog input value while the actual analog input is disabled.
2. Provide a SCADA screen for each and every analog output that allows the Operator to access said analog input to:
   a. Force an output value entered from the SCADA system to the PLC.
   b. Hold the last analog output value while the programmed output is disabled.

PART 2 PRODUCTS

2.1 CONTROL LOOP DESCRIPTIONS

A. WET WELL CONTROL

1. The wet well will be controlled to a level setpoint with control feedback from the level transmitter. There will be (2) small pumps and (3) large pumps run in lead-lag fashion small to large.
   a. Hi Level a band-width above the setpoint starts the lead small pump
   b. When the first small lead pump reaches 55Hz (operator adjustable) the second small pump starts, and both control to the same frequency together.
   c. When both small pumps reach 55Hz, the first large pump starts, and both small pumps ramp down and turn off.
   d. When the first large pump reaches 55Hz, the second large pump starts, and both control to the same frequency together.
   e. The third large pump is standby. Lead/Lag/Standby pumps are alternated with each start/stop cycle of the pump set (small set / large set) or with every month. If a lead pump is running during the altering time, the lag pump will start and the lead will ramp down becoming the lag pump.
   f. When inflows reduce the large pumps will reduce frequency naturally to maintain the

setpoint. When both large pumps drop to 30 Hz, the lag pump turns off. The lead pump ramps up naturally to keep the setpoint.

g. When the lead pump alone drops to 30Hz, both the small pumps start and ramp to meet the setpoint together.
h. When the small pumps drop to 30Hz, the small lag pump turns off. The small lead pump ramps up naturally to keep the setpoint.
i. When the small lead pump drops to 30Hz, it stays at 30Hz. The level will begin to drop.
j. When the level drops to the low-level stop shutoff, all pumps are turned off, and await the high level start again.

2. High and Low level floats perform hard-wired backup directly to the VFD. A high-high level float will latch an emergency run command. A low-low level float will release that latch. The low-low level float does not affect the normal operation of the system, just the emergency backup.
3. The (3) large pumps are electrically interlocked to prevent any more than (2) pumps from running at the same time for any reason. Emergency run, manual, and auto modes are all limited to (2) pumps running.

B. WET WELL LEAD PUMP CYCLING

1. The lead and lag pump for the small and large pumps, and the large stand-by pump will cycle at least once every month, or as often as each time that reduced demand causes an unneeded pump to turn off.
2. When two pumps are running at full capacity, as demand decreases naturally, both pumps control to a slower speed setpoint together. When the speed reaches 50%, then the PLC will stop the lead pump. This is when the cycling of pumps will occur because of a stopped pump scenario.
3. The lead pump is assigned as the stand-by pump. The lag pump is assigned as the lead pump. The stand-by pump is assigned as the lag pump.
4. With this new assignment, the lead pump now as stand-by will thereby turn-off and the lag pump continues to run, but as the new lead pump. The stand-by pump now as the lag pump will still not start because the demand level is only calling for 1 pump.
5. The new lead pump will then speed control to meet pumping demand.
6. Any time a lead pump cycle occurs, a cycle timer will reset again timing to one month.

C. MONTHLY CYCLING

1. Should the same number of pumps be run for a month, then no cycle will have occurred, and the timer will signify the need to cycle the pumps to keep them exercised. A special cycling routine will ensure no loss of pumping.
2. If one pump is running, then the lag pump will start. Both pumps will share the speed setpoint. The algorithm will return to normal control. The normal algorithm will detect that two pumps are running but only one needed, and will naturally shut down what was the lead pump.
3. If two pumps are running, then a cycle will be forced. This will naturally cause what was the lead pump to become stand-by and shut down. The flow demands will cause what was the stand-by pump but now is the lag pump to start to meet the need. The two pumps will naturally ramp up to the same setpoint it was just running at.

D. ALARMS

1. Wet well level transmitter HIGH and LOW alarms
2. Each pump, alarm
   a. Not in auto
   b. Pump Fail
   c. High Pressure Switch
   d. The three large pumps will have RTD monitoring, trending, and alarms.
3. Aerigator Fail
4. High Level Float
5. Low Level Float
6. Low flow proportional to size and count of pumps running
7. Pump room HIGH and LOW temperature
8. Pump room intrusion (door open)
9. Headworks room intrusion (door open)
10. Dry Pit flood alarm
11. Headworks building HIGH and LOW temperature
12. Headworks building high level alarm
13. Headworks building flood alarm
14. Headworks motor controller common alarm
15. Headworks building lights on too long (24 hours)
16. Headworks building HI LEL alarm
17. Headworks building HI HI LEL alarm
18. Generator Fuel Leak
19. Generator Pre alarm
20. Generator not in auto
21. Generator failure
22. ATS in standby

E. PUMP I/O

1. The controls on the VFD will include a Hand-Off-Auto switch, a Potentiometer speed dial, and a running, fail, high pressure, and speed indicator.
2. The signals to and from each VFD include:

I/O	**TYPE**	**DESCRIPTION**
AI	SI	PUMP SPEED REFERENCE
RTD (8)	TI	PUMP TEMP MONITOR, TREND, ALARM (3 LARGE PUMPS)
AO	SC	PUMP SPEED COMMAND
DO	YC	PUMP RUN COMMAND
DI	YI	PUMP RUN INDICATION
DI	YA	PUMP FAIL INDICATION
DI	YI	PUMP IN AUTO
DI	PAH	PUMP HIGH PRESSURE SD
INTERNAL	YQI	PUMP START COUNT
INTERNAL	YQIR	PUMP RUN TIME

F. BACKUP CONTROLLER

1. The backup controller is hardwired relays to hardwired switches located within the PLC cabinet. The signals to and from the PLC include:

I/O	TYPE	DESCRIPTION
DI	YA	WET WELL EMERGENCY RUN
DI	LALL	WET WELL LOW LOW LEVEL
DI	LAHH	WET WELL HIGH HIGH LEVEL

2. The Emergency run signal is an alarm to the PLC to indicate that the backup controller has initiated an emergency run to the VFDs directly. The PLC will not act to run the pumps in an emergency mode, but will prevent wind-up on the level controllers because the VFDs will not be responding to the speed setpoints and the level will not be responding to the PLC controllers.
3. The Low-Low and High-High signals come from level floats in the wet well and are passed via relays into the PLC. They are fail-safe, meaning a dropped signal will indicate the Low Low or High High signal respectively.

G. LEVEL TRANSMITTER

1. The Level Transmitter is used to control the pump run commands and VFD speed setpoints. The signals to and from the PLC include:

I/O	TYPE	DESCRIPTION
AI	LI	WET WELL LEVEL
INTERNAL	LAL	WET WELL LOW LEVEL
INTERNAL	LAH	WET WELL HIGH LEVEL
INTERNAL	LDA	WET WELL LEVEL DIFFERENTIAL

2. The Low Level Alarm is to be set at a level higher than the Low Low level float to alarm to operations of a possible problem, an impending low-low condition.
3. The High Level Alarm is to be set at a level lower than the High High level float to alarm operations of a possible problem, an impending high-high condition and corresponding electrical emergency backup operation.
4. The Level Differential alarm will be internal in the PLC and will be calculated as a difference between the low-low or high-high float and the Level Transmitter. There will be a difference tolerance and a time delay to prevent false alarms. The following conditions will create a level differential alarm within tolerance and time delay:

LALL	LAHH	LT
ON (LOW)	X	> LALL Level + Tolerance
OFF	X	< LALL Level - Tolerance
X	ON (HIGH)	< LAHH Level - Tolerance
X	OFF	> LAHH Level + Tolerance

H. FLOW TRANSMITTER

1. The Flow Transmitter indicates to operations the effluent process flow from the pump building. The signals to and from the PLC include:

I/O	TYPE	DESCRIPTION
AI	FT	LIFT STATION FLOW

INTERNAL	FAL	LOW FLOW ALARM

2. The low flow alarm will correspond to the anticipated flows for the count of pumps and size of pumps running. If it is lower than expected, and alarm will be generated

I. TEMPERATURE TRANSMITTER

1. A Temperature Transmitter in the Pump building, and one with probe into the headworks building monitors building temperatures:

I/O	TYPE	DESCRIPTION
AI	TT	PUMP BUILDING TEMP
INTERNAL	TAH	PUMP BUILDING HIGH TEMP
INTERNAL	TAL	PUMP BUILDING LOW TEMP
AI	TT	HW BUILDING TEMP
INTERNAL	TAH	HW BUILDING HIGH TEMP
INTERNAL	TAL	HW BUILDING LOW TEMP

2. Each building has a High and Low temperature alarm setpoint.

J. PLC POWER FAIL

1. The main power feeding the PLC cabinet if lost will alarm in the PLC
2. If the UPS has trouble, it will alarm in the PLC
3. The PLC power both feeding the PLC Cabinet, and the two critical 24V power supplies to the PLC and backup controller is monitored by a relay for each. Power loss on either 24V power supply, or power loss to the PLC cabinet will drop the signal to the PLC indicating the power failure alarm. It is fail-safe meaning that an open wire or power loss will indicate the failure. There is an alarm for each power supply.
4. The signals to and from the PLC include:

I/O	TYPE	DESCRIPTION
DI	EA	PLC POWER FAIL
DI	EA	PLC UPS TROUBLE
DI	EA	PLC POWER SUPPLY 1 FAIL
DI	EA	PLC POWER SUPPLY 2 FAIL

K. GENERATOR

1. Generator monitoring will provide the following information and alarms to operations:

I/O	TYPE	DESCRIPTION
AI	LI	FUEL TANK LEVEL
DI	YA	FUEL TANK LEAK
DI	YIR	GENERATOR RUNNING
DI	YA	GENERATOR FAIL
DI	YI	ATS NORMAL POSITION
DI	YI	ATS GENERATOR POSITION
INTERNAL	LAL	FUEL TANK LEVEL LOW
INTERNAL	LALL	FUEL TANK LEVEL LOW-LOW

2. The Internal Fuel Tank Level Low alarm is generated from the LI level indicator when below the low setpoint. The low-low alarm is below the low-low setpoint.
3. Alarm for the ATS in GENERATOR position.

L. FLOOD ALARM

1. The flood switch in the pumping room or the headworks building will open during a flood condition. The signals to and from the PLC include:

I/O	TYPE	DESCRIPTION
DI	LAH	PUMP ROOM FLOOD ALARM
DI	LAH	HEADWORKS FLOOD ALARM

M. INTRUSTION ALARM

1. All door switches are wired in series for the pump building. The headworks building would require class I Div 1 door switches and so to economize, will not include switches. The opening of any door will open the loop and drop the signal to the PLC indicating an Intrusion alarm. The signals to and from the PLC include:

I/O	TYPE	DESCRIPTION
DI	EA	PUMP ROOM INTRUSION ALM

N. GAS DETECTION

1. The Headworks gas alarm control panel detects and alarms with beacon the presence of LEL Gas. The alarm levels are at 10% LEL and 20% LEL respectively. The signals to and from the PLC include:

I/O	TYPE	DESCRIPTION
AI	AT	LEL GAS LEVEL
INTERNAL	AAH	HIGH LEL GAS LEVEL
INTERNAL	AAHH	HIGH HIGH LEL GAS LEVEL

O. HEADWORKS LIGHTS

1. Because the headworks building lights turn on the vent fan, if someone leaves the building and forgets to turn off the lights, the vent fan will continue to run. This will waste energy and in cold temperatures risks freezing. There will be an alarm

I/O	TYPE	DESCRIPTION
DI	XI	LIGHTS ON
INTERNAL	XA	LIGHTS ON TOO LONG

P. AERIGATOR

1. The Aerigators run in auto on a timer settable from the HMI by operators, or manually on/off by operators on the HMI. The timer is for “ON TIME” and “EVERY” in minutes. Where of course the on time needs to not exceed the “Every” time. For example ON

TIME of 10 minutes EVERY 60 minutes will then be on for 10, off for 50 minutes.

I/O	TYPE	DESCRIPTION
DO	YC	RUN COMMAND
DI	YI	RUN STATUS
DI	YA	FAIL
INTERNAL	YA2	FAIL TO RUN

2. Alarm for the aerigator failure signal.
3. Alarm if command to run but no run signal obtained

Q. SCREEN PRESS GRINDER CONTROLLER

1. A manufacturer's controller will control the headworks screen, press, and grinder. The signals to and from the PLC include:

I/O	TYPE	DESCRIPTION
DI	XI	SCREEN RUNNING
DI	XI	GRINDER RUNNING
DI	XI	AUGER RUNNING
DI	XA	COMMON ALARM
COM	LAHH	FLOOD SWITCH
COM	LT	INGRESS LEVEL
COM	LT	EGRESS LEVEL
COM	LAH	SCREEN LEVEL HIGH

2. The Internal Screen level high is if either level transmitter shows a level equal to or higher than the channel depth.

R. NOT CONTROLLED BY PLC

1. The following equipment is not controlled by the PLC but is rather controlled by local controllers.
   a. PUMP ROOM VENT FAN controlled by a vent fan controller. Constantly on with 6 air changes per hour. High speed initiated by hand switch rotary timer, or thermostat. Operation of fan opens damper motors.
   b. HEADWORKS ROOM VENT FAN controlled by thermostat, gas detection, or lights on. Operation of fan opens damper motors.
   c. PUMP ROOM HVAC Equipment controlled by thermostat
   d. ELECTRIC HEATERS controlled by integral thermostat
   e. LIGHTING controlled by light switches
   f. ATS by integral controls

- END OF SECTION -

SECTION 40 20 00
INSTRUMENTS GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in operation process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with all instrumentation, panels, controls, and process equipment control panels with the process control system as shown on the Drawings and as specified. Mounting of associated transmitters, indicators, power supplies, brackets, and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of the process instrumentation on process lines shall be provided under this Contract.

C. Taps and connections for primary process 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 as 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.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00 – Process Control and Instrumentation Systems

B. Division 26.

1.3 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
API RP550	Manual on Installation of Refinery Instruments and Control Systems, Part I – Sections 1 Through 13
ISA S20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology

1.4 GENERAL INFORMATION AND DESCRIPTION

A. These Specifications are intended to give a general description of what is required, but do

not cover all details which will vary in accordance with the requirements of the equipment furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery, and complete installation and field testing of all instruments and appurtenances whether specifically mentioned in the Specification or not.

B. The instruments shall be furnished and installed with all necessary accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. The installations shall incorporate the highest standards for the type of service shown on the Drawings including loop testing of the entire installation and instruction of operating personnel in the care, operation, calibration, and maintenance of all instrumentation.

C. All instrumentation shall be of first class workmanship and shall be entirely designed and suitable for the intended services. All materials used in fabricating the equipment shall be new and undamaged.

PART 2 PRODUCTS

2.1 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, all instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

B. Equipment installed in hazardous areas shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electric Code.

C. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

D. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in paragraph 3.1.B. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable, except for speed and valve position. Floating outputs shall be provided for all transmitters.

E. Unless otherwise specified, field instrument and power supply enclosures in corrosive environments shall be 316 stainless steel, fiberglass, or PVC coated copper free cast aluminum NEMA 4X construction.

F. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

G. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture, and fungus. Solid-state components shall be conservatively rated for long term performance and dependability over ambient atmospheric fluctuations. Ambient conditions shall be –15 to 50 degrees C and 10 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

H. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models which are currently in production. All equipment

provided, where applicable, shall be of modular construction and shall be capable of field expansion.

I. All non-loop powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage reduction, constant voltage transformers shall be supplied.

J. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

K. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials is available.

2.2 ACCESSORIES

A. Isolation Valves – Valves shall be full port ball valves with ASTM A276, Type 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Parker CPI, Whitey, Hoke, or equal.

B. Gage Valves – Gage valves shall be machined from ASTM A276 bar stock and shall be provided with 1/2-inch NPT connections and integral bleed valve. Valves shall be Anderson, Greenwood & Company M9530, Hoke 6801L8Y, or equal.

C. Root Valves – Root valves shall be ASTM A276, Type 316 stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, Type 316 stainless steel bleed valve. ASTM A276, Type 316 stainless steel plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson, Greenwood & Company M5 AVS-44, Hoke 6802L8Y, or equal.

D. Manifolds – Manifolds shall be three-valve bar-stock type. Manifold body shall be machined from 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified. Manifolds shall be Anderson Greenwood M4TVS, Hoke 8123F8Y, or equal.

E. Tubing – Instrument tubing between the process connection and instruments shall be 1/2-inch x 0.065-inch seamless annealed ASTM A269, Type 316 stainless steel. Tubing fittings shall be Type 316 stainless steel. Fittings shall be of the swage ferrule design and shall have components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer. Flare and ball sleeve compression type are not acceptable. Fittings shall be Parker CPI, Crawford Swagelok, Hoke Gyrolok, or equal.

F. Chemical Seals

1. Diaphragm – Seal shall be the diaphragm type with flushing connection, Type 316 stainless steel body and Type 316L diaphragm unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.
2. Annular Ring – Seal shall be the in-line full stream captive sensing liquid type. Metallic wetted parts shall be Type 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated 200 psig with not more than 5-inch WC

hysteresis. Seals shall be Ronningen-Petter Iso-Ring, Red Valve series 40, or equal.

3. Fill Fluid – Chemical seals and associated instruments shall be factory filled as follows: Instrument side of seal, capillary tubing, and instrument shall be evacuated to an absolute pressure of 1.0 Torr or less; filled; and sealed. Unless otherwise specified, fill fluid shall be silicone oil, Dow Corning DC200, Syltherm 800, or equal.

G. Bushings and Thermowells – Bushings or thermowells shall comply with SAMA PMC17-10. Temperature taps shall be 1/2-inch NPT, and lagging extensions shall be provided on insulated vessels or pipes. Thermowells and bushings shall be machined from Type 316 stainless steel bar stock unless otherwise specified.

H. Purge Assemblies

1. Air – Air purge assembly shall consist of a constant-differential relay, needle valve, check valve and 0.2 to 2.0 scfh rotameter. Assembly shall be Moore Products 62VA, Fischer & Porter 10A3137N-3BR2110, or equal.
2. Water – Water purge assembly shall consist of a strainer, constant-differential regulator, needle valve, check valve, and 20 to 200 cc/m rotameter. Assembly shall be Moore Products 63BD4A, Fischer & Porter 10A3137N-53BR2110, or equal. Strainer shall be 155 micron wye-type, ASCO 8600A2, Crane, or equal.

2.3 POWERED INSTRUMENTS GENERAL REQUIREMENTS

A. Powered instruments are those instruments which require power (120 VAC or 24 VDC loop power) to operate. Each instrument includes an element or analyzer and a transmitter/controller.

B. Transmitters shall be 4 to 20 milliampere output two-wire type with operating power derived from the transmission circuit. Transmitter shall support an external load of 0 to 600 ohms or greater without requiring trimming resistors with a transmission circuit power supply of 24 volts. Transmitter output shall be galvanically isolated from the process and the transmitter case. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.5 to 5.0 seconds. Transmitter output shall increase with increasing measurement except where "reverse action" is specified in the instrument schedule.

C. Electrical parts of transmitter and/or primary element mechanisms shall, as a minimum be housed in enclosures meeting NEMA 250, Type 4 requirements. Where electrical mechanisms are located outdoors or in areas specified as corrosive, enclosures shall meet NEMA 250, Type 4X requirements.

D. Transmitters located outdoors shall be provided with surge protectors: Rosemount Model 470A, Taylor 1020FP, or equal.

E. Where two-wire transmitter is located in an area classified as hazardous, it shall be made safe by means of an intrinsic safety barrier. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD. type MT3042, Stahl 9005/01-252/100/00, or equal.

F. Where four-wire transmitters are permitted, they shall be provided with a loop powered signal current isolator connected in the output signal circuit. Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits. Isolator shall be housed in a NEMA 250, type 4/7 conduit body and shall derive its operating power from the signal input circuit. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an

output load of 250 ohms. Isolator shall be Moore Industries SCX/4-20MA/ 4-20/MA/6.5DC/-RF(EX).

2.4 PROCESS SWITCHES GENERAL REQUIREMENTS

A. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm. Contact outputs used to control equipment shall be ordinarily open and shall close to start the equipment. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and designed for switching currents from 20 to 100 mA at 24 volts DC. Contacts monitored by electromagnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures. Switch electrical enclosures shall be rated NEMA 250, type 4 minimum. Contacts in Class 1, Division 1 areas and monitored by solid-state circuits shall be made safe by suitable intrinsic safety barriers as specified in Section 26 09 13.

PART 3 EXECUTION

3.1 INSTALLATION

A. General – Equipment shall be located so that it is accessible for operation and maintenance. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square, ½-inch thick aluminum steel baseplate. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than ½-inch by use of phenolic spacers. Expansion shields in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.
2. Embedded pipe supports and sleeves shall be schedule 40, 304 stainless steel pipe, with stainless steel blind flange for equipment mounting as shown on the Drawings.
3. Materials for miscellaneous mounting brackets and supports shall be 304 stainless steel.
4. Pipe stands, mounting brackets, and supports shall comply with the requirements of Division 5.
5. Where transmitters are supported from process piping, leveling saddles shall be provided. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring – Electrical, control, and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits pass from classified to unclassified areas.

3.2 CLEANING AND ADJUSTMENT

A. General

1. The Contractor shall comply with the requirements of Division 1 and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation

and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserve 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.

2. The Contractor 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 provided all personnel, equipment, and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field Instrument Calibration Requirements

1. 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 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 Bureau of Standards.
2. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures, name of person performing the calibration, listing of 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.
3. If doubt exists as to the correct method for calibrating or checking calibration of an instrument, the manufacturer's recommendations shall be used as an acceptable standard, subject to approval of the Engineer.
4. 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 being subjected to overvoltages, incorrect voltages, overpressures, or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.
5. Upon completion of instrumentation installation, the Contractor 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.

- END OF SECTION -

SECTION 40 21 20
MAGNETIC FLOW METERS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the magnetic flowmeter systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

B. Refer to Section 40 91 23 for additional requirements.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00 – Process Control and Information Systems

B. Section 40 20 00 – Instruments, General

C. Section 40 91 23 – Miscellaneous Properties Measurement Devices

PART 2 PRODUCTS

2.1 MAGNETIC FLOWMETERS

A. Acceptable Manufactures are:

1. Siemens Sitrans FM MAG 5100 W.
2. No substitutions permitted.

B. Process connections shall be flanged, ANSI B16.5, Class 150, raised face.

C. Magnetic flow meter shall be provided as a system consisting of a flow tube and separate converter/ transmitter complete with interconnecting cables. Converter/transmitter shall be suitable for full-scale flow rates from 3.0 to 30 feet per second. System error shall not exceed the greater of 0.5 percent of rate or 0.1 foot per second. Flow tubes located in lined or non-conductive pipelines shall be provided with grounding spools or swages fabricated from ASTM A312, Type 316 stainless steel. Grounding spools or swages inside diameter shall be 1/16 inch smaller than flow tube inside diameter. Where pipe run size is different from specified flow tube size, uniformly diverging swages with a total angle between walls not exceeding 15 degrees shall be provided. Excitation power requirements shall not exceed 100 volt-amperes.

D. Flow tubes size 0.5 through 6 inches shall be ceramic lined wafer-style ductile-iron body with platinum electrodes. Flow tubes larger than 6 inches shall be cast aluminum full-body flanged construction with 316L stainless steel electrodes. Unless otherwise specified, liner shall be polyurethane.

E. The transmitter shall contain all electronics associated with the magnetic flow meter system. Enclosure shall be NEMA 4 cast aluminum compartment for power, field connections and calibration adjustments separate from digital circuitry. Transmitter shall contain means to calibrate the metering system without use of external calibration units. The transmitter shall contain self-diagnostics and shall be interchangeable with other units of the same type without special re-calibration. Transmitter shall include an integral 3-digit LCD flow indication calibrated in process units. Adjustable dampening

shall be provided. Provision for accepting an external contact to force signal output to zero shall be provided. Where pulse frequency output is specified, pulse frequency shall cut out at flows below 2 percent of maximum range. The signal cable between the primary element and transmitter shall be provided by the system manufacturer. A sufficient length of cable shall be provided for installation of a continuous run between the primary element and the transmitter.

F. Remote mounted display/transmitters shall be provided where indicated on the drawings. Flow tubes with integral display/transmitters shall be provided where indicated on the drawings.

PART 3 EXECUTION

3.1 REQUIREMENTS

A. Refer to Section 40 20 00 and Section 40 91 23.

- END OF SECTION -

SECTION 40 24 10
LEVEL DETECTOR

PART 1 - GENERAL

1.1 REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the Radar level sensor and transmitter systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00-Process Control and Information Systems

B. Section 40 20 00-Instruments, General

PART 2 - PRODUCTS

2.1 LEVEL DETECTOR/WITH REMOTE DISPLAY/TRANSMITTERS

A. The level detector shall be of the non-contact microprocessor based type for the continuous measurement of liquid levels.

B. The unit shall be a two piece transmitter/display meter and transducer with interconnecting cables.

C. The transmitter shall store the level profile in the computer memory and moment by moment, analyze the profile to determine the actual liquid level.

D. All program data shall be safeguarded internally in non-volatile EEPROM memory.

E. The transducer shall be encapsulated and shall be capable of:

1. Accuracy of ± 0.25% of range.
2. Range 0.8 to 26.2 feet or the maximum depth of the measured material whichever is greater.
3. Provide for flange mounting, or provide wall mounted mounting bracket as detailed on the drawings.
4. With integral temperature compensation or without temperature factors playing into the level measurements.
5. The unit shall utilize a narrow beam transducer which is rated Class 1 Division 1, explosion proof. The unit shall be provided with factory fabricated lead cable integral to sensor unit and shall extend to the meter unit within the electrical room.

F. The control transmitter shall be in a NEMA 6P enclosure with an integral from panel mounted meter indicating in scaled engineering units.

1. The unit shall provide a 4-20 mA analog output signal directly proportional to level, driven from the PLC and its associated power supplies.
2. The unit shall be capable of displaying by software selection:
   a. Distance to liquid surface from transmitter.
3. The unit shall contain four relays for use as programmable alarm or hard-wired control points.

4. Power requirements shall be 24VDC (fed from a UPS via a power supply.)
5. 4-20 mA output into 750 Ohms at 24 VDC.
6. Selectable damping 1 to 10 m/min.
7. 4 button HMI, wall mounted controller allowing for programming from the panel face, including blanking distances and obstruction blanking.

G. The programming unit shall be incorporated into the body of the instrument.

H. Operating temperature range -40º to 60° C.

I. Mount transducer with non-metallic mounting only.

J. Three wire extended range.

K. As manufactured by:

1. Siemens Hydroranger LT500 with LR110 or LR150 series radar.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Refer to section 40 20 00.

B. Transducers shall be provided with flange mounting options. Mount to flanged support rigidly attached to wall or concrete square and plumb to building. Sensor shall be mounted to avoid all signal interferences.

- END OF SECTION -

SECTION 40 27 10
LIQUID LEVEL SWITCHES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the liquid level switches with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00 – Process Control and Information Systems

B. Section 40 20 00 – Instruments, General

PART 2 PRODUCTS

2.1 LIQUID LEVEL SWITCHES

A. Level Switch Tipping Float

1. Device identification: See Section 40 20 00.
2. Float actuated switch shall be a dry contact type switch in a hermetically sealed polypropylene casing, suspended on a PVC coated cable.
3. The number of floats per level system shall be as shown.
4. The switch rating shall be at least 10 amps at 120 VAC.
5. Switch set points shall be as shown on the drawings.
6. Mercury switch type capsules are not allowed.
7. As manufactured by:
   a. WE Anderson/Dwyer FSW Series
   b. Or approved equal

B. Room flood monitoring switches

1. Device identification: See Section 40 20 00.
2. Stem and mounting shall be 304 Stainless Steel.
3. The float shall be Buna N material.
4. The wetted parts shall be manufactured of Beryllium Copper, Copper Nickel, or Polycarbonate.
5. Dry contact with an electrical rating of 20VA.
6. Operating Temperature of -40 F to 140F.
7. Gems Sensors LS-270 or approved equal

C. The CONTRACTOR shall deliver to the OWNER all required spare parts. The spare parts shall not be used as replacement parts during system start-up or the guarantee period.

PART 3 EXECUTION

3.1 REQUIREMENTS

A. See Section 40 20 00.

- END OF SECTION -

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SECTION 40 27 60
PRESSURE SWITCHES AND SEALS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure switches and seals with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 MANUFACTURERS

A. Section 40 10 00 – Process Control and information Systems

B. Section 40 20 00 – Instruments, General

PART 2 PRODUCTS

2.1 Pressure Instrumentation

A. Seals

1. All pressure switches and/or transmitters shall be provided with seals.
2. Pressure switches, gages, and/or transmitters and seals shall be assembled and oil filled at the factory prior to shipment. Filling fluid shall be compatible with piping contents and temperature.
3. Pressure switches and/or transducers attached to systems involving chemical solutions, corrosive fluids, or other liquids containing one percent or more of solids, shall be equipped with diaphragm or annular seals whether shown or not on the drawings, or equal protective pressure sensing devices, as follows:
   a. Clear process water applications:
4. Type 316 stainless steel for pressures over 15 psi.
5. Elastomer for pressures of 15 psi and below.
6. Type 316 stainless steel nuts and bolts, fill connection and valved flush port size of ¼-inch NPT, capable of disassembly without loss of filler fluid.
7. As manufactured by:
   a. Ashcroft Type 101
   b. Or prior approved equal.
8. For chemical solutions, sludge, etc., where breakage does not create major shutdown:
   a. Seals with PVC body for removable mounting rated at 200 psi.
   b. Type 316 stainless steel bolts and nuts
   c. ½-inch inlet
   d. ¼-inch outlet
   e. Liquid-filled with Teflon diaphragm for pressure.
   f. Elastomer diaphragm for vacuum service.
9. For sludge, liquids containing solids, pulsating flow:
   a. Pressure instrument protectors shall be of the isolation ring type seal with integral instrument removal device.
   b. Construction
      1) Unit consists of a body, 360 degree flexible elastomeric cylinder with positive O-ring type sealing arrangement, captive fill fluid and two assembly flanges.

2) Includes integral instrument removal device to remove instrumentation without interrupting process flow. The isolation ring I.D. shall match the pipeline I.D. The isolation ring O.D. shall not exceed the I.D. of the piping flange bolt circle. Units are designed to fit 135#, 150# and 300# ANSI piping flanges.

3. Materials
   a. Body is 316 Stainless Steel unless otherwise required. Two assembly flanges are 316 S.S. Flexible elastomeric cylinder is Silicone. Captive sensing liquid is glycerin, Silicone or Halocarbon as required for the piped fluid.
4. As manufactured by:
   a. Ashcroft Type 80, 81.
   b. Prior Approved Equal.

2.2 Pressure Switches High

A. General:

1. Enclosure NEMA 4X
   a. Manual Reset trip on increasing pressure
   b. DPDT
   c. Actuator Seal: Teflon
   d. Each pressure switch shall have visible scale and contact operation.
      1) Pressure switches shall have a contact rating of 10 amperes at 125 VAC.
      2) Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.
      3) Diaphragm seals shall be provided and included at the locations shown.
      4) Automatic reset
      5) Standard Ranges:
         a) 10” H20, Proof psi 20, Burst psi 35
         b) 30” H20, Proof psi 20, Burst psi 35
         c) 60” H20, Proof psi 20, Burst psi 35
         d) 100” H20, Proof psi 20, Burst psi 35
         e) 150” H20, Proof psi 20, Burst psi 35
         f) 15” H20, Proof psi 500, Burst psi 1000
         g) 30” H20, Proof psi 500, Burst psi 1500
         h) 60” H20, Proof psi 500, Burst psi 1500
         i) 100” H20, Proof psi 1000, Burst psi 3000
         j) 200” H20, Proof psi 1000, Burst psi 3000
         k) 400” H20, Proof psi 2400, Burst psi 3000
         l) 600” H20, Proof psi 2400, Burst psi 3000
      6) As manufactured by:
         a) Mercoid.
         b) Or approved equal.

2.3 Pressure Switches Low

A. Device identifications: See Section 40 20 00

B. General:

1. Enclosure NEMA 4X
2. Manual Reset trip on increasing pressure
3. DPDT
4. Actuator Seal: Teflon

5. Each pressure switch shall have visible scale and contact operation.

C. Pressure switches shall have a contact rating of 10 amperes at 125 VAC.

D. Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.

E. Diaphragm seals shall be provided and included at the locations shown.

F. Automatic reset.

G. As manufactured by:

1. Mercoid.
2. Or approved equal.

H. The CONTRACTOR shall deliver to the OWNER all required spare parts. The spare parts shall not be used as replacement parts during system start-up or the guarantee period.

PART 3 EXECUTION

3.1 REQUIREMENTS

A. See Section 40 20 00.

- END OF SECTION -

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SECTION 40 71 00
CONTROL SYSTEMS – PANELS, ENCLOSURES AND COMPONENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes requirements for:

1. Design, fabrication and assembly requirements for all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:
   a. Custom built instrumentation and control panels, including PCMs, PLCs, LCPs, Instrument Junction boxes (IJBs) and power junction boxes (PJBs) etc.
   b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCP) and chemical feed panels.
   c. Control components.
   d. Control panel fabrication and installation.
   e. Interfaces between control panels and the SCADA/PLC System.

B. Related Sections:

1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. Specific References:

1. National Electrical Code (NEC): NFPA 70.
2. National Electrical Manufacturer's Association (NEMA):
   a. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. NEMA ICS 6 - Enclosures for Industrial Control and Systems.
3. Underwriters Laboratories Inc. (UL):
   a. UL 50 - Enclosures for Electrical Equipment.
   b. UL 508 - Industrial Control Equipment.
   c. UL 508A - Standard for Industrial Control Panels.

1.3 DEFINITIONS

A. Specific Definitions:

1. The term “panel” in this Section is interchangeable with the term “enclosure.”

1.4 SYSTEM DESCRIPTION

A. Provide enclosures suitable for the location and environmental conditions in which they are located, unless otherwise indicated.

B. Panel Dimensions:

1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer's non-certified information. It is the responsibility of the Contractor or Manufacturer to design and size all panels:
    a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.
    b. Panel sizes that substantially deviate (± 3 inches in any dimension) from the sizes shown on the Drawings must be approved by the ENGINEER.
    c. Maximum panel depth: 30 inches, unless otherwise indicated.

C. Structural Design:

1. Completed and installed panel work shall safely withstand seismic requirements specified in Section 26 05 00. Enclosures and internal equipment shall be braced to prevent damage from specified forces.

1.5 SUBMITTALS

A. Provide submittals in accordance with Sections 40 10 00 and 40 20 00.

B. Provide a two phase control panel hardware submittal, for each control panel and enclosure being provided on this project, including but not limited to:

1. Product Data:
    a. Enclosure construction details and NEMA type.
    b. Manufacturer's literature and specification data sheets for each type of basic material to be installed within or on the panel or enclosure.
2. Shop Drawings:
    a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
        1) Provide draft for review and approval of ENGINEER. The ENGINEER has the authority to substantially alter initial panel layouts.
    b. Complete nameplate engraving schedule.
    c. Structural details of fabricated panels.
3. Calculations – Seismic considerations
    a. Provide installation details based on calculated shear and tension forces:
        1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.
    b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:
        1) Weight including panel internal components.
        2) Seismic forces and overturning moments.
        3) Shear and tension forces in connections.
4. Calculations – Heat Release
    a. Cooling Calculations, to include but not limited to:
        1) Highest expected ambient temperature for the enclosure's location
        2) Internal heat load:
        3) Exposure to direct sunlight.
        4) Dimensions of the enclosure in inches.
        5) Maximum desired temperature inside the enclosure.

C. Phase I shall be the Control Panel Hardware submittal which shall include but not be limited to:

1. Enclosure construction details and NEMA type.
2. Finish, including color chart for ENGINEER selection of color.
3. Layout.
4. Power circuits.
5. Signal and safety grounding circuits.
6. Fuses.
7. Circuit breakers.
8. Signal circuits.
9. Internally mounted instrumentation.
10. PLCs.
11. SCADA system components.
12. Face plate mounted instrumentation components.
13. Internal panel arrangements.
14. External panel arrangements.
15. Construction drawings drawn to scale which define and quantity.
16. The type and gage of fabrication steel to be used for panel fabrication.
17. The ASTM grade to be used for structural shapes and straps.
18. Panel door locks and hinge mechanisms.
19. Type bolts and bolt locations for section joining and anchoring.
20. Details on the utilization of “UNISTRUT” and proposed locations.
21. Stiffener materials and locations.
22. Electrical terminal box and outlet locations.
23. Electrical access locations.
24. Print pocket locations.
25. Writing board locations.
26. Lifting lug material and locations.
27. Physical arrangement drawing drawn to scale which define and quantity the physical groupings comprising:
28. Control panel sections.
29. Auxiliary panels.
30. Subpanels.
31. Racks.
32. Cutout locations with nameplate identifications shall be provided.
33. A bill of material which enumerates all devices associated with the control panel.

D. Phase II shall be the Control Panel Wiring Diagram submittal which shall include but not be limited to:

1. Schematic/Elementary diagrams shall depict all control devices and circuits and their functions.
2. Wiring/Connection diagrams shall locate and identify:
3. Electrical devices.
4. Terminals.
5. Interconnecting wiring.
6. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.
7. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment.

8. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.
9. Control sequence diagrams shall be submitted to portray the contact positions or connections required to be made for each successive step of the control action.

E. Testing plans, forms, procedures, and other testing submittals as specified in Section 26 05 08 and Section 27 08 01.

1.6 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by Underwriters Laboratories to assemble and certify UL-labeled control panels:

1. Provide all components and equipment with UL508 listing.
2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL508A labeling.

1.7 DELIVERY, STORAGE AND HANDLING

A. Crate all panels for shipment using a heavy framework and skids:

1. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit.
2. Provide suitable shipping stops and cushioning material for all instruments shipped with the panel to prevent damage due to mechanical shock during shipment.
3. Provide each separate panel unit with removable lifting lugs to facilitate handling.

B. Ship all panels by dedicated air ride van, unless otherwise specified or approved.

1.8 PROJECT OR SITE CONDITIONS

A. Environmental Suitability:

1. Provide all control panels and instrument enclosures that are suitable for operation in the site conditions associated with the locations designated in the Contract Documents or as indicated on the Drawings including, but not limited to, material compatibility, site altitude, site seismic, ambient temperature, and humidity conditions.
2. Intrinsically safe.

1.9 SEQUENCING

A. Sequence and schedule in accordance with Section 26 05 00 and accepted progress schedule submitted in accordance with Section 01 31 00.

1.10 WARRANTY

A. Refer to Section 26 05 00.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. As listed below in the individual component paragraphs.

B. Provide instruments and other components performing similar functions of the same type, model, or class, and from one Manufacturer.

2.2 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:

1. Enclosures shall have the following properties:
   a. NEMA 1: Steel.
   b. NEMA 4: With gasketed door, rain-tight.
      1) Outdoor: Stainless steel.
      2) Indoor: Stainless steel.
   c. NEMA 4X: With gasketed door, rain-tight.
      1) Outdoor: Stainless steel.
      2) Indoor: Stainless steel.
   d. NEMA 12: Polycarbonate or fiberglass reinforced polyester (FRP) with gasketed door, dust-tight.
   e. NEMA 7: Cast aluminum.

B. Bolting Material:

1. Commercial quality 1/2-inch diameter, plated carbon steel hex-head grade 5 bolts, nuts and washers, with unified coarse (UNC) threads.
2. Carriage bolts shall be used for attaching end plates.
3. All other bolted joints shall have S.A.E. standard lock washers.

2.3 MANUFACTURED UNITS

A. Panels/Enclosures:

1. Manufacturers:
   a. One of the following:
      1) Rittal.
      2) Hoffman Engineering.
      3) Saginaw Control & Engineering.
      4) Prior-approved equal.
2. Panel assembly:
   a. General guidelines for panel fabrication include:
      1) Continuous welds ground smooth.
      2) Exposed surfaces free of burrs and sharp edges.
      3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2 inch holes at 12 inch spacing to accommodate anchoring of freestanding enclosures to floor.

b. Construct enclosure and mounting panel using stretcher level sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Up to 57	12	12
57 - 69	12	10
69 - 82	12, except 10 on back	10
82 or more	10	10

1) Use heavier sheet metal to meet seismic requirements specified in Section 26 05 00 or, when required due to equipment requirements.

c. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient tensional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.

d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.

e. Doors construction:
   1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
   2) Sufficient width to permit door opening without interference with rear projection of flush mounted instruments.
   3) Heavy gauge, piano type, continuous stainless steel hinges.
   4) Oil resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
   5) Gasket installed to seal against roll lip on the enclosure opening.

f. Latches:
   1) For panels, other than large types NEMA 4 and 4X, each door provided with a 3-point latching mechanism and padlocking handle with rollers on the ends of the latch rods. Latch rods connected to a common door handle, hold doors securely, forming a compressed seal between door and gasket, at the top, side, and bottom.
   2) Include an oil-tight key-locking, 3-point latching mechanism on each door:
   3) Provide 2 keys per panel.
   4) All locks keyed the same.
   5) For large type NEMA 4 and NEMA 4X cabinets, not available with 3-point latching hardware, provide multiple clips and padlock hasps.

g. Panel cut-outs:
   1) Cut, punch, or drill cut-outs for instruments, devices, and windows. Smoothly finish with rounded edges.
   2) Allow a minimum of 3 inch envelope around all devices.
   3) Reinforce around cut-outs with steel angles or flat bars for the following:
      a) Large panel cutouts; for example, openings for local operator interfaces.
      b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.

3. In addition to the requirements specified above, the following requirements for NEMA 4X stainless steel enclosures apply:
    a. Minimum 14 gauge stainless steel.
    b. Captive stainless steel cover screws threaded into sealed wells.
    c. Finish: Unpainted, brushed finish.
    d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.
4. In addition to the requirements specified above the following requirements for NEMA 4X non-metallic enclosures apply:
    a. Fiberglass construction.
    b. 10 gauge plate steel reinforcing on the sides, top, and bottom.
    c. All seams sealed.
    d. Fiberglass hinges with no exposed metal parts.
    e. Captivate stainless steel door screws.
    f. Provisions for internal, sidewall, mounting panels either by welded channels to the interior, or by welded collar studs.
    g. Provide aluminum mounting panels.
    h. Non-metallic enclosures are not an acceptable substitute for stainless steel unless indicated on the Drawings.
5. Outdoor Panels. Supplementary requirements for panels located outdoors are as follows:
    a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
    b. Finish: Other than stainless steel and fiberglass, the finish shall be outdoor-rated, baked powder coated over dip-coated primer.
    c. Door hardware: stainless steel.
    d. Bases: Heavy channel, gasketed iron bases, flanges up, for anchoring to pad.
    e. Provide rain canopy and sun shield.
6. Arrangement of Components:
    a. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
    b. Arrange panel instruments and control devices in a logical configuration associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.
    c. Mount internal control components on an internal back-panel. Devices may be mounted on the side-panel only by special permission from the ENGINEER.
    d. Group cables, and firmly support wiring to the panel. Provide minimum 8 inches clearance between terminal strips or wiring duct and the base of the enclosure for conduit and wiring space.
    e. All control panel mounted operator interface devices shall be mounted between 3 feet and 6 feet above finished floor.
7. Grounding:
    a. Provide the following equipment grounding system:
        1) Equipment grounding conductors and equipment bonding jumpers.
        2) Equipment grounding conductor terminals.
        3) Conductive structural parts of the enclosure.
    b. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
    c. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.

d. Provide equipment ground bus with lugs for connection of all equipment grounding wires.
e. Connect all exposed, noncurrent-carrying conductive parts, devices, and equipment shall be connected to the equipment grounding circuit.
f. Provide an equipment grounding terminal for each incoming power circuit, in the vicinity of the phase conductor terminal.
g. Design so that removing a device does not interrupt the continuity of the equipment grounding circuit.
h. Identify equipment grounding conductor terminals with the word “GROUND,” the letters “GND” or the letter “G,” or the color green.
i. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.
j. Signal (24 VDC) Grounding: Terminate each drain wire of a signal (shielded) cable to a unique grounding terminal block, or common ground bus at the end of the cable as shown on the Loop Drawings.
    1) Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding bus sized in accordance with NEC Table 250.122.
    2) Bond together all PLC or RTU racks (remote or local) processor racks, and conductive enclosures of power supplies and connect to the equipment grounding circuit.
k. Protection:
    1) Provide disconnecting, short-circuit, and overcurrent protection for all control panels.
    2) Select and apply protective devices with proper consideration given, but not limited to the following:
        a) System maximum available fault current at the point of application.
        b) Interrupting rating of the protective device.
        c) Voltage rating of the system.
        d) Load and circuit characteristics:

8. Normal operating current.
9. Inrush characteristics.
10. Thermal withstand capability (I^2t).
11. Magnetic withstand capability (I_p).
    a. Current-limiting ability of the protective device.
    b. Coordination of the protective devices to each other.
        1) Provide a separate protective device for each 120 VAC powered electrical device.
        2) Each 120 VAC Control Loop and Instrument shall have an individual circuit breaker within its respective control panel and clearly identified for function.
        3) Each 120 VAC and 24 VDC PLC output shall have its own individual fuse external of the I/O card with blown fused indication:
        4) Size external fuse to open before any I/O card mounted fuses.
        5) Provide a protective fuse device for each PLC discrete output coordinated to open before the protective device on the PLC I/O card.
        6) Protective devices shall be located on the back mounting panel and identified by a service nameplate in accordance with the wiring diagrams.
        7) Provide dedicated single pole circuit breakers, one for the panel lighting luminaire(s), and one for the panel receptacle(s):
        8) 15 amperes, 120VAC.
        9) The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts ac with a nominal

clamping voltage of 200 volts. Surge protectors shall be a non-faulting and non-interrupting design with a response time of less than 0.5 nanoseconds in normal mode and less than 5 nanoseconds in normal mode Peak surge current capability shall be rated for at least 15,000 amps, line to neutral, line to ground and neutral to ground.

c. Manufacturer: Control Concepts Model IC + 130/IC + 130WL rated 30 amps, or as directed.

12. Conductors and Cables:
    a. Power and Control Wiring:
        1) Materials: Stranded, soft annealed copper.
        2) Insulation: 600V type MTW.
            a) Minimum Sizes:
            b) Primary power distribution: 12 AWG.
            c) Secondary power distribution: 14 AWG.
            d) Control: 16 AWG.
        3) Color:
            a) AC power (line and load): BLACK.
            b) AC power (neutral): WHITE.
            c) AC control: RED.
            d) DC power and control: BLUE.
            e) Ground: GREEN.
    b. Signal Cables:
        1) Materials: Stranded, soft annealed copper.
        2) Insulation: 600V, PVC outer jacket.
        3) Minimum Size: 16 AWG paired triad.
        4) Overall aluminum shield (tape).
        5) Copper drain wire.
        6) Color:
            a) 2 Conductor:
                (1) Positive (+): BLACK.
                (2) Negative (-): WHITE, RED.
            b) 3 Conductor:
                (1) Positive (+): BLACK.
                (2) Negative (-): RED.
                (3) Signal: WHITE.
        7) Insulate the foil shielding and exposed drain wire for each signal cable with heat shrink tubing.

13. Conductor Identification:
    a. Identify all conductors and cables with wire markers in accordance with Section 26 05 09
    b. Readily identified without twisting the conductor.

14. General Wiring Requirements:
    a. Wiring Methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
    b. Install all components in accordance with the manufacturer’s instructions included in the listing and labeling.
    c. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a control power transformer and flange mounted disconnect. The disconnect shall be mechanically interlocked with the control enclosure doors so that no door can be opened unless the power is

disconnected. Interlocking shall be reactivated automatically when all the doors are closed.

d. Control panels supplied with 120 VAC:
    1) Provide an internal breaker with the line side terminals covered by a barrier.
    2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring that the source be disconnected before opening the door to the enclosure.
    3) Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
    4) Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
    5) Provide surge protection device on input supply power.
    6) Provide nonmetallic ducts for routing and organization of conductors and cables:
        a) Size ducts for ultimate build-out of the panel, or for 20 percent spare, whichever is greater.
        b) Provide separate ducts for signal and low voltage wiring from power and 120 VAC control wiring:
            (1) 120 VAC: Grey colored ducts.
            (2) 24 VDC: White colored ducts.
    7) Cables shall be fastened with cable mounting clamps or with cable ties supported by any of the following methods:
        a) Screw-on cable tie mounts.
        b) Hammer-on cable tie mounting clips.
        c) Fingers of the nonmetallic duct.
    8) The free ends of cable ties shall be cut flush after final adjustment and fastening.
    9) Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
    10) Support panel conductors where necessary to keep them in place.
    11) Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
    12) Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
        a) Factory applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
    13) The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:
        a) Solenoid valves.
        b) Instruments, both mounted in the control panel and remotely connected to the control panel.

e. Thermal Management:
    1) Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range as specified in Section 26 05 00.
    2) Air Conditioning:
        a) Cooling:
            (1) Provide filtered, fan forced type cooling system for each control cabinet.

(2) Size fans, louvers and filters to maintain a cabinet temperature no more than 10°F above ambient electrical room temperature.
(3) Cooling system includes the following components:
(4) Ventilation fans with louver and filter.
(5) Relief air louvers.
(6) Thermostat.
(7) 5 micron air filters for each opening.

b) Heating:
(1) Provide all panels located in areas that is not climate controlled with thermostatically controlled strip heaters; except, where all of the following conditions apply:
(2) The panel is not supplied with 120 VAC power.
(3) There are no electronics or moisture-sensitive devices in the enclosure.
(4) The panel is smaller than 38 inches high.

3) Enclosure Temperature Sensor:
a) Wall mount RTD sensor to measure internal cabinet temperature.
b) Platinum RTD.
c) 4-20 mA output.
d) Sensor and electronic enclosure.
e) Accuracy: ±2.0 degrees Fahrenheit.

15. Manufactured by:
a. Omega, EWS series
b. TCS Basys Controls, TS Series

2.4 COMPONENTS

A. Panel Meters:

1. Digital:
a. Self-contained instruments that display process signals directly in engineering units.
b. Suitable for panel mounting.
c. LED display:
1) 0.56-inch height.
2) Multi-range capabilities.
3) Integral provisions for scaling.
4) Switch programmable decimal points.
5) NEMA 4/IP65 sealed front metal bezel.
d. Current and Voltage indicators:
1) 3 1/2 - digit.
e. Accuracy:
1) AC/DC volts: ± (0.1 percent of reading + 2 digit).
2) DC current:
a) 4 - 20mA: ± (0.1 percent of reading + 1 digit).
b) 0 - 10V: ± (0.1 percent of reading + 1 digit).
3) Ratings, protection, and indication:
a) Maximum applied voltage: 300 VAC/VDC.
f. Operating voltage: 120 VAC.
g. Operating temperature: 0 degrees Celsius to 60 degrees Celsius.
1) Manufacturer, One of the following

b) Red Lion.

B. Manual Operator Interface Devices:

1. General:
   a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
   b. Size:
      1) 30.5mm.
   c. Lamp Color:
      1) On/Running/Start/Open: Green.
      2) Close/Off/Stop: Red.
      3) Power: White.
      4) Alarm: Red.
      5) Status or Normal Condition: White.
      6) Opened: Amber.
      7) Closed: Blue.
      8) Failure: Red.
2. Indoor and Outdoor Areas:
   a. NEMA type 4/13.
   b. Heavy duty.
   c. Pushbutton:
      1) Contacts rated:
         a) NEMA A600.
      2) Furnish one spare normally open and normally closed contact with each switch.
      3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
      4) Manufacturer: One of the following:
         a) Allen Bradley Type 800T.
         b) Square D Class 9001 Type K.
         c) General Electric Type CR104P.
         d) IDEC TWTD.
   d. Selector switches:
      1) Contacts rated:
         a) NEMA A600.
         b) Knob type:
      2) Manufacturer: One of the following
         a) Allen Bradley Type 800T.
         b) Square D Class 9001 Type K.
         c) General Electric Type CR104P.
         d) IDEC TWTD.
      3) Furnish one spare normally open contact and normally closed contact with each switch.
      4) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
   e. Pilot lights:
      1) Type:
         a) LED for all interior installations.
         b) Full Voltage for exterior installations.
      2) Push to Test.

3) LED Lamp.
4) Manufacturer: One of the following
a) Allen Bradley Type 800T.
b) Square D Class 9001 Type K.
c) General Electric Type CR104P.
d) IDEC TWTD.

3. Corrosive Areas:
a. NEMA 4X.
b. Exterior parts of high impact strength fiberglass reinforced polyester.
c. Pushbutton:
1) Contacts rated:
a) NEMA A600.
2) Manufacturer: One of the following:
b) Cutler Hammer Type PB2.
c) Square D Class 9001 Type SK.
d) Allen Bradley Type 800H.
e) IDEC TWTD.
d. Selector switches:
1) Contacts rated:
a) NEMA A600.
b) Knob Type:
2) Manufacturer: One of the following:
a) Cutler Hammer Type E34.
b) Square D Class 9001 Type SK.
c) Allen Bradley Type 800H.
d) General Electric Type CR104P.
e) IDEC TWTD.
e. Pilot lights:
1) Type:
a) LED for all interior installations.
b) Full Voltage for exterior installations.
2) Corrosion resistant.
3) Push to test.
4) Manufacturer: One of the following:
a) Cutler Hammer Type E34.
b) Square D Type SK.
c) Allen Bradley Type 800H.

4. Hazardous (Classified) Areas/Class I Division I:
a. NEMA 7.
b. High impact strength fiberglass reinforced polyester.
c. Pushbutton:
1) Contacts rated:
a) NEMA B600.
b) Contacts contained within a hermetically sealed chamber.
c) UL listed and labeled for Class I Division 2 areas.
2) Manufacturer: One of the following
a) Allen Bradley Type 800H.
d. Selector switches:
1) Contacts rated:
a) NEMA B600.
b) Contacts contained within a hermetically sealed chamber.

c) UL listed and labeled for Class I Division 2 areas.
d) Knob Type:
2) Manufacturer: One of the following:
a) Allen Bradley Type 800H.
e. Pilot lights:
1) Type:
a) LED for all interior installations.
b) Full Voltage for exterior installations.
2) Corrosion resistant.
3) UL listed and labeled for Class I Division 2 areas.
4) Push to test.
5) Manufacturer: One of the following:
a) Allen Bradley Type 800H.

5. Potentiometer and Slide wire Transmitters:
a. Provide a DC output in proportion to a potentiometer input.
b. Potentiometer input:
1) 100 ohms to 100K ohms.
2) Impedance ≥ 1M ohms.
3) Zero Turn-Up: 80 percent of full scale input.
4) Span Turn-Down: 80 percent of full scale input.
c. Field configurable output:
1) Voltage and Current: All conventional current loops and voltage control signals.
d. Accuracy including linearity and hysteresis ± 0.1 percent max at 25 degrees Celsius.
e. Operating temperature: 0 degrees Celsius to 55 degrees Celsius.
f. Supply power: 9 to 30 VDC.
g. Manufacturer: One of the following:
1) Phoenix Contact.

C. Signal isolators and converters:

1. Furnish signal isolators that provide complete isolation of input, output, and power input:
a. Minimum isolation level: 1.5 kV AC/50 Hz for at least 1 minute.
b. Signal input: All conventional current loops and voltage control signals.
c. Signal output: All conventional current loops and voltage control signals.
d. Operating voltage: As shown on the Drawings.
e. Adjustable span and zero.
f. Accuracy: ± 1.0 percent of span.
g. Ambient temperature range: -20 degrees Celsius to +65 degrees Celsius.
h. DIN rail mounting on 35mm rail.
i. Wire connection: Pluggable terminal blocks.

D. Relays:

1. General:
a. For all types of 120 VAC relays, provide transient surge protection across the coil of each relay.
b. For all types of 24 VDC relays, provide a free-wheeling diode across the coil of each relay.

2. General Purpose:
    a. Magnetic control relays.
    b. NEMA A300 rated:
        1) 300 Volts.
        2) 10 Amps continuous.
        3) 7,200 VA make.
        4) 720 VA break.
    c. Plug-in type.
    d. LED indication for relay energized.
    e. Coil voltages: As indicated on the Drawings.
    f. Minimum poles: 2PDT.
    g. Touch safe design: All connection terminals to be protected against accidental touch.
    h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
    i. Quantity and type of contact shall be as shown on the Drawings or as needed for system compatibility.
    j. Sockets for relays shall have screw-type terminals.
    k. Provide additional (slave/interposing) relays when the following occurs:
        1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
        2) Higher contact rating is required in order to interface with starter circuits or other equipment.
    l. DIN rail mounting on 35mm rail.
    m. Ice Cube type relays shall be provided with retainer clips to secure relay in socket.
    n. Integrated label holder for device labeling.
    o. Manufacturer: One of the following:
        1) Phoenix Contact PLC series.
        2) Potter and Brumfield Type KRP or KUP.
        3) IDEC R* series. (* = H, J, R, S, U).
        4) Allen Bradley Type 700 H Series.
        5) Square D Type K.
        6) Turck
3. Machine Tool Relays:
    a. Magnetic industrial relays.
    b. NEMA A600 rated:
        1) 600 Volts.
        2) 10 Amps continuous.
        3) 7,200 VA make.
        4) 720 VA break.
    c. Coil voltage: As indicated in the Contract Documents.
    d. Convertible contact cartridges to convert any contact from a normally open to a normally closed configuration.
    e. Contact cartridges shall have a clear cover for visual inspection.
    f. Contact material shall be fine grade silver.
    g. Minimum number of poles: 4 Type “A” or Type “B”, or as indicated on the Drawings, plus 1 spare.
    h. Machine tool type.
    i. Touch safe design: All connection terminals to be protected against accidental touch.
    j. Integrated label holder for device labeling.

k. DIN rail mounted on 35mm rail.
l. Manufacturer: One of the following
    1) Allen Bradley type 700P.
    2) Square D type 8501XO.
    3) Cutler Hammer D15 series.

4. Latching:
    a. Magnetic latching control relays.
    b. NEMA B300 rated:
        1) 300 Volts.
        2) 10 Amps continuous.
        3) 3,600 VA make.
        4) 320 VA break.
    c. Plug-in type.
    d. DIN rail mounting on 35mm rail.
    e. Coil voltage: 120 VAC.
    f. Minimum poles: 2PDT; as indicated on the Drawings, plus 1 spare.
    g. Touch safe design: All connection terminals to be protected against accidental touch.
    h. Clear cover for visual inspection.
    i. Provide retainer clip to secure relay in socket.
    j. Manufacturer:
        1) One of the following, or equal:
            a) Square D type 8501 Type K.
            b) IDEC TWTD.
5. Time Delay:
    a. Provide time delay relays to control contact transition time.
    b. NEMA A300 rated:
        1) 300 Volts.
        2) 10 Amps continuous.
        3) 7,200 VA make.
        4) 720 VA break.
    c. Plug-in type.
    d. DIN rail mounting on 35mm rail.
    e. Coil voltage: as indicated in Contract Documents.
    f. Provide Electronic type with on-delay, off-delay, and on/off delay.
    g. Minimum poles: 2PDT; as indicated on the Drawings, plus minimum 1 spare.
    h. Units shall include adjustable dial with graduated scale covering the time range in each case.
    i. Minimum timing range: 0.1 seconds to 10 minutes.
    j. Manufacturer: One of the following:
        1) Agastat type Series 7000.
        2) Allen Bradley type 700HR.

E. Terminal blocks:

1. Din rail mounting on 35mm rail.
2. Suitable for specified AWG wire.
3. Rated for 30 amperes at 600 Volts.
4. Screw terminal type.

5. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
6. Finger safe protection for all terminals for conductors.
7. Construction: Polyamide insulation material capable of withstanding temperature extremes from - 40 degree Celsius to degree 105 Celsius.
8. Terminals: Plainly identified to correspond with markings on the diagrams:
    a. Permanent machine printed terminal identification.
9. Identify terminals suitable for use with more than 1 conductor.
10. Position:
    a. So that the internal and external wiring does not cross.
    b. To provide unobstructed access to the terminals and their conductors.
11. Provide minimum 25 percent spare terminals.
12. Manufacturer: One of the following:
    a. Phoenix Contact UK5 Series.
    b. Entrelec M4/6.
    c. Allen Bradley Series 1492.
13. Wire duct:
    a. Provide flame retardant plastic wiring duct, slotted with dust cover.
    b. Type:
        1) Wide slot.
        2) Narrow slot.
        3) Round hole.
    c. Manufacturer: One of the following:
        1) Panduit.
14. Fuses (holders) and circuit breakers:
    a. Fuse holders:
        1) Modular type:
            a) DIN rail mounting on 35mm rail.
            b) Touch safe design: All connection terminals to be protected against accidental touch.
            c) Incorporates blown fuse indicator.
        2) Provide nameplate identifying each fuse:
            a) In accordance with Section 16075.
        3) Manufacturer: One of the following:
            a) Phoenix Contact.
            b) Entrelec.
            c) Allen Bradley 1492-FB Series B.
15. Control Circuit Breakers:
    a. DIN rail mounting on 35mm rail.
    b. Manual OPEN-CLOSE Switch.
    c. Rated 250 VAC.
    d. Interrupt Rating: As indicated on the Drawings.
    e. Current ratings: As indicated on the Drawings.
    f. Provide nameplate identifying each circuit breaker, refer:
        1) In accordance with Section 16075.
    g. Manufacturer: One of the following:
        1) Phoenix Contact.
        2) ABB.
        3) Allen Bradley Series.
        4) Square D.

5) Entrelec.

F. Transient / Surge Protection Devices:

1. Provide Surge Protection Device (SPD) for Power Entrances:
   a. Nominal 120 VAC with a nominal clamping voltage of 200 Volts.
   b. Non-faulting and non-interrupting design.
   c. A response time of not more than 5 nanoseconds.
2. Control Panel Power System Level Protection, non-UPS powered:
   a. Design to withstand a maximum 10 kA test current of a 8/20µs waveform according to ANSI/IEEE C62.41.1-2002 Category C Area.
   b. Provide both normal mode noise protection (between current carrying conductors) and common mode (between current carrying conductor and neutral) surge protection.
   c. DIN rail mounting.
   d. Attach wiring to the SPD by means of a screw type cable-clamping terminal block:
      1) Gas-tight connections.
      2) The terminal block: Fabricated of non-ferrous, non-corrosive materials.
   e. Visual status indication of MOV status on the input and output circuits.
   f. Dry contact rated for at least 250 VAC, 1 Amp for remote status indication.
   g. Meeting the following requirements:
      1) Response time: ≤ 100 ns.
      2) Attenuation: ≥ - 40dB at 100 kHz as determined by a standard 50 ohms insertion test.
      3) Safety approvals:
         d) UL 1283 (EMI/RFI Filter).
         e) UL 1449 2nd Edition.
   h. Manufacturer: One of the following:
      1) Phoenix Contact type SFP TVSS/Filter.
      2) Liebert Accuvar series.
      3) Islatrol.
3. Data and Signal Line Protectors – Panel Mounted:
   a. Surge protection minimum requirements: Withstand a 10 kA test current of a 8/20µs waveform in accordance with ANSI/IEEE C62.41.1-2002 Category C Area.
   b. DIN rail mounting on 35mm rail (except field mounted SPDs).
   c. SPD's consisting of 2 parts:
      1) A base terminal block.
      2) A plug protection module:
         f) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
         g) Base and plug shall have the ability to be coded to accept only the correct voltage plug.
   d. SPD Manufacturer: One of the following:
      1) Phoenix Contact Plugtrab Series.
      2) Joslyn JMD Series.
4. Data and Signal Line Protectors – Field Mounted:
   a. Surge protection minimum requirements: Withstand a minimum 10 kA test current of a 8/20µs waveform in accordance with ANSI/IEEE C62.41.1-2002 Category C Area.

b. Manufacturer: One of the following:
   1) Phoenix Contact type SFP TVSS/Filter.
c. SPD Manufacturer: One of the following:
   1) Phoenix Contact Pipetrab.
   2) Boxtrab.
   3) Joslyn JMD Series.

G. Power supplies:

1. Design power supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the system operation.
2. Convert 120 VAC to 24 volt DC or other DC voltages required or as indicated on the Drawings.
3. Provide backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
4. Provide power supplies configured as fully redundant units consisting of 2 power supplies connected with an automatic switchover unit with alarm contacts monitored by the PLC and alarmed in SCADA.
5. Sized to provide 40 percent excess rated capacity.
6. UL508C listed to allow full rated output without de-rating.
7. Provide fuse or short-circuit protection.
8. Provide a minimum of 1 set of dry contacts configured to change state on failure for monitoring and signaling purposes.
9. Output regulation: ± 0.05 percent for a 10 percent line change or a 50 percent load change:
   a. With remote voltage sensing.
10. Operating temperature range: 0 degrees Celsius to 50 degrees Celsius.
11. Touch safe design: All connection terminals to be protected against accidental touch.
12. DIN rail mounting on 35mm rail.
13. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
14. Manufacturer: One of the following:
    a. Phoenix Contact Quint series.
    b. IDEC PS5R series.
    c. Sola.
    d. Acopian.
    e. Puls.

H. Intrinsic Safety Barriers:

1. Transformer isolated barrier:
   a. Containing a transformer to provide complete:
      1) Isolation between the safe and hazardous areas for loop powered devices.
      2) 3-way isolation between the safe area, hazardous area and power supply powered devices.
   b. Resistor for current limitation.
   c. Fuses for short circuit protection.
   d. Provide barriers with pluggable connectors that are coded for easy replacement.
   e. Transmission error shall be less than or equal to 0.1 percent of full scale.
   f. DIN rail mounted on 35mm DIN rail.
   g. Approvals:

1) FM.
2) UL 913 & 1604.

2. Types:
   a. Switch Isolators:
      1) Designed and approved for use with discrete inputs.
      2) Supply Power: 20-30VDC.
      3) Output to track input.
      4) With an LED in the cover to indicate the status of the input.
      5) With a selector switch to change the logic of the input.
      6) Input - dry contact.
      7) Output - SPDT relay.
   b. Transmitter and Converters for use with 4-20 mA signals without Hart® communications capability:
      1) Designed and approved for use with 4-20 mA analog signals.
      2) Designed for powering 2 and/or 3 wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
      3) Supply voltage: 20-30VDC.
   c. Transmitter and converters for use with 4-20 mA signals with Hart® communications capability:
      1) Designed and approved for use with 4-20 mA analog signals.
      2) Designed for powering 2 and/or 3 wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
      3) In addition, transfer digital signals from the hazardous area to the safe area.
      4) Complete bi-directional communication between a smart transmitter located in the field and the suitable equipment located in the safe area.
      5) Supply voltage: 20-30VDC.
3. Manufacturer: One of the following:
   a. Phoenix Contact ME Series.
   b. Pepperl + Fuchs.
   c. Turck.

I. Disconnects and starters:

1. Flange Mounted Main Disconnect:
   a. Rated 22KAIC or as required by the short circuit and coordination study specified in Section 16305, whichever is larger:
      1) Size in accordance with the NEC, total connected horsepower and associated locked rotor current, and provide larger unit if needed based on any of these criteria.
   b. Interlocked with the door of the control panel so that the door of the panel cannot be opened with the disconnect switch in the closed position, with defeater.
   c. Door mounted disconnects are not acceptable.
   d. Manufacturer: One of the following:
      1) Allen Bradley - 1494.
      2) Cutler Hammer - C361/C371.
      3) ITE - FH011.
      4) Square D - Class 94222.
2. Magnetic Motor Starters:
   a. In conformance with the requirements of Section 16421.
   b. Minimum 22 KAIC or as required by the Short Circuit and Coordination study, which ever is larger.

3. Integral Self-Protected Starters:
    a. In conformance with the requirements of Section 16421.

J. Limit Switches:

1. NEMA-4X.
2. AC contact rating 120V, 10A.
3. DC contact rating 125V, 0.4A.
4. DeviceNet Compatible as indicated in the drawings.
5. Provide robust actuation mechanism not prone to degradation.
6. Provide complete actuator mechanism with all required hardware.
7. Allows for contact opening even during contact weld condition.
8. UL approved.
9. Operating Temperature Range: -18 degrees to +110 degrees Celsius (0 degrees to 230 degrees Fahrenheit).
10. Manufacturer:
    a. Allen Bradley 802.
    b. Honeywell HDLS.
    c. Omron D4.
    d. Eaton E47, E49, E50.
    e. ABB equal.

2.5 ACCESSORIES

A. Provide panels with an inside protective pocket to hold the panel Drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

B. All enclosures which will have a computer mounted inside shall have a shelf to support the computer tower.

C. Provide 15 inch floor stands or legs where needed or as indicated on the Drawings.

D. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.

E. Tag or identifying number of the panel as indicated on the Drawings.

1. Provide in accordance with Section 16075 on all internal and external instruments and devices.
2. Provide a nameplate with the following markings that is plainly visible after installation:
    a. Manufacturer’s name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
    b. Supply voltage, phase, frequency, and full-load current.
    c. Short-circuit current rating of the panel based on one of the following:
        1) Short-circuit current rating of a listed and labeled assembly.
        2) Short-circuit current rating established utilizing an approved method.

F. Provide a window kit where indicated on the Drawings. The window shall meet the following requirements:

1. Safety plate glass.
2. Secured by rubber locking seal.
3. Allow full viewing of devices issuing visual process data or diagnostics.

G. Luminaires:

1. Provide 1 luminaire, on the interior of the panel, located every 4 feet of enclosure width, spaced evenly along the top-front of the enclosure door opening(s):
   a. Covered or guarded.
   b. LED or fluorescent 40W max.
   c. Manual On-Off switches.

H. Receptacles:

1. Provide one duplex receptacle located every 4 feet of enclosure width, spaced evenly along the back mounting panels.
2. GFCI, 125-volt, single-phase, 15-ampere.

2.6 FINISHES

A. Finishes:

1. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
2. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry film thickness, and allowed to dry before applying the finish coat.
3. Finish coat shall be a baked polyester urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
4. Exterior of enclosures located outdoors shall be UV resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.

B. Colors:

1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
3. Panel interiors shall be manufacturer's standard white.

2.7 SOURCE QUALITY CONTROL

A. Refer to Section 01 55 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Refer to Section 26 05 00.

3.2 INSTALLATION

A. Any components or panels damaged during installation shall be replaced.

B. Install enclosures so that their surfaces are plumb and level within ± 1/8 inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.

C. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.

D. Provide floor stand kits for wall-mount enclosures larger than 48 inches high.

E. Provide 3-1/2 inch high concrete housekeeping pads for free-standing enclosures.

F. Install gasket and sealing material under panels with floor slab cutouts for conduit:

1. Undercoat floor mounted panels.

G. Provide a full size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

H. All holes for field conduits, etc. shall be cut in the field, there shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miss-cut holes shall require that the entire enclosure be replaced.

I. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the conduit schedule, but shall be shown on the Loop Drawings prepared by the CONTRACTOR.

3.3 FIELD QUALITY CONTROL

A. Refer to Section 26 05 00.

3.4 CLEANING

A. Clean area during construction in accordance with Section 01 50 00.

3.5 PROTECTION

A. Refer to Section 26 05 00.

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SECTION 40 91 23
MISCELLANEOUS PROPERTIES MEASUREMENT DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers the Work necessary to install a ready to use and tested process and analysis system. CONTRACTOR shall provide all components required for a complete and functional system.

1.2 RELATED WORK

A. Related Work in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 207 Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
2. AWWA C 751 Magnetic Inductive Flowmeters

C. NSF INTERNATIONAL (NSF)

1. NSF/ANSI 61 Drinking Water System Components - Health Effects

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit catalog cuts on all process equipment including: switches, meters, sensors, or other items shown on Contract Drawings referencing each item by mark number. Information shall indicate manufacturer specification compliance and dimensional data.

C. CONTRACTOR shall supply operation and maintenance manuals for all process equipment.

1.5 WARRANTY

A. Manufacturer shall provide to OWNER written guarantee against defects in material or workmanship for a period of one (1) year.

1.6 DELIVERY AND STORAGE

A. All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants. Each system shall be factory calibrated and certified prior to delivery.

1.7 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of manufacturers regularly engaged in the design and manufacturing of this type of equipment. The manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving CONTRACTOR from responsibility for the proper installation and functionality of the work.

PART 2 PRODUCTS

2.1 GENERAL

A. Each process measurement system shall typically consist of a sensor and analyzer/transmitter. Where shown on the Contract Drawings, the analyzer/transmitter may be utilized for multiple sensors. When an analyzer/transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.

B. Each analyzer/transmitter shall be equipped with a means to transmit process measurement data to the plant SCADA system.

1. For hardwired signals, unless indicated otherwise on Contract Drawings, provide the following:
   a. 4-20 mA output signals for each process measurement (for up to 500 Ohm loads).
   b. Two programmable SPDT relay outputs, rated at 5A up to 230 VAC, for each process measurement.

2. Where shown on the Contract Drawings, provide the following digital communications to the plant SCADA system:
   a. HART Protocol
   b. PROFIBUS
   c. MODBUS

C. Each analyzer/transmitter shall be powered by 115VAC (+/- 10%) at 60 Hz unless shown on Contract Drawings as being powered by 24 VDC (+/- 15%). Each analyzer/transmitter shall retain its programmable settings in non-volatile memory. Battery powered instruments, analyzer, or transmitters will not be accepted.

D. Each sensor and corresponding analyzer/transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the analyzer/transmitter shall be protected from the sun such that direct sunlight will not shine on the display.

E. All analyzers/transmitters shall be waterproof and made from corrosion resistant materials.

F. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 MAGNETIC FLOW METERS

A. Refer to Section 40 21 20, Magnetic Flow Meters, for further requirements.

2.3 LEVEL SENSORS

A. Refer to Section 40 24 10, Level Detector.

PART 3 EXECUTION

3.1 INSTALLATION

A. All equipment shall be mounted and installed as per manufacturer recommendations. Coordinate final location with ENGINEER.

3.2 FLOW METER FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and ENGINEER shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC
2. Each instrument shall provide direct control of totalizer reset functions through the PLC
3. Each instrument shall be supported with a device profile permitting direct integration in the PLC

B. ENGINEER shall witness all instrument verifications in the field.

C. Manufacturers Field Services shall be provided for start-up and commissioning by a Factory field service representative or a manufacturer's authorized service provider (ASP).

1. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.
2. Manufacturer representative shall notify ENGINEER in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.
4. Manufacturer representative shall generate a configuration report for each meter.

3.3 TESTING

A. After installation of the equipment is complete, operating tests shall be carried out to assure that the equipment operates properly. All piping shall be tested hydrostatically and for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

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SECTION 40 94 33
CONTROL SYSTEMS - HUMAN MACHINE INTERFACE SOFTWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. General requirements for application software to be used in conjunction with the specified human machine interface hardware.

B. Related Sections

1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all Sections to ensure a complete and coordinated project.

1.2 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 40 10 00.

B. Furnish complete Product Data, Graphic Screens, Operating Manuals, Manufacturer's certifications, and other submittals as specified in Section 40 10 00, and below.

C. Additional Requirements:

1. Product Data:
   a. Operating system requirements.
2. Graphic Screens:
   a. Color printouts of each graphic screen and control pop-up.

1.3 QUALITY ASSURANCE

A. System Compatibility.

1. The software must be the standard operating software system designed specifically for use with the human machine interface hardware.
   a. The software must be furnished and developed by the manufacturer of the human machine interface hardware.

1.4 WARRANTY

A. Provide extended 2-year manufacturer's warranty support as follows:

1. Dedicated technical support department or handled by programming staff or distributor.
2. Telephone hours for support shall be 24 hours, 7 days per week.
3. Email & Web support addresses.
4. Document download via website.

1.5 MAINTENANCE

A. Provide system upgrades and maintenance fixes for a period of two years from substantial completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The human machine interface graphic software system shall be manufactured by the human machine interface hardware manufacturer.

B. The following no equal.

1. Rockwell Software Allen Bradley
2. Or match existing software to match the same on site HMI installed in new installations.

2.2 MANUFACTURED UNITS

A. Human machine interface software.

1. Provide a complete software package to be used for programming the necessary screens and operator interaction with the human machine interfaces.
2. Operating System:
   a. Microsoft Windows.
3. Software shall use preconfigured symbols, objects, graphics, and imported bitmaps for the generation of the displays.
4. Software shall allow bitmaps to be imported or exported to or from other applications.
5. Capable of generating custom reports, complete with screen prints.
6. Capable of working with multiple screens concurrently.
7. Shall provide dialog boxes for defining object attributes.
8. Objects shall be configured using fill in dialog boxes.
9. Graphic and text editor to allow custom formatting to customize and change the appearance of objects and text.
   a. Allow selection of different fill patterns to define object status.
10. As a minimum, provide the following object capabilities.
    a. Operator Inputs
       1) Momentary Push Button.
       2) Maintained Push Button.
       3) Latched Push Button.
       4) Multistate Push Button.
       5) Keypad Enable Button.
       6) Cursor Point.
    b. Control List Selectors.
       1) Standard Control List.
       2) Piloted Control List.
    c. Global Objects.
    d. Display Objects.
       1) Bar Graph.

2) Scale.
3) Message Display.
4) Multistate Indicator.
5) List Indicator.
6) Numeric Data Display.

e. Screen Selector Objects.
1) Go To.
2) Return.
3) Screen List Selector.

f. Embedded Variables.
1) Time.
2) Date.
3) Numeric Variable.

g. Graphics.
1) Lines.
2) Shapes.
3) Freeform Drawings.
4) Imported Graphics.
5) Background Text.
6) Selection Table for standard ISA symbols.
7) PID Controller Faceplate.

h. Alarm screens.

11. Documentation
a. The system shall provide complete user documentation, including examples of how to operate the various modules within the system.
b. The documentation must be in electronic format, HTML based with the ability to search for topics by keyword or search or specific text.

12. On-line Help
a. An on-line "help" facility, based upon Windows standard Hypertext, shall provide useful, context-sensitive information on the operation of the package.
1) This help facility shall be capable of being invoked on-line through a point-and-click operation.
2) The "help" facility must also support the ability to perform full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.

PART 3 EXECUTION

3.1 INSTALLATION

A. All tags used and/or assigned as part of the application programming work shall use the Tag and Loop identifications found on the P&IDs.

B. Station Graphics:

1. For each device both in the treatment plant, and/or process area, a station graphic display shall be configured, this graphic shall include:
a. Symbols for
1) Pumps.
2) Valves
3) Major instruments.
4) Flowmeters.

5) Pressure transmitter.
6) Level Transmitter
7) Etc.
    a) Alarm symbols including intrusion alarm.
    b) Relevant test and operational data.
    c) Each pump and valve shall include indication of status:
        (1) Hand.
        (2) Off.
        (3) Automatic
        (4) Local.
        (5) Remote.
        (6) Run.
        (7) Call.
        (8) Fail.
        (9) Open.
        (10) Close.
        (11) Hold.
        (12) Modulate.

2. Change of state of pumps and valves shall be depicted by change in color.
3. Production and Usage Bar Graph:
    a. A display shall depict the production for each site and/or piece of equipment, as determined during the requisite graphics meeting, within the treatment plant, summarized to type, and total usage, with a bar graph and numeric value for each analog value.

3.2 TRAINING

A. As specified in Section 40 10 00.

B. The training shall be performed by pre-approved and qualified representatives of the manufacturer of the human machine interface hardware or a representative of the vendor supplying the control panel. A representative of the vendor supplying the control panel may perform the training only if the representative has completed the manufacturer's training course for the human machine interface software.

- END OF SECTION -