

DIVISION 40 - PROCESS CONTROL

SECTION 40 68 00 – CONTROL SYSTEM INTEGRATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Review and approve all submitted control equipment and designs of other sections of the specifications prior to submission to the Authority.
- B. Supervise, inspect and test the installation of the control equipment and materials supplied under other sections.
- C. Provide all programming necessary to replace the functionality of the existing control system and to implement the new control functionality as specified.
 - 1. Programming shall include All Programmable Logic Controller (PLC) and Operator Interface Terminal (OIT) programming services necessary to provide a fully functional control system.
 - 2. Programming shall include the modification and integration of the new pump station into the Plant's existing HMI runtime application.
- D. Perform the Final Acceptance Testing of all control equipment and materials supplied under this Contract.
- E. Provide and coordinate the training of Authority personnel in the operation, configuration, and maintenance of the new control system.
- F. All items and created works performed under this contract shall become the property of the Authority and shall be turned over to the plant personnel at the completion of Testing.

1.02 CONTRACTOR RESPONSIBILITIES

- A. The Contractor shall retain the services of a qualified System Integrator to select equipment, provide any design details required to accommodate the selected equipment, completely configure and program the equipment, supervise and inspect the installation, test the systems, provide training, and prepare submittals and final documentation, all as herein specified.
- B. The Contractor shall furnish all labor, equipment and materials required to install a fully functional monitoring and control system including any and all items recommended by the System Integrator.
 - 1. The Contractor shall furnish all programming and configuration required for a complete and functional system to automatically control and monitor all of the equipment being supplied under this Project.
 - 2. The Contractor is responsible to notify the Engineer immediately upon recognition of an instruction or specification contained herein that would cause the supplied system to fail to meet the conditions set forth in these specifications.

- C. The Contractor shall coordinate the implementation and recommendations of the System Integrator with Contractors staff and the Contractor's subcontractors.

1.03 SYSTEM INTEGRATOR RESPONSIBILITIES

- A. The system integrator shall perform the following general activities:
 - 1. Selection and Evaluation of Components:
 - a. The System Integrator shall evaluate and select the individual components of the control system. The evaluation shall be based on the specification requirements, industry standards, compatibility between components and the experience of the System Integrator.
 - 1) The System Integrator shall review and approve all control hardware, software and control system related components prior to submission to the engineer.
 - 2) The System Integrator shall assist in the preparation of submittals and documentation of other sections of this specification as needed for a complete and coordinated hardware design.
 - 3) The Engineer shall review all equipment following approval by the System Integrator.
 - 2. Interfacing of Equipment:
 - a. The System Integrator shall interface between all components within the control system including those components supplied by others and existing equipment.
 - b. The system Integrator shall evaluate the interface between components and supply and/or modify systems to ensure compatibility.
 - c. The System Integrator shall provide any design assistance required to accommodate the selected equipment, to completely configure and program the equipment, and to the interface the new equipment to new and existing field devices.
 - 3. Information Gathering:
 - a. The System Integrator shall investigate plant documentation and as-found conditions of the plant control system to establish the use and configuration of the hardware and software of each control signal affected under this contract. This investigation shall include the entire signal path from the initiating hard wired field device through to the control room operator interface terminal.
 - 4. Coordination:
 - a. The System Integrator shall inspect the existing equipment to determine the best method for interfacing the new control system with the existing

equipment. All work required to interface to existing equipment and communications networks shall be provided by the System Integrator.

5. Programming:
 - a. The System Integrator shall provide all programming, control logic and software for the system controls and monitoring.
 - b. The System Integrator shall interact with the Engineer to determine detailed operational conditions and shall incorporate those conditions into the system control logic.
 - c. All configuration and programming performed under this contract shall be fully documented by the system Integrator and shall become the property of the Authority.
 - d. Programming for the control algorithms shall be performed with the equipment vendor's latest configuration software using the IEC ladder diagram configuration.

6. Installation:
 - a. The System Integrator shall oversee the installation and field connection of the control system.
 - b. The System Integrator shall make all the necessary modifications, additions and/or updates to hardware and software as required to accommodate the field conditions encountered.

7. Field Tests:
 - a. The System Integrator shall be present during the start-up of each programmable controller to respond to any discrepancies or questions which arise.
 - b. The System Integrator shall be on-call during the operational testing of the systems.

8. Documentation:
 - a. The System Integrator shall provide detailed documentation for the design of the control system. As a minimum the following design documentation is required:
 - 1) Cut sheets and descriptions of all components and hardware including ratings and limitations.
 - 2) Wiring diagrams for all connections and controls.
 - 3) Program logic on both hard copy printout and compact disk.
 - 4) Flow charts describing the functioning of the control system.
 - 5) As-built drawings for field wiring and connections.
 - 6) Panel layouts.
 - 7) Update existing plant control system documentation to show new connections to the PLCs.
 - b. The System Integrator shall document the field tests in accordance with detailed test reports.

- c. The System Integrator shall coordinate the final documentation, including as-built drawings, O&M Manuals and Warranty information. All documentation shall be submitted to the Engineer for review and shall become part of the Operation and Maintenance Manuals.
 - d. The System Integrator or contractor shall label all wires and equipment with a unique non repeating system. The labeling identification numbers shall be included on the As-Built, existing loop and interconnection drawings.
 - e. The System Integrator shall provide standard warranty services.
9. Training:
- a. The System Integrator shall provide or coordinate the training of control equipment provided for under this or other sections of the specification with Plant personnel.

1.04 SYSTEM INTEGRATOR QUALIFICATIONS

- A. The system integrator shall be subject to approval by the Authority.
- B. The system integrator shall meet the following minimum requirements:
 - 1. Actively involved in the control integration for control systems for a period of at least five years.
 - 2. Actively involved in the design and installation of Ethernet local area networks.
 - 3. Maintain a permanent staff of engineers and technicians who assemble, program, test and field service distributed control systems.
 - 4. Experienced in the installation, configuration, and programming of PC based SCADA software using the specified software.
 - a. The system integrator shall have provided these services for not less than two major projects, using the specified SCADA software, within the last 5 years.
 - b. This experience shall be documented by submitting two references, complete with project descriptions, services provided, contact names and phone numbers, for projects which included not less than 5 personal computers on a standard local area network using the specified SCADA software to monitor and control plant processes through programmable logic controllers.
 - c. Each of these systems shall be for a system with not less than 200 points.
 - 5. Experienced in configuring and programming PLCs for industrial processes, such as a pumping station, including PID control.
 - a. The system integrator shall have provided these services for not less than two major projects within the last 5 years.
 - b. This experience shall be documented by submitting two references, complete with project descriptions, services provided, contact names and

phone numbers, for projects which included multiple PLCs with not less than 100 points of I/O

1.05 SUBMITTALS

- A. Submit in accordance with requirements of Section 01 33 00.
- B. Review and approve all submitted control equipment and designs of other sections of this specification prior to submission to the Authority.
- C. In addition to the requirements of Section 01 33 00 submit the following information necessary to determine the adequacy of the system integrator.
 - 1. A detailed experience list of at least five control systems assembled and programmed by the system integrator. Include project descriptions, contact names and phone numbers in the list.
 - a. List shall include at least one control system upgrade of similar size and scope to this project.
 - 2. A description of the system integrator's capabilities. Include a listing of personnel who shall work on this project, test equipment available, and facility size and layout.
 - 3. All other references, resumes, and other information required to document that the proposed system integrator meets all requirements of the contract specifications and is capable of providing all required services.
 - 4. Provide a copy of the letter or stamp used to review and approve the submitted control equipment and designs of other sections of this specification.
- D. IP Address Listing
 - 1. Submit a complete IP address listing of all existing and proposed Ethernet components.
- E. I/O Data Base
 - 1. Submit an I/O Database for all new and modified PLC data points. Database shall include:
 - a. Unique Signal ID (Record Key Value)
 - b. PLC Tag Name
 - c. OIT Tag Name
 - d. HMI Tag Name
 - e. I/O Description
 - f. Drawing Reference
 - g. Source Unit
 - h. Source Unit Address
 - i. Signal Type

- j. Signal Level
- k. Signal Format
- l. Signal Power (Field or Panel)
- m. Raw_zero
- n. Raw_full
- o. Eng_zero
- p. Eng_full
- q. Eng_units
- r. Zero State
- s. One State
- t. Alarm

F. Programming

1. Submit detailed description of all proposed control equipment programming prior to delivery to the site. The submittal shall include:
 - a. A tabular listing of all I/O points.
 - b. Written functional description, including:
 - 1) Listing of the input signals, including a reference to the monitored instruments and devices.
 - 2) Listing of the output signals, including a reference to the controlled devices
 - 3) Listing of status tags and calculated values interfacing with all other plant control systems, including existing controllers and control systems specified in other sections and divisions of this Contract.
 - 4) A description of the control functions generating the output signals and calculated values
 - c. Preliminary program listings
 - d. HMI workstation graphics
 - e. OIT panel graphics
 - f. Any programming manuals or other documents required to interpret the program listings.
2. A detailed written description of all proposed configuration and programming of the existing PLC and HMI system, including all I/O lists, nicknames, register locations, and related items.

G. Testing Plan

1. Detailed step-by-step test procedures to demonstrate all functions and features of each component of the control system.
 - a. These test procedures shall cover all control and communication equipment and materials specified under other sections of these

specifications plus any additional items required to document that a complete and fully functional system has been installed.

2. Submit a detailed testing plan and procedure for each I/O data point and calculated value, including test forms.
 3. Refer to TESTING subsection in Part 3 of this specification for additional requirements.
 4. Test forms to document completion of field tests with written procedures, expected results, spaces for entry of actual results, spaces for comments, and spaces for sign off by the contractor, system integrator, and Plant representative.
- H. O&M Manuals
1. Submit detailed final documentation including as-built (record) drawings, Operation & Maintenance manuals, software documentation, and other items required to fully document the system as installed and commissioned.
 - a. The O&M manual shall include a detailed functional description and alarm section with descriptive trouble-shooting procedures for each alarm.
 - b. Refer to Section 01 33 00 and Section 01 78 23.
 2. Include final copies of all program listings with annotations, comments and cross reference tag list in both hard copy printout and on CDs in O&M Manuals.
 - a. Load final copies of all programs on the HMI workstation, along with the configuration programs, and verify communication and interaction of all development software with remote equipment prior to submitting O&M manual.

1.06 TRAINING

- A. Coordinate the training provided for under other sections of the specification with Owner personnel.
- B. All training must be coordinated with the activities of the plant personnel.
 1. The system integrator shall not schedule any training until it has been confirmed in writing that the proposed schedule is acceptable to the Authority.
 2. The system integrator shall submit the proposed schedule for each course not less than 4 weeks prior to the proposed training date.
 3. If the proposed dates for training are not convenient to Authority personnel, the system integrator shall adjust the schedule accordingly.
- C. Training shall be scheduled to the convenience of Authority personnel and shall be coordinated with the Authority.

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION

3.01 CONFIGURATION AND PROGRAMMING

- A. Completely configure all programmable controllers, data communications equipment, and field devices supplied under other sections of this specifications.
 - 1. Provide all calculations and functions called for in other sections of these specifications or noted on the contract drawings.
 - 2. Debug and trouble shoot all programming and software installation prior to the beginning of the testing phase.
- B. Network Configuration
 - 1. Provide all programming necessary to interface the new control and communication equipment with the existing SCADA communications system.
 - a. Work with the Authority's integrator to modify and test the existing network of Human Machine Interface (HMI) operator interface units (client workstations) and SCADA system servers on the plant-wide local area network to accept the new and modified signals from the new PLC and HMI hardware.
 - 2. Work with the Authority's integrator to coordinate and organize the new control equipment communication addresses with the existing SCADA at the plant.
 - 3. Completely configure the refresh rate and polling configuration of all nodes on the PLC and HMI LAN to optimize the transfer of data under worst case conditions.
- C. I/O Coordination
 - 1. Create, compile and install all databases required to monitor and control the plant processes from any and all Operator Workstations.
 - 2. Create and configure a variable tag for each input point and each output point for each new PLC and other input devices.
 - 3. Configure all calculated variables required to present the desired information.
- D. Programmable Logic Controller (PLC) Programming
 - 1. Programming for the control algorithms shall be performed with the Owner's current software using the IEC ladder diagram configuration.
 - a. All Programming shall be done in ladder logic format; function blocks, structured text, or other programming methods shall not be acceptable.
 - 2. Configure the new PLC equipment to monitor and control the field devices described in the Function Description.
 - 3. Map each hardwired discrete input I/O point to a series of consecutive registers in the PLC CPU.

4. Map each hardwired analog input I/O point to a series of consecutive registers in the PLC CPU.
 - a. Program a second set of analog values, stored in a series of consecutive registers, representing the engineering value of each of the input and output signals.
 - b. Multiply the raw numerical value by the engineering scale, plus the zero offset
 5. Program the control logic required for the analog outputs and discrete outputs as indicated under Function Description.
 6. Program the control logic required to generate and maintain a calculated value to be passed to the HMI system.
 - a. Provide calculated values for all functions indicated in this and other sections of these specifications.
 7. Program the control logic required to allow operator override control of all PLC outputs passed from the HMI system.
 - a. Provide programming necessary for the HMI to monitor and control every data point that the PLC is monitoring and controlling.
- E. Human Machine Interface (HMI) programming
1. Provide graphic programming for the existing HMI server for all work performed for the project. Programming shall provide all the functionality and control that an operator would have when standing in front of the local control panels and equipment.
 - a. General Requirements
 - 1) Display all monitored process values and device status in a tabular format.
 - 2) Display an alarm log screen in a tabular format with time and date stamp.
 - 3) Display an exaggerated alarm indication on unacknowledged alarm conditions.
 - 4) Display motor run times as both resettable and unresettable values. Motor run times shall be individually resettable from the operator interface terminal.
 - 5) Display a 24 hour trend screen of the monitored process values.
 - b. Display all monitored I/O points.
 - 1) Provide HMI operator forced override to all monitored I/O points
 - c. Display all controlled I/O points.

- 1) Provide HMI operator manual override to all controlled (output) I/O points.
2. Provide tag modifications and communication configuration of the existing Human Machine Interface (HMI) terminals.
 - a. Provide all programming and coordination necessary to create control equipment addresses tags, links to screen components and configuration in the existing HMI.
 - b. Investigate each of the I/O signal tags that are listed in the HMI tag list dump at the beginning of construction.
 - 1) Identify each tag that is not affected by the work under this Contract.
 - 2) Identify each tag that needs to be redirected due to the work under this Contract.
 - 3) Identify each tag that needs to be added due to the work under this Contract.
 - 4) Identify each tag that needs to be removed from the database due to the work under this Contract.
 - c. Create new tags for I/O not presently in HMI system.
 - 1) Create new graphic screens displaying a tabular list linking all I/O tags with a displayed indicator or control for each I/O tag not actively displayed in the HMI at the beginning of construction.
 - d. Remove existing tags from the abandoned pump stations which are not going to be reused in the HMI system.
 - e. Verify the function of each I/O tag by actuating the field device or graphic control and verifying that the corresponding graphic indicator or controlled field device responds appropriately.

3.02 FUNCTIONAL DESCRIPTIONS

- A. This section specifies programming work required for specific process applications in addition to the general programming descriptions above and described in Section 40 61 96.
 1. Manual Control: A Hand-Off-Auto selector switch shall be provided on the Pump Control Panel for each pump. When the Pump Control Panel selector switch is turned to Hand the associated pump will start immediately unless:
 - a. Over-temperature Alarm is active.
 - b. Seal-Failure Alarm is active.
 2. Auto Control: For Auto control operations to work the Hand-Off-Auto selector switch on the VFD must be in the Auto position. When the Pump Control Panel

selector switch is in the Auto position the system will automatically start and stop all pumps available for operation as indicated below:

- a. Normal Operation: The control system is to utilize the submersible pressure transducer for level indication and as the reference to start and stop the pumps.
 - 1) The start and stop settings for pump operation shall be user adjustable.
 - 2) The controls are to incorporate a dead-band or utilize de-bounce timers to start and stop the pumps to eliminate “chattering” the starters.
- b. High Level Float: In the event that the High Level Float is triggered a back-up five float based level control system (Low level, Pumps Off, Lead Pump Start, Lag Pump Start, High Level) shall take over for control of the pumps as follows:
 - 1) Turn on both submersible pumps.
 - 2) High Level Float alarm will be sent through SCADA, requiring the operators to acknowledge the alarm.
 - 3) Run both submersible pumps until to the pump shutoff float turns the pumps off.
 - 4) The back-up level control system shall remain in control until an operator selects primary level control.
- c. Loss of Power: In the event of a power failure, the system will automatically re-start the pumps based on the wet well level.
- d. The lead/lag pump designation shall be alternated to the next successive available pump each time the pumps stop.
 - 1) The operator shall be able to choose the lead, lag configuration (i.e. 1-2. 2-1. None).
 - 2) The operator shall also have the option to alternate the lead pump on a weekly basis.
- e. Pump Failure: If a pump fails to start or is not in Auto, the next successive pump in the sequence (or the other available pump) shall be started immediately.
- f. Pump speed for the submersible pump shall either be constant or vary based upon level within the Wetwell. Consult with the Authority for requirements. For speed variance, as the pumps start, the submersible pumps shall start at their minimum speed setting (defined by pump manufacturer to prevent cavitation of submersible pump). As wetwell level rises, submersible pump(s) speed shall increase to maximum speed at a user defined set point. As wetwell level decreases, the submersible pump speed shall decrease to the minimum pump speed (defined by pump manufacturer to prevent cavitation of submersible pump).

3. Hardwire Interlocks:
 - a. Pump shall be shutdown on Low Level float activation in auto control.
4. Local Monitoring and Alarms:
 - a. The following status and alarm conditions will be indicated on the Control Panel utilizing an Operator interface as specified in as well as other points listed in the I/O list contained in Part 4 - I/O List:
 - 1) Pump Run indication.
 - 2) Pump Stopped indication.
 - 3) Pump Runtime Meter.
 - 4) Pump Seal-Failure Alarm.
 - 5) Pump Overtemp Alarm.
 - 6) Pump Failure Alarm.
 - 7) Pump Motor High Temp.
 - 8) Pump Motor Seal Fail
 - 9) Low Level Float Alarm.
 - 10) High Level Float Alarm.
 - 11) VFD Fail Alarm
 - 12) Wetwell Level.
 - 13) Wetwell Level High (based on LIT).
 - 14) Wetwell Level Low (based on LIT).
 - 15) Active alarm screen.
 - 16) Alarm history screen.
 - 17) Analog scaling setup screen for analog points.
 - 18) Control Method (Normal or Back-up)
5. Remote Monitoring and Alarms:
 - a. The following status and alarm conditions will be monitored at the SCADA System as well as other points listed in the I/O list contained in Part 4 - I/O List:
 - 1) Pump Run indication.
 - 2) Pump Stopped indication.
 - 3) Pump Runtime.
 - 4) Pump Seal-Failure Alarm.
 - 5) Pump Overtemp Alarm.
 - 6) Pump Failure indication.
 - 7) VFD Failure Alarm

- 8) Low-Low Level Float Alarm.
 - 9) High-High Level Float Alarm.
 - 10) Wetwell Level.
 - 11) Wetwell Level High (based on LIT).
 - 12) Wetwell Level Low (based on LIT).
 - 13) Loss of Normal Power.
 - 14) Generator Running.
 - 15) Fuel Tank Low
 - 16) Fuel Tank Rupture
6. Instruments:
- a. The following is a list of instruments to be provided by the system integrator (Refer to Section 40 72 00):
 - 1) Submersible Pressure Transducer.
 - 2) Low Level Float.
 - 3) (3) Intermediate Level Floats.
 - 4) High Level Float.
7. Control Panel: The following is a list of the minimum equipment to be included in the control panel. Refer to specification Section 40 90 10 for equipment specifications as well as applicable panel layout and wiring requirements.
- a. Enclosure rating: Nema 4X.
 - b. Power requirements: 120VAC.
 - c. Programmable Logic Controller.
 - d. Seal-Failure and Overtemp detection: All necessary transformers and relays associated with moisture and overtemp detection shall be contained within the control panel and provided by the pump manufacturer.
 - e. Control Relays.
 - f. Signal Isolators.
 - g. GFI Receptacle.
 - h. Terminal Blocks.
 - i. Circuit breakers.
 - j. Fuse cut-outs.
 - k. UPS.
 - l. Coordinate with the Authority for communication requirements.

3.03 TESTING

- A. Submit test plans and procedures, including test forms, to the Authority for review and approval within one week after the equipment has been delivered to the site.
 - 1. Demonstrate that each network connected device installed under this contract is properly installed and functioning.
 - 2. Demonstrate that the SCADA software modifications executed under this Contract has been installed and are functioning as intended.
 - 3. Demonstrate that the SCADA software is properly communicating with each I/O point on each PLC or other devices and that the field data is available at all network nodes.
 - 4. Demonstrate that all displays, trends, alarms, and reports have been configured and are properly operating.
 - 5. Demonstrate that all real-time data is being collected as historical data and is accessible from PCs on the existing LAN.
 - 6. Demonstrate that all control system configuration software is properly operating on the HMI workstation, and that the final configuration files can be uploaded, modified, and downloaded into the network attached control equipment.
- B. Unless otherwise approved in writing, all testing shall be performed in the presence of authorized Plant personnel from both the Operations and Maintenance.
- C. Test forms shall be prepared and submitted by the contractor prior to scheduling of each test.
 - 1. These forms shall be completed at the time of witnessed testing and signed by both the contractor and Authority's representatives.
- D. Perform or assist in the performance of all field tests listed in other sections of these contract specifications.

PART 4 - DATA

4.01 I/O LIST

Discrete Inputs:

No.	Description	Condition	Source	Destination
1	Submersible Pump #1	Running	VFD	PLC
2	Submersible Pump #1	Fault	VFD	PLC
3	Submersible Pump #1	Over-Temp	VFD	PLC
4	Submersible Pump #1	Seal-Leak	VFD	PLC
5	Submersible Pump #2	Running	VFD	PLC
6	Submersible Pump #2	Fault	VFD	PLC
7	Submersible Pump #2	Over-Temp	VFD	PLC
8	Submersible Pump #2	Seal-Leak	VFD	PLC
9	VFD #1	Fault	VFD	PLC
10	VFD #2	Fault	VFD	PLC
11	High-High Level Float	Alarm	Float	PLC
12	High Level Float	Indication	Float	PLC
13	Mid Level Float	Indication	Float	PLC
14	Low Level Float	Indication	Float	PLC
15	Low-Low Level Float	Alarm	Float	PLC
16	Loss of Normal Power	Alarm	ATS	PLC
17	Generator Running	Status	Generator	PLC
18	Generator Fault	Status	Generator	PLC
19	Fuel Tank Low	Alarm	Generator	PLC
20	Fuel Tank Rupture	Alarm	Generator	PLC
21	Commercial/Utility Power	Status	Generator	PLC

Discrete Outputs:

No.	Description	Condition	Source	Destination
1	Submersible Pump #1	Run Command	PLC	VFD
2	Submersible Pump #2	Run Command	PLC	VFD

Analog Inputs:

No.	Description	Condition	Source	Destination
1	Submersible Pump #1	Speed Feedback	VFD	PLC
2	Submersible Pump #2	Speed Feedback	VFD	PLC
3	Submersible Pressure Transmitter	Level	Transmitter	PLC

Discrete Outputs:

No.	Description	Condition	Source	Destination
1	Submersible Pump #1	Speed Control	PLC	VFD
2	Submersible Pump #2	Speed Control	PLC	VFD

END OF SECTION