

ADDENDUM | No. 1

PROJECT	2020 Madison Water System Improvements – Water Tower		
BID DATE	11:00 AM	CDT	08/11/2020
BID LOCATION	City of Madison 116 West Center Street, Madison, SD 57042		
ISSUE DATE	08/06/2020		
NOTICE	Failure to acknowledge all addenda in the BID may cause rejection of the BID. See Instructions to Bidders.		

SCOPE OF THIS ADDENDUM

The following becomes a part of the original project manual and drawings, taking precedence over the items that may conflict. The bidder shall note receipt and make acknowledgment of the Addendum on his/her bid form, incorporating its provision in his/her bid.

GENERAL

Clarification:

Soils report indicated an anticipated footing bearing elevation of 1694.00 for preliminary design. Detail 3/4.1 shows a cover of 8'-0" to allow the piping to come out of structure above the footing while maintaining minimum cover. Footing bearing elevation needs to be adjusted to account for this change in depth. Bearing pressure is expected to remain the same with the deeper bearing elevation.

PROJECT MANUAL

The following additions, changes and clarifications have been made to the Project Manual.

Section 08 7110 – Door Hardware,

3.6 Door Hardware Schedule, Hardware Group 1

Clarification: Security Access systems shall be sole-sourced through Midwest Alarm Company of Sioux Falls, SD. This includes the card reader and entrance alarm security system.

Clarification: The Mortised Entrance Lock - electrified shall have the back-up key access (keying) compatible with all other existing entrance locks, Door Supplier to coordinate keying with Owner.



Section 09 9200 – STEEL TANK COATINGS & 09 9600 – HIGH-PERFORMANCE COATINGS

Clarification: Shop priming/coating is allowed. All requirements as specified shall be followed.

Section 09 9600 – HIGH-PERFORMANCE COATINGS

3.1B. Items to be painted

Add: "3. Galvanized surfaces in interior wet.

3.2B. Items not to be painted

Add: "2. Galvanized surfaces, unless specifically indicated to be painted."

Section 13 2100 – COMPOSITE ELEVATED WATER STORAGE TANKS

Change: References to "D100" shall be changed to "**D107**"

Clarification: Concrete for tower shall be per AWWA D107 and the 13 2100 section for materials and performance. Quality control shall include the requirements from 03 3000 (whichever is more stringent).

2.3 Concrete Support Structure – Tank Floor

Change: "Tank floor shall be a reinforced concrete dome not less than 8 inches thick." to read "Tank floor shall be a reinforced concrete dome **or slab** not less than 8 inches thick

2.6B.3 Tank Interior Wet Ladder

Add: "Tank interior wet ladder shall be coated in accordance with the tank interior wet coating system."

2.6B.H Access Tube

Change: "Provide a minimum 42 in. diameter centrally located ..." to read "Provide a minimum **60** in. diameter centrally located ..."

Section 13 2120 – SPHEROID ELEVATED WATER STORAGE TANKS

1.8A. Project Conditions

Clarification: Building permit shall be obtained and paid for by the Contractor.

2.3B.6 Ladders

Change: "Tank interior ladders shall be coated in accordance ..." to read "Tank interior **wet** ladders shall be coated in accordance ..."

Add: "Tank interior dry ladders shall be hot-dip galvanized."

Section 40 0000– Process Integration,

Remove entire section and replace with revised Section 40 0000



DRAWINGS

The following additions, changes and clarifications have been made to the Drawings.

Drawing Sheet 4.1

Detail 3/4.1 – Section Spread Footing,

Change: "10'-0" MIN. OVER EXCAVATION" to read as: "3'-0" MIN. OVER EXCAVATION".

Change: "1'-0" CRUSHED ROCK" to read as: "1'-0" DRAINAGE ROCK"

Change: "ENGINEERED FILL" to read as: "GRANULAR STRUCTURAL FILL"

Drawing Sheet 5.1.

Detail 1/5.1 Composite Tower Floor Plan,

Change: "Coiling Door" to read as: "Sectional Door".

Change: "10' x 12' Overhead Coiling Door" to read as: "10' x 12' Sectional Door w/high-lift track"

Add: "General Notes: 1. Approach Slab and stoop at exterior door shall be constructed as detailed in 3/1.4 and 4/1.4"

Drawing Sheet 5.2.

Detail 1/5.2 Spheroid Tower Floor Plan,

Add: "General Notes: 1. Stoop at exterior door shall be constructed as detailed in 4/1.4"

Drawing Sheet 11.1.

Door Schedule,

Change: Door Material shall read as "Aluminum".

Frame Material shall read as "Aluminum"

Drawing Sheet 11.1.

Door Details 2/11.1, 4/11.1 & 6/11.1,

Change: Door & Frame Material shall read as "Aluminum".

Drawing Sheet 11.1.

Door Frame Elevations,

Change: Frame Dimension: 4" head shall read as 2"

Drawing Sheet 19.4.

I/O & Alarm Display List: South Water Tower Control Panel, RTU-122

Change: "MicroLogix 1100" to read as: "MicroLogix 1400".



NOTE

The Plan Holders List and Addendums are available on our website at <http://www.bannerassociates.com> by clicking on **View Bid Information / Project Name / Project Information** link.

Project Manual and Drawing inquiries regarding the work should be directed to:

CONTACT PERSON(S)

Banner Associates, Inc. Tel 1-605-692-6342 | Toll Free 1-855-323-6342 | Fax 1-605-692-5714

Kristin Bisgard

Project Manager

kristinb@bannerassociates.com

ATTACHMENTS

1. Electrical Addendum #1 dated 8/5/2020 (PE Group)
2. Revised Specification Section 40 0000

A handwritten signature in blue ink that reads "Pat Carey, P.E.". The signature is written in a cursive, flowing style.

Pat Carey, P.E.



"Integrity, Teamwork...Excellence"

Electrical Addendum No. 1

TO: All Plan holders

FROM: Mark W. Joffer, PE

DATE: 8-5-20

RE: New Water Tower
Madison, SD
PE Group #30-19242



The following addendum items shall become a binding part of the contract documents and shall be included as part of the contract price:

Drawings:

Sheet16.2

1. Key Card Access: Provide a weatherproof single gang box at both the interior and exterior side of the walk-in door entrance to the Tower for a Key Card Access unit, furnished by others. Provide ¾" conduit between the boxes. Also provide an empty ¾" conduit from the interior box to the room within the Tower base containing the Panelboard and Control Panel. This raceway is for signal wiring. In addition, provide 120V power to Key Card location as presently shown.

Sheet16.3

1. Key Card Access: Provide a weatherproof single gang box at both the interior and exterior side of the walk-in door entrance to the Tower for a Key Card Access unit, furnished by others. Provide ¾" conduit between the boxes. Also provide an empty ¾" conduit from the interior box to the room within the Tower base containing the Panelboard and Control Panel. This raceway is for signal wiring. In addition, provide 120V power to Key Card location as presently shown.

Clarifications:

1. As a matter of clarification, any and all electrical cable and wire is required to be installed in conduit.

End of Addendum

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SECTION 40 0000 – PROCESS INTEGRATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Work shall consist of performing all labor and furnishing all material to provide a complete and workable control system for the proposed 750,000-gallon elevated storage tower. This section includes specifications for the control panels, appurtenances, and associated materials and equipment. This section also defines responsibilities and requirements for coordination of the Work, shop drawing submittals, operator training, system checkout, spare parts, and warranty.
 - 1. The instrument and control system consists of all primary elements, transmitters, switches, controllers, computers, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the systems as specified in the Contract Documents.
 - 2. Unless otherwise required for instrument compatibility, electric control signals shall be 4 to 20 mA, 24 Vdc, and pneumatic signals shall be 3 to 15 psi.
 - 3. All signals shall be directly linearly proportional to measured variable unless specifically noted otherwise.

1.2 CONDITIONS AND SYSTEMS RESPONSIBILITY

- A. The Control System Integrator shall be responsible for coordination of all aspects of control system work including:
 - 1. Building and furnishing Remote Control Panel (RTU)
 - 2. Interfacing of controls with instruments and equipment,
 - 3. Interfacing of controls with telemetry system,
 - 4. Calibration and testing of control systems,
 - 5. Integration with existing control system and the proposed Work,
 - 6. Coordination with the Engineer and Owner,
 - 7. Providing all necessary Operator Training,
 - 8. System checkout and repair during the warranty period, and
 - 9. Complete system documentation.
- B. The control system installation shall be coordinated with the Engineer and Operating Staff to minimize disruptions of operation of the existing system during the connection of additional equipment to the control system. The Control System Integrator shall provide drawings showing the interconnecting wiring requirements to connect the control panels to the process equipment and to the motor control centers. This information shall include wire counts for specific control and instrument systems. The Contractor will furnish copies of the process equipment submittal information to the control system integrator for coordination and completion of the control submittal drawings. It is expected that this coordination will require on-site coordination and such coordination shall be included as a part of the bid for the control system integration.

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1. A planned sequence of operations is required to integrate the Work to the existing system while keeping the existing system in operation. It shall be the responsibility of the Control System Integrator to closely schedule his work so that his work will be installed at the proper time and without delaying the completion of the entire project. The plan for the sequence of operations shall be reviewed with the Owner, Engineer, and General Contractor prior to starting installation of the equipment to minimize service disruptions.
2. It is the responsibility of the General Contractor and his Subcontractors to install all equipment in strict accordance with manufacturer's recommendations, with adequate on-site supervision being provided by the manufacturer of the equipment or his authorized representative.
3. The software packages furnished as a part of the control and telemetry system shall be licensed to the Owner. Software shall be fully documented, and a backup copy of the software shall be provided on a CD-ROM or equivalent long-term storage medium. Software license shall be for run-time license.
4. The authorized representative of the manufacturers supplying equipment shall notify the Engineer that the equipment has been satisfactorily installed and is ready for operation. No form of energy shall be turned on to any part of the control and monitoring system prior to receipt by the Engineer of a statement of approval of the installation from the Contractor containing his Supplier's authorization for turning on energy to the system.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of related work are specified and included in other sections of these Specifications:
 1. Division 1 for Submittal Requirements
 2. Division 26 for Electrical, Power, Lighting, and Controls
 3. Division 40 Section "Instrumentation and Control for Process Systems," for general requirements for hardware products and integration.
 4. Division 44 Section "Interior Piping and Valves," for interior piping, valves, fittings, and appurtenances.
- B. The materials specifications for wire, appurtenances, and equipment apply to the materials required for the control system. The Control System Integrator shall coordinate control and monitoring system wiring requirements.

1.4 QUALIFICATIONS OF CONTROL SYSTEM CONTRACTORS

- A. Control System Contractors proposing to bid the work specified herein shall be approved by the Owner and the Engineer. In addition to the system specifications, the following minimum requirements shall be met by the Contractor:
 1. At least five (5) years of experience in design and installation of control systems for water and/or wastewater treatment plants.
 2. Demonstrated ability to serve as Control System Integrator via three relevant project references.
- B. The following Control System Integrators are approved for this Contract:
 1. Sweeny Controls – Fargo, ND
 2. No exceptions.

1.5 QUALITY ASSURANCE

A. Referenced Standards:

1. Canadian Standards Association (CSA)
2. FM Global (FM)
3. The Instrumentation, Systems, and Automation Society (now International Society of Automation, ISA):
 - a. S5.1, Instrumentation Symbols and Identification
 - b. S5.2, Binary Logic Diagrams for Process Operations
 - c. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems
 - d. S5.4, Standard Instrument Loop Diagrams
 - e. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves
 - f. RP7.1-56, Pneumatic Control Circuit Pressure Test
2. National Electrical Manufacturers Association (NEMA)
3. National Institute of Standards and Technology (NIST)
4. Underwriters Laboratories, Inc. (UL)

B. Miscellaneous:

1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

1.6 SHOP DRAWINGS REQUIREMENTS

- A. The Controls System Integrator shall both submit copies of shop drawings for their respectively supplied equipment in accordance with Division 1 Section “General Requirements” to Contractor and Electrical Sub-contractor for all hardware items and software products listed under “Products”. Shop drawings shall include all catalog cuts, descriptive data, and drawings for the entire control system. If catalog cuts are furnished, the specific model number, color, and all requirements shall be indicated on each copy of the shop drawings.
- B. Submit copies of the proposed method of control system expansion, including a listing of additional hardware required, additional software required, and implementation requirements. The data acquisition and monitoring system supplier shall also submit a detailed explanation of the procedure for integrating the Work process controls into the existing facilities.
- C. Submit system documentation as described in paragraphs 3.1 of this Specification.
- D. Submittals shall be prepared from original printed material or clear unblemished photocopies of original printed material. Facsimile information is not acceptable.
- E. Product technical data including:
 1. Acknowledgement that products submitted meet requirements of standards referenced
 2. Equipment catalog cut sheets
 3. Instrument data sheets:

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- a. ISA S20 or Engineer approved equal
 - b. Separate data sheet for each instrument
 - 4. Materials of construction
 - 5. Minimum and maximum flow ranges
 - 6. Pressure loss curves
 - 7. Physical limits of components including temperature and pressure limits
 - 8. Size and weight
 - 9. Electrical power requirements and wiring diagrams
 - 10. NEMA rating of housing
 - 11. Submittals shall be marked with arrows to show exact features to be provided.
- F. Loop diagrams per ISA S5.4.
- 1. Each loop diagram on a separate sheet
 - 2. Each sheet shall contain the following minimum information:
 - a. All loop devices clearly identified
 - b. Identification of the loop and each loop component, including connections to such things as recorders and computers. Numbering and tagging must agree with the P&ID.
 - c. All interconnections with identifying numbers for:
 - 1) Electrical cables
 - 2) Conductor pairs
 - 3) Pneumatic or hydraulic tubing
 - d. Identification of connections including:
 - 1) Junction boxes
 - 2) Terminals
 - 3) Bulkheads
 - 4) Ports
 - 5) Computer input/output connections
 - 6) Grounding systems
 - e. Signal levels and ranges
 - f. Device location
 - g. Energy sources designating voltage, pressure, and other applicable requirements
 - h. Enough process lines and equipment to clearly show the process side of the loop and provide clarity of control action. This includes:
 - 1) What is being measured
 - 2) What is being controlled
 - 3) Other information required to complete the process loop
 - i. Reference to supplementary records and drawings to show inter-relation to other control loop.
 - j. Controller action
 - k. Control valve action upon electronic, hydraulic, or pneumatic failure
- G. Process connected instrument installation details containing the following minimum information:

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1. Bill of materials providing as a minimum the following information:
 - a. Tube material and size
 - b. Connection size
 - c. Fitting size, material, and rating
 - d. Valve type and material
 - e. Instrument description
 - f. Pipe stand size and material
 2. Tube slope requirements
 3. Required elevations and dimensions
- H. Comprehensive set of point-to-point wiring diagrams showing all interconnections between packaged systems or equipment control panels, motor control centers, instrumentation, and all other electrical equipment as required to depict a complete and functional electrical control system. Instrumentation wiring already shown on loop diagrams need not be included on point-to-point wiring diagrams.
1. Diagrams shall provide the following minimum information:
 - a. Terminal block identification (includes terminals on remote equipment furnished by Others
 - b. Wire identification number.
 - c. Wire size
 - d. Wire type
 - e. Wire color
 - f. Wire shielding and insulation type
 - g. Conductor quantities and associated conduit size
 - h. Ground points
 - i. Interconnection requirements to existing systems or equipment furnished by Others
 2. Diagrams shall be provided on Drawings of sufficient size so as to minimize the number of drawings.
 - a. Drawing size: 11 x 17 IN
- I. Electrical schematic control diagrams. Diagrams shall include:
1. Terminal identification
 2. Unique identification of all control devices and contacts
 - a. Utilize Owner's device identification numbers where applicable
 3. Wire identification
 4. Equipment identification
 5. Indication of remote and local devices and wiring
 6. Overcurrent protection indication
 7. Voltage
 8. All control logic
- J. Panel fabrication drawings

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- K. PLC/DCS equipment drawings
- L. Graphic layouts
- M. Graphic component construction
- N. Nameplate layout drawing
- O. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
 - 1. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed exclusively throughout submittals.
- P. Certifications:
 - 1. Documentation verifying that calibration equipment is certified with NIST traceability.
 - 2. Approvals from independent testing laboratories or approval agencies, such as UL, FM, or CSA. Certification documentation is required for all equipment for which the specifications require independent agency approval.
- Q. Testing reports:
 - 1. Source quality control reports
- R. Warranties: Provide copies of warranties and list of factory authorized service agents.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish and coordinate instrumentation system through a single Instrumentation Subcontractor. The Instrumentation Subcontractor shall be responsible for functional operations of all systems, performance of control system engineering, supervision of installation, final connections, calibrations, preparation of drawings and operation and maintenance manuals, startup, training, demonstration of substantial completion, and all other aspects of the control system.
- B. Ensure coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.
- C. The functions and features specified herewith are the minimum acceptable requirements for the SCADA system. The provided system shall equal or exceed each requirement.
- D. In some cases, the specifications may allow the accomplishing of certain functions by means of more than one hardware/firmware/software approach. Any approach that is proposed shall equal or exceed all functional, operational, convenience, and maintenance aspects of the one described.

- E. Major equipment, component, and software items are specified; however, the Contractor shall provide all appurtenant items necessary to achieve the required operation as hereinafter specified.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. System Operating Criteria:

1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two cycles per minute or a magnitude of movement of 0.5 percent full travel.
2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position final element.
5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0 percent of full scale.
6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.3 FUNCTIONAL REQUIREMENTS

- A. General: The scope of Work under this Contract includes connecting and configuring the new equipment that is installed under this Contract and development of the appropriate displays, reports, and logs to record the information generated by the new equipment and instruments. All wiring and appurtenances required for a complete and functional system addition shall be provided under this Contract. The monitoring and control functions are described in the functional description of the control system. The control equipment and material specifications are described in the Specifications for control system hardware and materials.
- B. Description of the Work to be performed: The following subsections define the Work that will be completed under this Contract.
 1. Control Panel (RTU-122): The Control System Integrator shall furnish and install a new RTU as shown on the plans. The new control panel shall utilize the telemetry system to communicate with the existing telemetry system. The I/O required for this RTU is shown on the project plans.
 2. Contractor to coordinate with engineer to determine appropriate antenna height and location to successfully communicate data between the existing RTU (100) at the Madison Water Treatment Plant and the new RTU (122) at the new water tower using 900 MHz spread spectrum radios.

2.4 PROCESS CONTROL FUNCTIONS

- A. Summary Listing of Points: The point list provided in the plans indicates the number of new or modified inputs and outputs to and from the control system. The number of wires and terminations will vary with configuration of the control system. The list of points is provided as a reference list for the functional specifications. The control system shall monitor and control the Analog/Discrete inputs and outputs summarized on the plan sheets.

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- B. The lists do not include the contact closure points required to drive status and alarm lights and horns on the control panels. The analog output lists do not include the outputs required to drive displays. The outputs necessary to drive the displays, indicators, and recorders are described in the functional specifications and in the P&ID drawings included in the Plans.
- C. Operational Description - Control Functions:
 - 1. General: The City of Madison is served by both the Lewis and Clark Regional Water System and their own water plant. Water from the two sources mixes in the ground storage reservoir located at the Water Treatment Plant and the blended water is pumped out to the system through the high service pump station.
 - a. General Requirements: The existing control and monitoring system uses a Programmable Logic Controller based system sized to handle all analog and contact closure signals necessary for the monitoring and control functions specified.
 - b. Status and Alarm Monitoring: Equipment alarms shall be designed to inform the Operator of any un-commanded change of status. Equipment failure alarm logic shall include adjustable time delays to prevent nuisance alarms due to time delays in the starting controls. The motor starter controls for process equipment generally include time delay relays to sequence restart after power failure. The time delays for the alarms shall be set longer than the time delay for start to prevent nuisance alarms.
 - 1) Analog input alarms shall be annunciated when a setpoint limit is violated or a signal is lost AND an operator selected timer expires. Zero flow signals on flow meters will not necessarily be an alarm condition; setpoints for low flow must be adjustable to prevent nuisance alarms at zero flow. Operator shall enter alarm limits using the keyboard for the process control interface.
 - 2) Status and alarm engraving is shown on the Plans. The engraving schedules and arrangements shown are intended as a guide for control panel layouts. Variations to the shown arrangements will be reviewed at the time of shop drawing submittal.
 - 2. Functional Description of Process Controls: The following is narrative of the normal operation procedures for each major piece of equipment. The parameters in brackets are initial setpoints for operator selected variables. All operator selected setpoints shall allow the Operator to change or modify variables in the control of the equipment.
 - a. Panel Locations: Coordinate final location of the process monitoring and control panel (RTU-122) with Engineer and Owner prior to installing panel and associated conduit. This panel shall serve as the interface between the remote site and the tower monitoring and control system. All I/O signals as listed on the PLC I/O plan sheet shall be configured to function as described with the equipment here in these specifications.
 - b. Tank Overflow Alarms: The overflow structure flap-gate will be equipped with a limit switch (LS-122.02) that shall be wired normally closed to RTU-122. An alarm conditions shall be generated and annunciated if and when a limit switch contact open condition is detected.
 - c. Intrusion Alarms: The tower will be equipped with an intrusion alarm system to indicate unauthorized entry by using limit switches (ZS-122.01, ZS-122.02, ZS-122.03, ZS-122.04, ZS-122.05) mounted on the door of the enclosure as shown on the device location plan sheet. An alarm condition shall be annunciated locally and remotely in the existing HMI software when the door switch status is violated. The alarm shall display which door switch status has been violated. An disable/enable pushbutton (PB-122.01) shall be

installed on the side of the local control panel (RTU-122) to allow an operator to enter the building and press the button within an operator selected time [60 seconds] to acknowledge and disable the intrusion alarm before it is annunciated. Once the alarm has been disabled it will remain disabled for all door switches for an operator selected time [120 minutes]. After the set time is passed the alarm will be re-enabled. If the Operator presses the pushbutton (PB-122.01) before time has expired, then the alarm shall reactivate within an operator selectable setpoint time of [120 seconds].

- d. Wet Floor Switch: Wet floor switch (FS-122.01) shall be furnished and installed approximately at location as shown in the project plans. The wet floor switch shall initiate an alarm when it comes in contact with water.
- e. General Purpose Relay – Power Outage: RTU-122 shall be equipped with a timer relay (RLY-122.02) that monitors the incoming line power. Upon power failure and an operator adjustable amount of time [30 sec], an alarm will be generated in RTU-122 and annunciated on the RTU-122 HMI.
- f. FAA Light Relay – Power Outage: FAA Panel relays (RLY-X.02 and RLY-X.03) shall be supplied and installed by the equipment supplier. Each relay shall correspond to a light. Upon power failure an alarm will be generated in RTU-122 and annunciated on the RTU-122 HMI should a power failure be detected.
- g. Float Level Switch – Sanitary Sewer Holding Tank: The float level switch (FLS-122.01) installed in the sanitary sewer holding tank shall annunciate an alarm when the water in the sanitary sewer holding tank reaches the float level. The float shall be installed at such a level so that the alarm will alert operators of tank level with sufficient time to arrange for pumping of the holding tank prior to the tank overflowing. The level of the float level switch shall be coordinated with Owner and Engineer during construction.
- h. Pressure Transmitter – Tank Level: The water level in the elevated water storage tank will be monitored by a pressure transmitter (PIT-122.01). The pressure transmitter shall generate and transmit a 4-20 mA signal proportional to the water level in the tank. The signal will be connected to RTU-122 to generate alarm conditions. Operator adjustable setpoints in RTU-122 shall be provided to annunciate alarm conditions for either a high water level [40 feet] or a low water level [10 feet] in the storage tank.
- i. Room Temperature Transmitter: A temperature transmitter (TT-122.01) shall be furnished and installed in the piping room as shown in the project plans. Low temperature [40°F] and high temperature [90°F] alarms shall be annunciated when the air temperature drops below or rises above an operator-selected setpoint.
- j. Humidity Transmitter: A humidity transmitter (HT-122.01) shall be furnished and installed in the piping room at the general location as shown in the project plans. Coordinate final location with Engineer or Owner. A high humidity [50%] alarm shall be annunciated when the humidity within the control vault rises above an operator-selected setpoint. Humidity alarms shall be annunciated differently from process alarms.

2.5 MONITORING AND CONTROL SYSTEM HARDWARE AND MATERIALS

- A. General: The monitoring and control system work under this Contract shall consist of the following major items:
 - 1. Furnish and install RTU, radio, and antenna at the new Madison South water tower;
 - 2. Furnish and install new process instrumentation;
 - 3. Furnish and install conduit and cable;
 - 4. Integrate the I/O addresses for the HMI system to include all the new input/output signals,
 - 5. Provide system to include automatic and manual capabilities to monitor and control the processes.
- B. Remote Terminal Unit

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1. Description: This Work shall consist of performing all labor and furnishing all materials to install the new RTU.
 - a. The control panel shall also contain the power supplies necessary to power the field transmitters requiring 12 VDC and 24 VDC power. Terminals shall be supplied for all input signals, in addition to the signals necessary to support the control system, and a connection to the communications network. Electrical circuits for instrumentation shall be separate from the electrical circuit for the process control system even if they are located within the same process control panel.
 - b. Control switches and push buttons shall be furnished and installed to provide the functions necessary to provide a fully functioning RTU. All switches and pushbuttons shall be labeled with appropriate nameplates. Switches and pushbuttons shall be suitable for installation in a high humidity and corrosive environment.
 - c. The new panel shall be completely factory or shop wired. Main groups of wire shall be routed in plastic nonflammable wiring duct. Smaller groups of wires shall be secured with nylon cable clamps and ties or plastic spiral wraps. Terminal blocks shall be used for all external wiring connections. Field wiring to terminal strips shall be routed through non-flammable wiring duct.
 - d. Equipment connections shall be made with screw-type connections torqued to the manufacturer's recommended tightness except where devices specified are available only with solder-type terminals. Connections shall be made as recommended by the manufacturer.
 - e. The circuit breaker panel board shall be mounted inside the control panel at a readily accessible location.
 - f. The complete installation shall be done such that all relays, control devices, and panel instruments are completely accessible without major dismantling of panel equipment.
 - g. Relays, timers, and other control panel mounted control devices shall be plug-in design for convenient maintenance. All relays and timers for similar use shall be identical and interchangeable.
 - h. Condensation protection shall be provided. Enclosure shall have a heater which operates continuously to prevent condensation build-up. A freeze protective heater and thermostat shall also be provided at those outdoor locations containing hydraulics or sensitive electronic equipment subject to freezing conditions.
 - i. Enclosures: The controls furnished and installed under this Contract shall be backplane mounted in the control panel enclosures. The new process control panel front may include the following; operator interface (size as indicated on the plans), an intrusion horn, indication lights, keypad, and switches as required to facilitate the control sequences specified herein. PLCs, OI, and backplane equipment shall be installed. See plans for panel front device layout.
 - j. Enclosures shall be corrosion resistant NEMA Type 4X Stainless Steel.
 - k. Serialized UL Label Requirement (508A)
 - 1) Panels provided under this section shall be constructed in compliance with Underwriter's Laboratories Inc. category 508A standards - Enclosed Industrial Control Panels listing and following-up. The control panel(s) shall bear the Underwriter's Laboratories serialized label for "Enclosed Industrial Control Panel".
 - 2) While the use of UL listed components is encouraged, their use alone will not be considered an acceptable or satisfactory alternate to the "Enclosed Industrial Control Panel" serialized label specified above. Upon request from the Engineer, the panel manufacturer shall supply documentation to the Owner proving they are a U.L. recognized manufacturing facility for the type of equipment required. Only

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- the labeled products of U.L.508A/“Enclosed Industrial Control Panel” recognized panel manufacturer shall be considered acceptable for use on this project.
- 3) Control panel enclosure shall be a UL-listed panel as manufactured by Hoffman Engineering Company, EQUIPTO Enclosures, Dakota Supply Group, or an Engineer approved equal.
 - 4) Warning sign: A warning sign shall be installed inside each enclosure indicating the presence of separate externally derived sources for voltage in the panel. The signs shall be a minimum of 6 inches by 12 inches in size. The signs shall be red and white or similar color scheme acceptable to the Engineer.
 - 5) Arc Flash: An “Arc Flash” warning sticker shall be applied to the control panel in accordance with NEC 110.16 (2002) Arc Flash Hazard Marking Requirements.
 - 6) Interior brackets, hinged equipment racks, and mounting pans shall be provided for mounting panel equipment. Temporary equipment bracing shall be provided to allow the panel sections to be turned on their side for moving into the control room.
 - 7) Nameplates and Signs: Nameplates and signs shall be engraved as shown on the Plans. Nameplates for the control panel front shall be made of a phenolic laminate with satin black surface and white core. Engraving shall be done in a manner which exposes the white core. The edges of nameplates shall be beveled to expose the color of the core. The nameplates shall be 0.040 inch thick.
 - 8) Lettering on nameplates shall be a minimum of 3/8" in height for capital letters. Engraving schedules shall be approved by the Engineer prior to engraving the nameplates.
 - 9) Nameplates shall be attached to the panel by adhesive and a mechanical fastener. Screws or rivets shall be brass, stainless steel, or chromium plated steel.

1. Control and Wiring Devices and Appurtenances:

- 1) Conductors: Conductors for receptacles, interior lighting, and other similar loads shall be AWG No. 14, 41 strand, copper (minimum). Conductors for low power loads of 120 VAC or lower voltages shall be AWG No. 18, 16 strand, copper (minimum). All conductors shall be identified at both ends with wire tags. Conductors for 4-20 mA low level signals shall be AWG No. 22 twisted shielded pair with thermo-plastic insulation
- 2) Terminal Blocks: Terminal blocks for all external connections shall be rated at 600 VAC. Terminal blocks for internal panel connections of AWG No. 14 conductor and smaller shall be rated at 300 VAC. White terminal marking strips indicating point identification and diode or capacitor polarity shall be installed on each terminal block. Terminal blocks shall include disconnect switch terminal block sections suitable for interrupting control voltages where a control voltage source enters the enclosure from a remote location.
- 3) Fused Terminal Blocks: Fused terminal blocks shall be used for all analog input and output signals. The fused terminal blocks shall be provided with an indicator light. Fused terminal blocks shall be Allen Bradley 1492-H5 or Engineer approved equal.
- 4) Receptacles: A duplex receptacle shall be mounted inside the panels. Duplex receptacles shall be of the 20 ampere, 125 VAC, 2 pole, 3 wire, grounding type complete with box.
- 5) Interior Illumination: Interior illumination shall be installed inside the control panel with a door switch that will turn the light on when the enclosure door is opened. Control panel interior lighting fixtures shall be complete with ballast, wiring, and fluorescent lamps. Fixtures shall be controlled by a switch mounted inside the panel.

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- 6) All wiring shall be in complete conformance with the National Electric Code, state, local and NEMA electrical standards. All incoming and outgoing wires shall be connected to numbered terminal blocks and all wiring neatly tied and fastened to chassis as required. For ease of servicing and maintenance, all wiring shall be color coded and uniquely numbered. The wire color code and number shall be clearly shown on the drawings, with each wire's color and number indicated.
- m. Circuit Breaker Protection: Circuit breakers shall be quick-make, quick-break, thermal-magnetic, trip-indicating and have a common trip on all multiple breakers. Provisions for additional breakers shall be such that field addition of connectors or mounting hardware will not be required to add breakers to the panelboards. All instrumentation systems, annunciator panels, lighting circuits, or similar major devices requiring 120 VAC power shall have an individual circuit breaker. Circuit breaker trip ratings shall be as recommended by the manufacturer of the equipment being protected. Each control panel shall have space provided for a minimum of two additional circuit breakers. Control circuits including flow pacing signals to each chemical feeder shall be independent and independently fused so that a circuit problem with one feeder does not interrupt operation of other feeders.
- n. Power Supplies: Constant voltage transformers shall be used to supply power to all equipment requiring a constant voltage supply, which does not have self-contained voltage regulation equipment. AC and DC power supplies shall be furnished for control circuits and indicating lights where not supplied from power supplies furnished as a part of major equipment items.
 - 1) Constant Voltage Transformers: Constant voltage transformers shall be rated as follows:
 - i) Input Voltage: 95-125 VAC.
 - ii) Output Voltage: 115 VAC.
 - iii) Regulation: +/- 1 percent.
 - iv) Size: As Required.
 - v) Constant voltage transformers shall be equipped with surge protection to protect control circuits from voltage spikes.
 - vi) Constant voltage transformers shall be as manufactured by Allen Bradley, General Electric, Square D, Sola Electric Company, or an Engineer approved equal.
 - 2) AC Power Supplies: AC power supplies shall be rated as follows:
 - i) Primary Voltage: 120 VAC.
 - ii) Secondary Voltage: 24 VAC.
 - iii) Size: As required.
 - iv) AC power supplies shall be as manufactured by General Electric, Square D, Allen Bradley, SOLA Electric Company, or an Engineer approved equal.
 - 3) DC Power Supplies: DC power supplies shall be rated as follows:
 - i) Input Voltage: 105-125 VAC.
 - ii) Output Voltage: 12-32 VDC adjustable.

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- iii) Line Regulation: 50 mV for +/- 10V Line Change.
 - iv) Load Regulation: 100 mV for Full Load Current Change.
 - v) Ripple: 35 mV RMS.
 - vi) Transient Response Time: From 5 to 50 ms; Typical Overshoot between 0.5 and 1.15 volts.
 - vii) DC power supplies shall be as manufactured by Allen Bradley, Square D, General Electric, SOLA Electric Company, or an Engineer approved equal.
- 4) Uninterruptible Power Supplies: Uninterruptible power supplies shall be furnished and installed in each new and refurbished PLC enclosure along with one for the new SCADA Computer. Provide on-line UPS that will continue to operate flawlessly in the event of a power failure. UPS shall provide 20 minutes of operation without utility power. UPS shall be manufactured by Eaton, Powerwave, APC or Engineer approved equal.
- o. Control Relays: Control relays shall be plug in relays. Relay contacts on 110 VAC circuits shall be rated for 300 VAC and up to 10 amps of load. Coil voltage and contact configuration shall be as required to implement the control and instrumentation loops indicated.
- 1) Control relays shall be General Electric, Allen Bradley, Square D, IDEC RH series, Potter Brumfield, or an Engineer approved equal.
- p. Timing Relays: In general, timer control functions may be provided in the control logic furnished for the type which begins the time delay upon energizing the coil and reset automatically when de-energized. The timing relays shall contain contacts of the voltage and current ratings required to implement the control functions indicated.
- 1) Timing relays for periods greater than 200 seconds shall utilize solid state electronics. Timers shall have 11 pin base which matches other timers used. Timers shall be ATC 328 Series or an Engineer approved equal.
- 2) Timing relays for periods of 200 seconds and less shall be solid state with adjustable timing ranges of 10-180 seconds, suitable for interior panel mounting. Timers shall have an 11 pin base which matches the other timers used.
- 3) Timers shall be as manufactured by Allen Bradley, General Electric, Square D, AGASTAT Series 7000, IDEC RTY series, or an Engineer approved equal.
- q. Switches and Pushbutton Controls: Sequence selector switches shall be multiple deck, rotary-type detent switches with silver finish phosphor-bronze moveable wiping contacts. The number of decks shall be as required to implement the switching action indicated on the Drawings and/or in the functional description of the controls.
- 1) MANUAL-AUTO selector switches shall be heavy-duty, oil-tight type switches with maintained contacts.
- 2) Pushbutton switches shall be heavy-duty, oil-tight switches with momentary contacts.
- 3) Acceptable Manufacturers:
- i) General Electric Series CR2940,
 - ii) Allen Bradley
 - iii) Square D
 - iv) Engineer approved equal

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- r. Fuse Holders: Fuse holders for AC and DC instrument systems shall be Buss Snap-Lock Type HLD fuse holders or an Engineer approved equal.
 - 1) Each power supply, process instrument, and motor control circuit operating within the panel shall be individually-fused using terminal block fuse connectors installed per the manufacturer's recommendations.
 - 2) Provide spare fuses for each AC and DC circuit. Spare fuses shall be stored in a spare fuse cabinet located inside the panel enclosure near the fuse holder mounting brackets.
- s. Process Controllers: The process control and monitoring functions shall be provided by a programmable logic controller. The PLCs shall be used for the process monitoring and control at the locations shown on Plan Sheets. The programmable control system may be used for driving:
 - 1) Control loops
 - 2) Sequential controls
 - 3) Status and alarm lights and horns
 - 4) Digital displays of analog signals
 - 5) Non-resetting flow totalizer
 - i) Manual control for the equipment shall be independent of the programmable control system and wired so that a failure of the programmable control system will not limit the ability of the Operator to control the process.
 - ii) Programmable Logic Controller (PLC): The PLC furnished shall be designed for ladder logic control sequence programming using an open architecture software system. The PLC shall be equipped with input/output boards and terminal strips necessary for the control functions specified. The PLC the Madison South Water Tower shall be the Allen-Bradley MicroLogix 1400 or Engineer approved equal. The number of inputs and outputs shall be determined by the Control System Integrator and will be governed by the control functions required and the configuration of signals within the panel. The system shall be configured with a minimum of one (1) spare of each type of input and output. All spare I/O shall be wired to terminal blocks located within the enclosure.
 - a) The PLC's shall be rack mounted within the control panel. The controller and I/O boards shall include LED's for status indication and diagnostics. The PLC shall include multiple communication ports. One port shall be for communication with the input/output racks for the master control panel, one port shall be provided for connection of a personal computer system interface, and one port shall be provided for connection of the operator interface.
 - b) Control loops for the various processes shall be configurable from both a PLC program loading device and a personal computer. The control loop parameters shall be defined by preprogrammed control function blocks of a field proven design demonstrated to have been used successfully on systems of equal or greater complexity. Entry of configuration data for control blocks shall be through operator interface screens similar to spreadsheets and shall use descriptive text.
 - c) System input/output (I/O) capacity for the control addition shall be provided for the inputs and outputs listed in the plans plus 20% spare of each type. The (I/O) system shall be constructed using rack

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mounted modular I/O cards. Rack capacity furnished shall be greater than that required for the number of cards furnished, including spares. The rack capacity shall permit the addition of at least two (2) more cards of the types used in the system. System software shall permit an unlimited number of tags for system input signals

- t. Software: Work under this contract shall include provisions to purchase and install software to operate the control system. The following is general description of the software available/needed to completely integrate the control system
- 1) RSLogix 5000 or approved equal: The Control System Integrator shall provide one (1) license of the programming software needed to program the PLC's.
 - 2) RSLogix 500 or approved equal: The Control System Integrator shall provide one (1) license of the programming software needed to program the PLC's.
 - 3) FactoryTalk View Site Edition or approved equal: Control System Integrator shall provide one (1) copy of FactoryTalk View Site Edition for the developing and testing machine level HMI applications. This software shall be installed on the main personal computer used for the control system
- u. Operator Interface: Provide 6-inch NEMA 4 front panel mounted touch screen. OIT shall be Allen Bradley Panel View Plus 7 or engineer approved equal.
- v. Managed Power over Ethernet (PoE) Switch Interface
- 2) Managed Power over Ethernet (PoE) switch shall be capable of CAT-6 cable interface according to Plan Sheets.
 - i) 24VDC powered
 - 3) Acceptable Manufacturers:
 - i) N-TRON
 - ii) MOXA EDS Series
 - iii) Allen Bradley Stratix Series
 - iv) Hirschmann Spider Series
 - v) Or Engineer Approved Equal
- w. Spare Parts: All required spare parts shall be delivered to the Owner prior to final acceptance of the Work. The spare parts shall not be used as replacement parts during the warranty period. The Control System Supplier shall furnish the following spare parts for RTU-122:
- 1) PLC Parts,

vi) Power Supply	One (1)
vii) Analog Input Module	One (1) of Each Type
viii) Analog Output Module	One (1) of Each Type
ix) Discrete Input Module	One (1) of Each Type
x) Discrete Output Module	One (1) of Each Type
xi) Managed PoE Switch	One (1)
xii) UPS	One (1)
 - 2) 24 VDC Power Supply

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C. Telemetry System:

1. Description: This Work shall consist of performing all labor and furnishing all material to install the new radio telemetry systems for the Work shown on the project plans and specified in these sections. All antennas, mounting brackets, licenses, and other appurtenances and services necessary to furnish and install a complete and operable system in accordance with the plans and specifications shall be furnished as a part of this Contract.
 - a. The Integrator shall be responsible for integrating all the signals I/O points shown on the plans into the SCADA.
2. Major equipment, component, and software items are specified; however, the Contractor shall provide all appurtenant items necessary to achieve the required operation as hereinafter specified.
3. Antenna, Cable, Masts, and Poles:
 - a. Provide one (1) new antenna at the Madison South Tower, orientated towards the Madison Water Plant, that meets the following requirements:
 - 1) Enclosed Log Periodic Antenna for Wireless Data Transmission
 - i) Frequency Range: 800-1000 MHz appropriate to frequency of operation.
 - ii) Gain: 5 dBd
 - iii) Polarization: Vertical
 - iv) Bandwidth: 200 MHz
 - v) Front-to-Back Ratio: 25 dB
 - vi) Lightning Protection: Direct ground protection
 - vii) Wind Survival Rating: 165 mph with ½ radial ice.
 - viii) Connector: N-Female
 - ix) Mounting Hardware: Mount per manufacturer's recommendations for supplying a rigid connection.
 - x) Antenna Hardware Kits: All the aforementioned items should be supplied from the equipment provider in a complete, easy to use kit that provides all the necessary items to properly connect the antenna.
 - xi) Construction: Molded ABS, UV inhibited, and paintable radome cover on antenna.
 - b. Provide cable grounding, cable hanging, connectors, and all other apparatuses for complete, operable, and reliable cabling system.
 - c. Provide 1/2" foam dielectric heliax cable with solid center conductor at site as manufactured by Andrew CommScope model number LDF4-50A or approved equal for connection of the antenna to the radio transceiver. The transmission line shall be terminated only in connectors rated for the required service. A lightning arrester shall be placed between the transceiver and coaxial cable.
 - d. Provide straight coaxial connectors such as L4TNM-PSA Type N Male Positive Stop connectors as manufactured by Andrew CommScope or approved equal.
 - e. Provide Type TSX-NFF surge protection devices to protect radio components and 24VDC power supply from surges in the power supply to the radio.
 - f. Provide all masts, lightning suppressors, and any other apparatus required to assemble a complete, operable, and reliable fixed wireless data system.
 - g. Enclosed Log Periodic 800-1000 MHz antenna shall be manufactured by Sinclair model number SP440-SF2SNF or approved equal.

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- h. Antenna shall be installed on antenna mast on tower roof railing as directed by Engineer. Particular attention shall be given to the correct installation of the antenna to give adequate protection from nearby lightning strikes by providing a low resistance DC path to ground. Instructions for installing these antennas shall be given to the Contractor so as to insure reliable operation.
 - i. Contractor shall furnish all mounting masts or poles as required to support the antenna at the elevations and orientations required. Masts and poles shall be suitable for outdoor environmental conditions, provide adequate support and protection for transmission lines, and be provided complete with all necessary mounting accessories.
- 4. 900 MHz Spread Spectrum Ethernet Radio:
 - a. Provide one (1) new radio at the Madison South Tower
 - b. Radio specifications:
 - i) Transmit Power: 1 Watt at 6VDC to 30 VDC
 - ii) Interface: Ethernet RJ-45
 - iii) Modulation rates 125 kbps, 250 kbps, 500 kbps, 1000 kbps, 1250 kbps
 - iv) Relative Humidity: 95% at 40°C (104°F); non-condensing
 - v) Temperature: -30C to 60C
 - vi) Input Power: 10 to 30VDC, negative ground
 - vii) Agency Approval: FCC Part 15 approved
 - c. Provide Type IC1 SPD surge protection devices to protect radio components and 24VDC power supply from surges in the power supply to the radio.
 - d. Provide antenna surge suppressor manufactured by Polyphaser or approved equal and connect to coaxial cable as manufactured by Andrew CommScope or approved equal.
 - e. Provide all masts, supports, lightning protection, and other apparatus required to make a complete and operable radio system.
 - f. Acceptable Manufacturers:
 - i) GE MDS iNET 900
 - ii) No equals allowed.

PART 3 - EXECUTION

3.1 CONTROL SYSTEM

- A. General: In addition to the shop drawings and descriptive literature required by the General Requirements, the Control System Integrator shall provide complete system documentation necessary for installation, operation, and maintenance. The documentation shall be provided prior to shipment of hardware. The documentation shall include, but not necessarily be limited to, the following:
 - 1. General description of equipment.
 - 2. Panel front dimensional drawings.
 - 3. Panel mounted equipment location map.
 - 4. Software licenses and documentation identifying the Owner as the holder of the software license. Licenses shall be developer's licenses which permit the Owner to make additions and modifications to the system.

5. Wiring diagrams for panels and telemetry system.
 - a. Control system documentation listing the control system address for each and every analog and contact closure input and output in the system. Documentation must include an English language descriptor for each input and output and the scale for the analog inputs and outputs.
 - b. Control schematics including field wiring requirements and identification of terminal numbers for both the control panels and the field terminations.
6. Listing and description of routine maintenance, requirements and equipment necessary to perform required maintenance. (Include in O&M Manual only).
7. Specifications and descriptions of panel mounted hardware including lights, switches, annunciators, controllers, displays, and power supplies, etc.
8. List of spare parts provided.
9. System Test: Control panels shall be tested prior to delivery to the site. Testing procedures shall be developed by the equipment supplier and approved by the Engineer. Testing shall be open to observation by the Owner and Engineer upon request. The testing shall include, but not necessarily be limited to, the following:
 - a. 48-hour "burn-in" of all panel mounted hardware with no failures.
 - b. Testing of all analog and digital inputs using a signal generator.
 - c. Testing of analog and digital outputs using indicating devices to show output.
 - d. Testing of controllers: input, output, operator interface, and accuracy of control loop.
10. Installation and Startup: Control panels shall be installed under the direction of the Control System Integrator. Installation shall include, but not necessarily be limited to, setting equipment in place and connection of power and signal wiring. Power wiring shall consist of connecting 120 VAC circuits from distribution panels supplied by the Electrical Sub-Contractor. Connections shall be made to screw-type terminals. The Control System Integrator shall provide terminal to terminal interconnection drawings for all terminations between motor control cabinets and local control panels. The Electrical Sub-Contractor will install wiring between the process control panels and motor control centers and shall make wiring terminations in the motor control cabinets. The Control System Integrator will supervise and approve terminations in the process control and monitoring panels.
11. Equipment shall be delivered to the site in undamaged condition. Equipment shall be stored above ground and protected from the weather. Equipment shall be installed in strict accordance with manufacturer's recommendations, the Plans, and Specifications. The Control System Integrator shall supply all materials, labor, and appurtenances to provide a functional Process Instrumentation.
12. The control panels shall be installed at the locations shown on the Drawings or as directed by the owner. All panels shall be set plumb and level. After all field connections have been completed, close all openings to prevent debris from entering the panels. Seal all conduits with duct seal. Field connections of power and control wiring shall be made through terminal blocks.
13. The Control System Integrator shall provide at least one (1) day system start-up assistance by a team of factory-based engineering and programming personnel after installation and wiring is complete. During this start-up period, the personnel are to thoroughly check all equipment and repeat the factory acceptance test specified earlier.
14. Operational Training: Operator training for operation and maintenance of the process control panels shall be provided. The training shall include all instruction necessary to provide operating personnel the ability to perform all control functions, routine periodic maintenance, and light emergency maintenance on the system.
15. Operator training for operation, maintenance, and troubleshooting shall be provided. The training shall be conducted at the job site. At least two (2) individuals representing the Owner shall

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receive the training. The training sessions shall be a minimum of one (1) eight-hour day and shall include "hands-on" training on the system furnished under this Contract. The Owner reserves the right to videotape the training sessions for future reference.

16. The Control System Integrator shall provide:

- a. Programmable Logic Controller and RTU system documentation shall include three (3) copies of descriptions for all loops and the operator's manual describing procedures for routine adjustments to process control and communications loops. Description of control loops shall be copies of printout of the ladder logic diagram used for control with explanatory annotation.
- b. Two (2) printed copies of the entire documentation package shall be provided along with one (1) electronic copy. One of the hard copies shall be provided for use by the Operator. This copy shall be in loose leaf form bound in ring binders to facilitate modifications and additions. The manual shall detail steps required for operator interface with the process control system.

17. After successful completion of the control and telemetry system, but prior to final acceptance of the work, the Control System Integrator must submit to Owner and Engineer complete documentation of the ladder logic for each PLC in the system. Control System Integrator is to submit two (2) printed copies and one (1) electronic copy of program files (of the PLC software) prior to final completion.

3.2 TELEMETRY SYSTEM

B. General: Control System Integrator shall be responsible for making modifications to the existing radio telemetry system. Work included, but not limited to furnishing and installing new radios, antennas, and tower, radio and antenna replacement, and antenna realignment as described in the following paragraphs:

1. Install new antenna and radio at the new Madison South tower and seamlessly integrate new radio into existing telemetry system to allow for communication with the Madison WTP RTU radio.

3.3 SYSTEMS ACCEPTANCE

A. System acceptance shall be defined as that point in time when the complete system has passed the mutually defined field acceptance test and has performed as a functioning unit for 30 consecutive days without the loss of process control functions or process management functions. Loss of process control functions shall be defined as follows:

1. Loss of a process loop controller. Loss of the alarm annunciator subsystem.
2. Loss of process variable display and recording functions.
3. Loss of communication with SCADA system without automatic restart.
4. One (1) year warranty on the equipment begins upon successful completion of the field acceptance test.

3.4 INSTALLATION OF INSTRUMENTATION CONDUIT AND CABLES

A. Furnishing and installation of all conduits needed for instrumentation and control signals or any other instrumentation or control conduit shall be the responsibility of the Electrical Contractor. Furnishing and

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installation of the instrumentation or control wiring shown on the Plans shall be the responsibility of the General Contractor. General Contractor shall coordinate sub-contractors, including but not limited to the Electrical Contractor and Control System Integrator, to provide a fully functional control system. Control System Integrator shall supervise and authorize wiring connections in the process control and monitoring panels.

- B. Use bottom entry for all conduit entry to instruments and junction boxes.
- C. Install electrical components per Division 26.
- D. Panel-Mounted Instruments:
 - 1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
 - 2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

3.5 GRAPHICS DISPLAY OF THE DESKTOP COMPUTER AT THE MADISON WATER TREATMENT FACILITY

- A. The Control System Integrator shall modify the existing SCADA system software at the Madison Water Treatment Facilities so that new screens are developed graphically depicting the new South Water Tower and provide control, statuses, setpoints, and alarms consistent with that of the project plans. System Integrator shall work with the Owner so that the upgrades are consistent in appearance and function with existing SCADA components, provide so that alarm conditions are annunciated to the proper personnel, and provide data logging and reporting displays.

3.6 DISPLAY OF HMI (RTU-122)

- A. The Control System Integrator shall provide development of the Madison South Water Tower HMI so that the new screen is developed to provide control, statuses, setpoints, and alarms consistent with that of the project plans. System Integrator shall work with the Owner so that the upgrades are consistent in appearance and function with existing SCADA components, provide so that alarm conditions are annunciated to the proper personnel, and provide data logging and reporting displays.

3.7 FIELD QUALITY CONTROL

- A. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments.
 - 1. Documentation requirements include the utilization of the forms located at the end of this section.
 - a. Loop Checkout Sheet
 - b. Instrument Certification Sheet
 - c. Final Control Element Certification Sheet
- B. Instrumentation Calibration:

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1. Verify that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
2. Calibrate all field-mounted instruments, other than local pressure and temperature gauges, after the device is mounted in place to assure proper installed operation.
3. Calibrate in accordance with the manufacturer's specifications.
4. Bench calibrate pressure and temperature gauges. Field mount gauge within 1 day of calibration.
5. Check the calibration of each transmitter and gauge across its specified range at 0, 25, 50, 75, and 100 percent. Check for both increasing and decreasing input signals to detect hysteresis.
6. Replace any instrument which cannot be properly adjusted.
7. Stroke control valves to verify control action, positioned settings, and solenoid functions.
8. Mark range, date, setpoint and calibrator's initials on each instrument by means of blue or black ink on a waterproof tag affixed to the instrument.
9. Calibration equipment shall be certified by an independent agency with traceability to NIST. Certification shall be up-to-date. Use of equipment with expired certifications shall not be permitted.
10. Calibration equipment shall be at least three times more accurate as the device being calibrated.

C. Loop checkout requirements are as follows:

1. Check control signal generation, transmission, reception, and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections. Use actual signals where available. Closely observe controllers, recorders, alarm and trip units, remote setpoints, radio systems, and other control components. Make corrections as required. Following any corrections, retest the loop as before.
2. Stroke all control valves, cylinders, drives, and connecting linkages from the from the control room operator interface.
3. Check all interlocks to the maximum extent possible.
4. In addition to any other as-recorded documents, record all setpoint and calibration changes on all affected Contract Documents and turn over to the Owner.

D. Provide verification of system assembly, power, ground, and I/O tests.

E. Verify existence and measure adequacy of all grounds required for instrumentation and controls.

3.8 OPERATION AND MAINTENANCE MANUALS

- B. The Contractor shall furnish Operation and Maintenance Manuals for each instrument provided in accordance with Section 01 7823 – OPERATION AND MAINTENANCE DATA.

PART 4 - MEASUREMENT AND PAYMENT

4.1 INSTRUMENTATION AND CONTROLS

- A. The entire control system including all instrumentation equipment, control panels, wiring, relays, terminal blocks, power supplies, and other appurtenances, including the removal of existing control and process equipment required to complete the Work in accordance with the Drawings and Specifications shall be measured as a completed item of work. Payment shall be made as part of the lump sum Bid price, which price and payment shall be full compensation for furnishing all labor, materials, tools and

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equipment, and all other incidentals required to furnish a complete and operating controls system in accordance with the Drawings and Specifications.

END OF SECTION 40 0000

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