



August 13, 2020

**ADDENDUM NO. 1 TO SPECIFICATION NO. 1401S**  
**MVRWRF SOLIDS HANDLING MCC REPLACEMENT**

This addendum to the specifications is for the purpose of adding, clarifying, or deleting certain information to the construction drawings and project specifications as follows:

**SECTION 16482 – LOW VOLTAGE MOTOR CONTROL CENTERS**

*ADD* the following sentence to the end of Paragraph 2.01.K.1.b:

All terminal blocks shall be finger-safe.

**SECTION 17020 – CONTROL AND INFORMATION SYSTEM MODIFICATIONS AND INTEGRATION**

*REPLACE* Section 17020 in its entirety with the attached revised Section.

**MANDATORY PRE-BID WALK THROUGH**

A mandatory pre-bid walk-through meeting was conducted on August 5, 2020 at 9:00 a.m.

NOTE: Refer to EMWDs website to obtain the Pre-Bid Walk-Through Sign-In Sheet.

**QUESTIONS & ANSWERS**

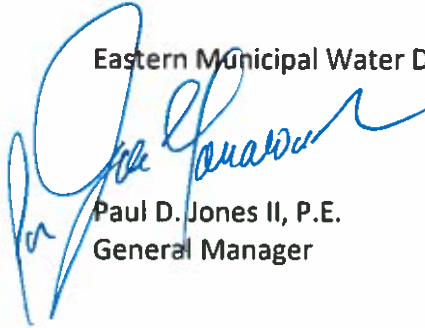
**Mass Electric**

Q1. Drawing “63E07” states conduits P-6304 and P-6310 are to connect to existing pull/junction boxes. Please clarify the location of these existing boxes as they are not currently shown on any of the plans.

A1. P-6304: Shows a new conduit between LP-DP4-M and an existing pull box. This pull box is located on the interior East wall of the MCC-4B room, towards the North-East corner of the room, within the DAF building.

P-6310: Shows a new conduit between DP-4 and a (new) junction box. Drawing 63E05 shows this junction box as new. This junction box shall intercept the existing conduit between MCC-4A and VCP-46.4060 in the vicinity above existing MCC-4A.

Eastern Municipal Water District



Paul D. Jones II, P.E.  
General Manager

PE: A.P.

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for DE: BXM

PDJ:AP:ta:ae

ATTACHMENT: Section 17020 - Control and Information System Modifications and Integration REV 1

SECTION 17020

CONTROL AND INFORMATION SYSTEM  
MODIFICATIONS AND INTEGRATION

PART 1 -- GENERAL

1.01 SCOPE

- A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor, all components, system installation services, as well as all required and specified ancillary services in connection with the Instrumentation, Control and Information System. The System includes all materials, labor, tools, fees, charges and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified. The system shall include all local control panels, digital hardware, interconnecting wiring and such accessories as shown, specified, and/or required to provide the functions indicated.
- B. The control system subcontractor is responsible for programming the new Inputs/Outputs (I/O) for the ventilation monitoring system, and MCC Power Monitors as outlined in Tables 1, 2, 3, and 4 in this section. This includes modifications to existing PLC and SCADA programming associated with the ventilation monitoring system I/O and MCC Power Monitors.
- C. The control system subcontractor is NOT responsible for any programming modifications associated with the replacement of MCC-6 or MCC-7, with the exception of programming modifications required to introduce data points from the new MCC Power Monitors to the SCADA Network. MCC-6 and MCC-7 shall have controls which replicate existing functionality. As such, control conductors shall be de-terminated from the MCC's and new control conductors shall be terminated to MCC-6 and MCC-7 as shown on the Contract Drawings with no programming modifications required.
- D. The scope of the work to be performed under this Division includes but is not limited to the following:
  - 1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein. The Contractor shall schedule and participate in integration services specific project meetings. Attendees shall include the Contractor, integration subcontractor and District Operations Staff.

2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.
  3. Furnish and install local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Division 17.
  4. Final termination and testing of all instrumentation and control system signal wiring and power supply wiring at equipment furnished under this Specification.
  5. Furnish and install surge protection devices for all local control panels including connections to grounding system(s) provided under Division 16.
  6. Coordinate grounding requirements with the electrical subcontractor for all local control panels. Terminate grounding system cables at all equipment provided under this Division.
  7. Provide system testing, calibration, training and startup services as specified herein and as required to make all systems fully operational.
- E. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

## 1.02 RELATED ITEMS

- A. Additional and related work performed under Division 16 includes the following:
1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for all equipment, control panels and accessories furnished under Division 17.
  2. Conduit and raceways for all instrumentation and control system signal wiring, grounding systems.
  3. Instrumentation and control system signal wiring.

4. Furnish and install grounding systems for all local control panels, provided under this Specification. Grounding systems shall be complete to the equipment provided under this Specification, ready for termination by the instrumentation subcontractor.
5. Termination of all instrumentation and control system signal wiring at all equipment furnished under other divisions of the Specifications.
6. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g. panelboards, motor control centers, and other sources of electrical power).

#### 1.03 GENERAL INFORMATION AND DESCRIPTION

- A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.
- B. In order to centralize responsibility, it is required that all equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating all signals, and furnishing all appurtenant equipment.
- C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment and/or systems and shall provide for the services of a qualified installation engineer to supervise all activities required to place the completed facility in stable operation under full digital control.

- D. Control system inputs and outputs are listed in the Input/Output Schedule. This information, together with the electrical control schematics, describes the real-time monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.
- E. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field-mounted equipment provided by others. The instrumentation subcontractor shall examine the electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the control and information system. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.
- F. The instrumentation subcontractor shall review and approve the size and routing of all instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.
- G. The Contractor shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.
- H. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.
- I. The Owner shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The instrumentation subcontractor and his equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.
- J. The terms "Instrumentation", "Instrumentation and Control System", and "Instrumentation, Control and Information System" shall hereinafter be defined as all equipment, labor, services and documents necessary to meet the intent of the Specifications.

#### 1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

- A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for wastewater treatment facilities. Instrumentation and control system subcontractors shall have a minimum of five years of such experience, and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers and/or models of major hardware or software products (PLC, HMI software, LAN, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term “completed” shall mean that a project has been brought to final completion and final payment has been made. Any instrumentation and control system subcontractor that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five calendar years shall not be acceptable.
  
- B. Acceptable instrumentation and control system subcontractor shall be Beavens Systems Inc., South Coast Automation Systems, or Trimax Systems Inc.

#### 1.05 DEFINITIONS

- A. Abbreviations: Specification abbreviations include the following:

AI	-	Analog Input
AO	-	Analog Output
CS	-	Control Strategy
DI	-	Discrete Input
DO	-	Discrete Output
DPDT	-	Double Pole, Double Throw
HMI	-	Human Machine Interface (Software)
I/O	-	Input/Output
NAI	-	Networked Analog Input
MCC	-	Motor Control Center
PAC	-	Programmable Automation Controller
PLC	-	Programmable Logic Controller
RNG	-	Running
RTU	-	Remote Telemetry Unit

- SPDT - Single Pole, Double Throw
- ST/SP - Start/Stop

- B. To minimize the number of characters in words used in textual descriptions on CRT displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

#### 1.06 ENVIRONMENTAL CONDITIONS

- A. Instrumentation equipment and enclosures shall be suitable for ambient conditions in which they are installed. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.
- B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).
- C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.
- D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

#### 1.07 EXISTING CONDITIONS / AS-BUILT DOCUMENTATION SUBMITTAL

- A. Prior to modifying, demolishing, removing, or decommissioning equipment, thoroughly investigate and document the existing conditions. Please note that Owner's record drawings alone are not sufficient for documentation. The record drawings, if present, shall be verified in the field prior to submitting. Submit drawings, markup, sketches, information, or other materials for documenting the following existing conditions:



1. All I/O on PLC modules that have its wiring modified or new I/O terminated or for any PLC that is being decommissioned/removed/demolished. Document module number, point number, wire numbers, terminal numbers, destination, and function.
  2. All wiring entering or leaving a PLC that is being decommissioned, removed, or demolished that is not otherwise accounted for.
- B. When all information has been gathered, it shall be submitted to Engineer along with a clear and unequivocal statement that the existing conditions have been documented and understood. Contractor shall be held responsible for all issues that arise due to Contractor's modifications, demolition, removal, or decommissioning of existing equipment, including necessary reversion back to previous conditions.

#### 1.08 SOFTWARE SUBMITTALS

##### A. Graphic Displays

1. Submit all graphic displays required to perform the control and operator interface functions specified herein. Submitted graphic displays shall be for both new and modified graphics.
2. Displays shall be printouts of actual process graphics implemented in the system.

#### 1.09 CONTROL PANEL SUBMITTALS

##### A. Submittals shall be provided for all control panels, and shall include:

1. Exterior panel drawings with front and side views, to scale.
2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.
3. Panel area reserved for cable access and conduit entry.
4. Location plans showing each panel in its assigned location.

##### B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:

1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
2. Catalog cuts, including complete part number breakdown information.

3. Complete technical, material and environmental specifications.
  4. Assembly drawings.
  5. Mounting requirements.
  6. Color samples.
  7. Nameplates.
  8. Environmental requirements during storage and operation.
- C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

#### 1.10 INSTRUMENT SUBMITTALS

- A. Submit information on all field instruments, including but not limited to the following:
1. Product (item) name and tag number used herein and on the Contract Drawings.
  2. Catalog cuts, including complete part number breakdown information.
  3. Manufacturer's complete model number.
  4. Location of the device.
  5. Input output characteristics.
  6. Range, size, and graduations.
  7. Physical size with dimensions, NEMA enclosure classification, and mounting details.
  8. Materials of construction of all enclosures, wetted parts and major components.
  9. Instrument or control device sizing calculations where applicable.
  10. Certified calibration data on all flow metering devices.
  11. Environmental requirements during storage and operation.
  12. Associated surge protection devices.
  13. Installation drawings/details.

#### 1.11 WIRING AND LOOP DIAGRAMS

- A. Submit interconnection wiring and loop diagrams for all panels and signals in the Control and Information System.
- B. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 X 17-inch reproducible prints.
- C. Loop drawings shall conform to the latest version of ISA Standards and Recommended Practices for Instrumentation and Control. Loop Drawings shall conform to ISA S5.4, Figures 1-3, Minimum Required.
- D. Loop drawings shall not be required as a separate document provided that the interconnecting wiring diagrams required in Paragraph B., above, contain all information required by ISA 5.4.
- E. Loop drawings and interconnect diagram native CAD files shall be provided.

#### 1.12 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall deliver equipment operation and maintenance manuals. Operation and maintenance (O&M) manuals shall consist of two basic parts:
  - 1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.
  - 2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.
- B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

- C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.
1. A comprehensive index.
  2. A functional description of the entire system, with references to drawings and instructions.
  3. A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.
  4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
  5. Full specifications on each item.
  6. Detailed service, maintenance, and operation instructions for each item supplied.
  7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
  8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.
  9. References to manufacturers' standard literature where applicable.
  10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.
- D. The operating instructions shall clearly describe the step by step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.

- E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.
- F. The hardware maintenance documentation shall include, as a minimum, the following information:
  - 1. Operation Information: This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment. Any changes to the equipment's default configuration shall be explicitly documented.
  - 2. Preventive Maintenance Instructions: These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.
  - 3. Corrective Maintenance Instructions: These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.
  - 4. Parts Information: This information shall include the identification of each replaceable or field repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross references between equipment numbers and manufacturer's part numbers shall be provided.
- G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:
  - 1. A program abstract that includes:
    - a. Program Name The symbolic alphanumeric program name.
    - b. Program Title English text identification.

- c. **Program Synopsis** A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by non-programming-oriented readers.
2. A program description that shall include, but not be limited to, the following:
    - a. **Applicable Documents** List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.
    - b. **Input Output** Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.
    - c. **Processing** This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.
    - d. **System Configuration** Describe in detail the system configuration or status required for program implementation, if appropriate.
    - e. **Limitations and Constraints** Summarize all known or anticipated limitations of the program, if appropriate.
    - f. **Storage** Define program storage requirements in terms of disk or RAM memory allocation.
    - g. **Verification** Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.

- h. **Diagnostics** Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.
- i. **Malfunction Procedures** Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.

#### 1.13 FINAL SYSTEM DOCUMENTATION

- A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.
- B. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected to describe final "as built" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance. All drawings shall be provided in native CAD format.
- C. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as built software configurations.
- D. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
- E. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.
- F. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.
- G. The Owner recognizes the fact that not all possible problems related to real time events, software interlocks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the instrumentation subcontractor through the Contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period.

All such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

#### 1.14 PROGRAMS AND SOURCE LISTINGS

- A. Provide one copy of all standard, off-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer.
- B. Provide one copy of source listings on digital media, acceptable to Engineer, for all custom software/logic written specifically for this facility, all database files configured for this facility, and all control strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.
- C. All software/logic shall be in both its native format and in Adobe Portable Document Format.

#### 1.15 SUBMITTAL/DOCUMENTATION FORMAT

- A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.
- B. All textual-type submittals and documentation shall be rendered and submitted in the latest version of Microsoft Word or in searchable Adobe Portable Document Format (PDF). Raster scans will not be accepted.

#### 1.16 ELECTRONIC O&M MANUALS

- A. Subject to acceptance by the Engineer, the O&M information may be submitted in part or in whole in an electronic format on digital media.
- B. Electronic O&M manuals shall contain information in standard formats (searchable Adobe PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible using standard, "off-the-shelf" software such as an Internet browser. Raster scans will not be accepted.

#### 1.17 GENERAL FIELD TESTING REQUIREMENTS

- A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:
  - 1. Primary elements such as transmitters and switch devices shall be calibrated and tested.



2. Each final control element shall be individually tested as specified hereinafter.
  3. Each control loop shall be tested as specified hereinafter.
  4. Each control strategy shall be tested under automatic digital control as specified hereinafter.
  5. The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.
- B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.
- C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.

#### 1.18 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.
- B. The Contractor shall be responsible for coordination of meetings with all affected trades.
- C. The Contractor shall ensure that the electrical subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.

- D. The Contractor shall ensure that the HVAC subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

#### 1.19 FINAL CONTROL ELEMENT TESTING

- A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.
- B. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

#### 1.20 LOOP CHECKOUT

- A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.
- B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.
- C. The accuracy of all DAC's shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.
- D. The accuracy of all ADC's shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.
- E. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

#### 1.21 CONTROL SYSTEM STARTUP AND TESTING

- A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.

- B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.
- C. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.
- D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.
- E. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for adjusting and testing all control loops as required to verify specified performance.
- F. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.
- G. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.
- H. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

#### 1.22 FACILITY STARTUP COORDINATION

- A. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.

- B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.
- C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.
- D. At least one qualified control systems technician shall be provided for control system startup and test activities

## PART 2 -- PRODUCTS

### 2.01 UNSHIELDED TWISTED PAIR CABLE

- A. Unshielded twisted pair cable for drops within buildings shall consist of 4 pair of 24 AWG copper conductors in a flame-retardant jacket. Cable shall be plenum rated (UL 910) and meet EIA/TIA-568 Category 6 specifications. Unshielded twisted pair cable shall be Hyper Grade Extended Distance cable as manufactured by Berk-Tek, Belden equivalent, or equal. Connectors shall be modular RJ-45 plug with strain relief.

### 2.02 DISCRETE INPUTS

- A. All discrete inputs to equipment and Control and Information System PLC's, from field devices, starters, panels, etc., shall be powered (wet) contacts in the field device or equipment, powered from the PLC's, unless specified otherwise.
- B. Sensing power (wetting voltage) supplied by the PLC shall be 120 VAC.

### 2.03 DISCRETE OUTPUTS

- A. All discrete outputs from Control and Information System PLC's shall be 24 VDC powered (sourced) from PLC's and shall be wired to 24 VDC interposing relays (located in local control panel or PLC cabinet). Interposing relay contacts shall be single pole double throw (SPDT) and rated for 120 VAC at 6 A.

#### 2.04 OTHER DISCRETE SIGNALS

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

#### 2.05 INPUT/OUTPUT SUBSYSTEMS

- A. Input/output hardware shall be plug-in modules in associated I/O backplane/chassis or DIN-rail mounting assemblies. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 20 percent spare I/O module space for the addition of future circuit cards or modules.
- B. Discrete inputs shall be 120 VAC signals (integral to the PLC) from dry field contacts. Discrete outputs shall be 24 VDC powered (sourced) from PLC's and shall be wired to 24 VDC interposing relays (located in local control panel or PLC cabinet). Interposing relay contacts shall be single pole double throw (SPDT) and rated for 120 VAC at 6 A as described in Section 17060 – Signal Coordination Requirements. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices.
- C. Maximum density for discrete I/O modules shall be 16 per input module and 16 per output module.
- D. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire.

- E. All input and output modules shall be wired to separate field terminal blocks. All field wiring shall be protect using a fused terminal block rated for a minimum of 2 A.

## 2.06 SOFTWARE REQUIREMENTS

- A. The Owner's existing SCADA (Human-Machine Interface or HMI) software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract.
- B. The Owner's existing control system shall be modified to include the inputs and outputs specified in the Input/Output Schedule and in this Section.

## 2.07 OVERALL SYSTEM CONFIGURATION

- A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the "look and feel" of the Owner's existing system. HMI software scope of work shall include but shall not be limited to the following:
  - 1. Create new graphic displays showing the new functions described herein complete with all associated equipment and instrumentation.
  - 2. Modify the existing plant overview display(s) for the SCADA system to include the new equipment, and create links to the new screens.
  - 3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.
  - 4. Modify existing reports to include the additional monitoring points specified under this Contract.
  - 5. Create new real-time and historical trends, and coordinate with the Owner appropriate grouping of the trend charts.
  - 6. Update the system status display to include new hardware provided under this Contract.

- B. Contractor shall schedule a minimum of one meeting with the Owner to review scope of work associated with HMI software modifications prior to first submittal. Contractor shall receive approval from Owner for HMI software modifications prior to performing any modifications to existing HMI.
- C. Ladder logic resident in existing PLCs shall be configured to perform the functions described as specified herein and in this Section. Specifically, the existing PLCs shall be programmed to accept the inputs specified in the Input/Output Schedule and to make this data readily available to the plant network, and shall be programmed to execute the logic necessary to implement all control functions associated with the scope of work specified under this Contract.
- D. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

**PART 3 -- CONTROL SYSTEM INPUT / OUTPUT SCHEDULE**

**Table 1- RTU-4/5 Input/Output Schedule**

Tag Number	Service Description	Type	State/Sp an	EGU	Type	Remarks
S32_FSL_63_560A	Exhaust Fan 561, Flow Switch	Low Flow	1	BOOL	DI	
S32_FSL_63_560B	Supply Fan 562, Flow Switch	Low Flow	1	BOOL	DI	

**Table 2- RTU-6 Input/Output Schedule**

Tag Number	Service Description	Type	State/Spa n	EGU	Typ e	Remark s
S32_EIT_78_0001	MCC- 6 Power Monitor	Voltage L-L	0-1,000	V	NAI	
S32_IIT_78_0001	MCC- 6 Power Monitor	Current Per Phase	0-1,000	A	NAI	
S32_W_78_0001	MCC- 6 Power Monitor	Watts	0-1,000	KW	NAI	
S32_EIIT_78_0001	MCC- 6 Power Monitor	VAR	0-1,000	KVA R	NAI	
S32_VA_78_0001	MCC- 6 Power Monitor	VA	0-1,000	KVA	NAI	
S32_PF_78_0001	MCC- 6 Power Monitor	PF	0.0-1.0	-	NAI	

Tag Number	Service Description	Type	State/Sp an	EGU	Type	Remarks
S32_FREQ_78_0001	MCC- 6 Power Monitor	Frequency	0-100	Hz	NAI	

**Table 3- RIO-7 Input/Output Schedule**

Tag Number	Service Description	Type	State/Sp an	EGU	Type	Remarks
S32_FSL_50_541A	Exhaust Fan 541, Flow Switch	Low Flow	1	BOOL	DI	
S32_FSL_50_541B	Supply Fan 541, Flow Switch 1	Low Flow	1	BOOL	DI	
S32_FSL_50_541C	Supply Fan 541, Flow Switch 2	Low Flow	1	BOOL	DI	
S32_EIT_50_0001	MCC- 7 Power Monitor	Voltage L-L	0-1,000	V	NAI	
S32_IIT_50_0001	MCC- 7 Power Monitor	Current Per Phase	0-1,000	A	NAI	
S32_W_50_0001	MCC- 7 Power Monitor	Watts	0-1,000	KW	NAI	
S32_EIIT_50_0001	MCC- 7 Power Monitor	VAR	0-1,000	KVAR	NAI	
S32_VA_50_0001	MCC- 7 Power Monitor	VA	0-1,000	KVA	NAI	
S32_PF_50_0001	MCC- 7 Power Monitor	PF	0.0-1.0	-	NAI	
S32_FREQ_50_0001	MCC- 7 Power Monitor	Frequency	0-100	Hz	NAI	

**Table 4- PLC-7 Input/Output Schedule**

Tag Number	Service Description	Type	State/Span	EGU	Type	Remarks
S32_FSL_72_0101_0102	Odor Control Fans, FAN-72.0101 & FAN-72.0102 Flow Switch	Low Flow	1	BOOL	DI	

Notes:

- Input/Output types are as follows:
  - DI - Discrete Input
  - NAI - Networked Analog Input



### PART 3 -- EXECUTION

#### 4.01 CLEANING

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

#### 4.02 FINAL ACCEPTANCE

- A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:
  - 1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.
  - 2. Completion of the Availability Demonstration.
  - 3. Completion of all specified control system training requirements.
  - 4. Completion of all punch-list items that are significant in the opinion of the Engineer.
- B. Final acceptance of the System shall mark the beginning of the extended warranty period.

- END OF SECTION -

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