

## SECTION 13300 INSTRUMENTATION AND CONTROLS, GENERAL REQUIREMENTS

### PART 1 GENERAL

#### 1.01 THE REQUIREMENT:

- A. The Contractor shall provide, through the services of a single Control System Integrator (CSI), all components and system installation services, as well as all required and specified ancillary services, whether reflected in the Contract Documents or not, in connection with the Instrumentation and Control System (ICS) as specified herein for a complete and operable system. The system shall include all materials, labor, tools, fees and documentation required to furnish, install, test and place into operation, a complete and operable ICS whether or not shown and/or specified within this section, related ICS specification sections, and subsections within equipment specifications. The system shall include all measuring elements, signal converters, transmitters, specialty cables, control panels, digital hardware and software, remote telemetry units (RTU), signal and data transmission systems, interconnecting wiring and such accessories as shown, specified and/or required to provide the functions indicated, whether specifically mentioned or not.
- B. The requirements provided within this section shall be applied to all of the Instrumentation and Controls specifications, Sections 13300 through 13330, as well as additional specifications sections as referenced. The ICS shall be provided as a single and complete system as specified herein and as specified within the following ICS specifications:
  - 1. Section 13310 - Instrumentation and Controls, Field Equipment
  - 2. Section 13320 - Instrumentation and Controls, Control Enclosures
  - 3. Section 13330 - Instrumentation and Controls, SCADA Equipment
  - 4. Section 13340 - Instrumentation and Controls, DFS RTU Equipment
- C. For the purposes of these specifications the Control System Integrator shall be referred to as the CSI. Where references are made to the SCADA System Programmer or the SSP, it shall be understood that CSI will not be providing that work under this Contract. Although the SSP will provide programming services outside of this Contract, that in no way relieves the CSI from providing all materials, labor, documentation, etc., including coordination, programming, startup, and testing services as necessary to ensure the complete system is fully capable of providing all specified functions, whether provided by the CSI or programmed by the SSP. Additional clarifications of responsibilities are provided herein and within related ICS specifications, as it pertains to the relationship between the CSI and the SSP.
- D. The Contractor shall be ultimately responsible for installation of the ICS. However, the CSI will include installation within the scope of the subcontract to provide for furnishing and installation of the complete system as specified. The CSI shall also coordinate this work with the Contractor to ensure that the proper type, size and number of wires with their conduits are provided and installed. This coordination will also ensure that proper electrical power circuits are provided for all components and systems.

- E. The Contractor's responsibilities, as distinct from the CSI's responsibilities, shall be to provide all additional materials and work necessary to supplement the materials and work provided by the CSI, thereby satisfying all requirements that are within ICS specification sections.
- F. The Contractor shall coordinate structural work, penetrations, painting, etc., as required for installation of a complete ICS. In-line or integrally mounted items (such as flow elements, level sensors, etc.) shall be installed under the supervision of the CSI.
- G. The Contractor shall be responsible for coordinating interfaces between ICS equipment provided under the ICS specification sections and the equipment provided under other sections of the specifications. The Contractor shall verify and coordinate space requirements, process equipment power supply and voltage, process equipment control power supply and voltage, compatibility of control signals, details of equipment installation and interconnection. Coordination shall include distribution of approved shop drawings to all vendors, subcontractors, etc., involved in the control interface. Likewise, the Contractor shall ensure that instrumentation and control devices provided under other sections of the specifications are compatible and of the same quality and characteristics as similar devices specified under the ICS specification sections.

## 1.02 SCOPE:

- A. The scope listed within this subsection pertains to major items of supply. Refer to the complete Contract Documents for additional requirements. For additional clarification of scope refer to related specification sections.
- B. This project shall provide for expanded monitoring and control of the Manatee County Master Reuse System (MCMRS) along with centralized management of the expanded system. Components of the project shall include the following:
  - 1. Two (2) new pressure monitoring sites
  - 2. Modifications to the three (3) existing reuse water booster stations
  - 3. Modifications to three (3) existing wastewater collection sites for reuse water pressure monitoring
  - 4. Modifications to eight (8) existing reuse water sites to add remote flow monitoring
  - 5. The addition of a plant water booster station at each of the North, Southeast and Southwest WRFs.
- C. This project will include and provide additions, upgrades and modifications to the SCADA System and existing ICS at each of the MCMRS booster stations and the existing SEWRF maintenance building.
- D. New Dataflow Systems solar powered standalone RTUs along with a pressure transmitter connected to the reuse distribution piping shall be provided at two (2) new remote sites to monitor the reuse system pressure as described herein and shown on the contract drawings.
- E. Modifications to the existing booster stations will include the replacement of non-functioning equipment, calibration of new and existing instrumentation, replacement and upgrade of the local operator interfaces, complete I/O signal testing over replaced field wiring and modifications to existing control panels to support new signals, as noted herein and shown on the contract drawings.

- F. Modifications to the existing wastewater collection sites will monitor the reuse system pressure with the addition of a pressure transmitter connected to the reuse distribution piping, as shown on contract drawings, using the existing Dataflow Systems Remote Terminal Unit (RTU) system, upgraded for the expanded capability. See contract drawings for specific requirements.
- G. Modifications to the existing reuse water stations will upgrade the existing flow meters to transmit the flow signal and connect to the existing Dataflow Systems RTU, upgraded for the expanded capability. See contract drawings for specific requirements.
- H. Site antenna alignments for the reclaimed water booster stations shall be verified and adjusted using the azimuth values provided herein.
1. Rye Road Pump Station: 323 degrees
  2. Spenser Parrish Pump Station: 271 degrees
  3. 63<sup>rd</sup> St. Pump Station: 56 degrees
- I. For the existing reuse water station radios listed above, the SEWRF and NWRF Access Point radios shall be upgraded to the latest firmware revision level as part of this project. Note: existing remote site and access point radios firmware shall match the spare being provided as part of this project.
- J. WRF Plant Water Booster Pump Stations will include the addition of VFD controlled pump stations with discharge pressure transmitters and discharge flow transmitter (SEWRF only). Modifications to existing plant SCADA control panels will be provided to support new I/O signals as noted herein and in the contract drawings. A new SCADA control panel and communications link will be provided for the NWRF Booster Pump Station. The existing SCADA control panels SP-13 at SWWRF will be relocated and modified as noted herein and in the contract drawings. The magnetic flow meter and pressure transmitter at SWWRF will also be relocated and calibrated.
- K. The existing master lift station Hyper Server located at SWWRF shall be updated and partitioned so information can be retrieved from the Dataflow system to the County's existing Programmable Logic Controllers (PLC) and Vijeo Citect Human Machine Interface (HMI).
- L. New computer workstations will be provided by OWNER unless noted otherwise herein. Monitors, accessories and software shall be provided as noted to centrally monitor and control the reuse system from the SEWRF maintenance building.
- M. The following additional major items of supply shall be provided:
1. Furnish and install instrumentation as specified.
  2. Furnish TVSS for instrumentation and control panels as specified. As noted herein, furnish and replace existing TVSS.
  3. Furnish and install new equipment to provide all specified SCADA Input/Output signals and functional requirements.
  4. Furnish and install/replace existing operator interfaces.

5. Provide, install and configure all SCADA software packages specified and as needed to complete the requirements noted herein.
6. Spare parts as described herein.
7. Training of Owner personnel.
8. Operations and Maintenance Manuals including updated drawings to reflect site modifications.

### **1.03 RELATED WORK SPECIFIED ELSEWHERE:**

#### **A. Division 16 - Electrical**

1. Where electrical subcomponents are to be provided as part of ICS equipment, but for which there is no specification, provide in accordance with Division 16 - Electrical. These subcomponents shall be compatible and of the same quality and characteristics as similar devices specified under Division 16 - Electrical. If possible the same make and/or model supplied under Division 16 shall be provided.
2. The following work shall be provided under Division 16 - Electrical:
  - a) Conduit, raceways and installation of wire and cable for all instrumentation and control system signal wiring, grounding systems, special cables and network cables except as noted.
  - b) Instrumentation and control system signal field wire.
  - c) Final wire preparation and termination of field wires to ICS equipment as directed by the CSI.
  - d) Grounding systems for all ICS equipment.
  - e) Mounting of ICS electrical enclosures (i.e. control panels, TVSS boxes, electronic instrumentation, etc.) with exclusion of final measuring elements of instrumentation (i.e. flow tubes, sensors in process piping, etc.) which shall be as coordinated by the Contractor.
3. The CSI shall provide all termination information for the ICS equipment, to support equipment terminations provided under Division 16. This information shall be provided within ten (10) days of ICS equipment arrival onsite or as required by the project schedule. The information shall be in the form of drawings and termination lists, showing complete termination information (to/from panels, terminal numbers, terminal block locations, signal types, voltages, etc.).

### **1.04 CODES AND STANDARDS:**

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

- B. The Instrumentation and Control System shall comply with the following codes and standards as well as any others within the specifications and drawings. In the event of any conflict between these codes, regulations, standards and Contract Documents, the most restrictive shall apply.
1. Applicable state, county and municipal code requirements.
  2. Applicable standards of the National Fire Protection Association (NFPA)
    - a) National Electrical Code (NEC).
  3. Applicable standards of the Underwriter's Laboratories, Inc. (U.L.)
    - a) UL 508 Industrial Control Equipment
    - b) UL 508A Industrial Control Panels
    - c) UL 698 Industrial Control Equipment for Use in Hazardous Locations
  4. Applicable standards of the Institute of Electrical and Electronics Engineers (IEEE)
  5. Applicable standards of the National Electrical Manufacturers Association (NEMA)
    - a) NEMA 250 Enclosures for Electrical Equipment (1000 V Maximum)
    - b) NEMA ICS 1 Industrial Control and Systems: General Requirements
    - c) NEMA ICS 6 Enclosures for Industrial Control and Systems
  6. Applicable standards of the International Society of Automation (ISA)
    - a) S5.1 Instrumentation Symbols and Identification
    - b) S5.4 Instrument Loop Diagrams
    - c) S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves
    - d) TR20.00.01 Specification Forms for Process Measurement and Control Instruments

**1.05 SUBMITTALS:**

- A. All shop drawings shall be in accordance with Section 01340 - Shop Drawings, Project Data and Samples. In addition to the requirements set forth in Section 01340 - Shop Drawings, Project Data and Samples, the following additional submittal requirements included herein shall apply.
- B. Every submittal shall have a separate section entitled "Requested Deviations from ICS Specifications" which shall clearly define and explain all requested deviations and exceptions of the Instrumentation and Control System to this Specification. Only those deviations requests listed in this section will be reviewed by the Engineer.

- C. After all changes or corrections resulting from the Engineer's review of the system supplier's drawings have been made, panels may be built and instrumentation devices may be supplied in accordance with the approved drawings. One set of 'As Shipped' prints shall be included in the panels when shipped from the system supplier's wiring and assembly shop.
- D. The following major list of submittals shall be provided as a minimum. Major submittals are generally listed in the order they are to be provided. Refer to related ICS specification sections and equipment subsections for additional submittals and submittal requirements.
1. Preliminary Design Review/Project Plan
  2. Process Field Instrumentation
  3. SCADA System Control Panel Modifications
  4. SCADA System Hardware and Software
  5. Preliminary Operation and Maintenance Manuals
  6. Training
  7. Testing Submittal
  8. Tools, Supplies and Spare Parts
  9. Site Installation/Startup Plan
  10. Final Operation and Maintenance Manuals
- E. Preliminary Design Review/Project Plan Submittal
1. The Project Plan shall provide an overview of the proposed system including system architecture diagrams, the approach to work, the proposed work schedule indicating milestones and potential meetings, project personnel and organization, details of factory testing and field testing, details of training programs, and a paragraph by paragraph review of the specifications indicating any proposed deviations. The schedule shall illustrate all major project milestones including the following:
    - a) Schedule for all subsequent project submittals.
    - b) Tentative dates for all project design review meetings.
    - c) Schedule of manufacture and staging of all instrumentation and control system equipment.
    - d) Schedule for all testing.
    - e) Schedule for shipment of all instrumentation and control system equipment and peripheral devices.
    - f) Schedule for equipment start up.
    - g) Schedule for all training.
  2. The Project Plan submittal will be followed by an ICS project kickoff meeting which will be a discussion of the Project Plan Submittal concerns and issues. This meeting will be scheduled a

minimum of two weeks following delivery of the submittal. No other submittals will be allowed prior to acceptance of the Project Plan.

F. Process Field Instrumentation Submittal

1. This submittal shall provide complete documentation of all field instruments and other instrument and control equipment not specified to be submitted elsewhere.
  - a) Provide data sheets for each component listing all model numbers, optional and ancillary devices that are being provided.

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

- 1) Plant Equipment Number and ISA tag number per the Loop Diagrams.
  - 2) Product (item) name used herein and on the Contract Drawings.
  - 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, enclosure NEMA classification and mounting details.
  - 8) Materials of construction of all components.
  - 9) Instrument or control device sizing calculations where applicable.
  - 10) Certified calibration data on all flow metering devices.
- b) Provide equipment specification sheets which shall fully describe the device including the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:
  - 1) Dimension, rigid clearances.
  - 2) Mounting or installation details.
  - 3) Connection.
  - 4) Electrical power or air requirements.
  - 5) Materials of construction.
  - 6) Environmental characteristics.
  - 7) Performance characteristics.

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

G. SCADA System Control Panel and Modifications Submittal

- 1. This submittal shall provide complete documentation of the proposed hardware (control panels, PLCs, peripherals, etc.) including:

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

The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communication links.

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

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

- 1) Equipment Number and ISA tag number per the Loop Diagrams (as applicable).
  - 2) Product (item) name used herein and on the Contract Drawings.
  - 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, enclosure NEMA classification and mounting details.
  - 8) Materials of construction of all components.
  - 9) Power supply device sizing calculations where applicable.
- c) Equipment specification sheets shall fully describe the device, the intended function, how it operates and its physical



environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:

- 1) Dimensions and working clearances.
  - 2) Mounting or installation details.
  - 3) Connection diagrams.
  - 4) Electrical power requirements (volts, amps).
  - 5) Materials of construction.
  - 6) Environmental characteristics.
  - 7) Performance characteristics.
- d) Provide detailed loop diagrams on a single 11-in x 17-in or 8.5-in x 11-in sheet for each monitoring or control loop. The loop diagram shall show all analog, digital and discrete components of the loop, including all relays, switches, dropping resistors, etc. which are being provided for proper operation. Loop numbers used shall correspond to the loop numbers indicated in the Contract Documents. The format shall be the International Society of Automation, Standard for Instrument Loop Diagrams, ISA-S5.4 plus the following requirements:
- 1) On each diagram, present a tabular summary of (1) the output capability of the transmitting instrument, (2) the input impedance of each receiving instrument, (3) an estimate of the loop wiring impedance based on wire sizes and approximate length used, (4) the total loop impedance, (5) reserve output capacity.
  - 2) Show all interconnecting wiring between equipment, panels, terminal junction boxes and field mounted components. The diagrams shall show all components and panel terminal board identification numbers and all wire numbers. This diagram shall include all intermediate terminations between field elements and panels (e.g. terminal junction boxes). The diagrams shall be coordinated with the electrical contractor and shall bear his mark showing this has been done.
  - 3) Show location of all devices.
  - 4) Show instrument description including type, manufacturer, model number, range, set points and operation (e.g. fail open, open on energization, normally closed, etc.) as applicable.
  - 5) Show all instrument loop power or instrument air requirements back to termination on terminal block or bulkhead, fuse block (including fuse size), etc., as applicable.
- e) Provide detailed drawings covering control panel consoles and/or enclosures which shall include:

- 1) Cabinet assembly and layout drawings to scale. These shall include both front, rear (where applicable) and interior layouts.
  - 2) Material, fabrication and painting specifications.
  - 3) Color selection samples for selection by the Engineer.
  - 4) Where graphic display panels are required, submit detailed layout to scale, including symbols and line widths, as well as color selection samples and details of fabrication. Half-scale layout will be acceptable.
  - 5) Panel wiring diagrams showing all power connections to equipment within and on the panel, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes and grounding. This wiring diagram shall be in ladder format and shall reference the appropriate loop drawing for continuations or details where required. Show all wire numbers and terminal block designations.
- f) The SCADA submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards, and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

#### H. SCADA System Hardware and Software Submittal

1. Software submittals shall include the following as a minimum:
  - a) Bill of materials with hardware components, software names, vendors and complete listings of included software modules.
  - b) Standard manufacturer's literature describing the products.
  - c) Description of function of software in ICS System.
  - d) Software features, limitations and constraints of software.
  - e) Minimum system (processor and memory) requirements.
2. Submit information on the following software, where applicable:
  - a) Operator Interface (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).
  - b) Control software (block oriented and/or ladder logic).
  - c) Office-type products, such as spreadsheets, word processors, etc.
  - d) Database management software.
  - e) Communications software, including all applicable local and wide area network software.
  - f) Programmable logic controller programming software.

g) Software configuration, including:

- 1) Graphic display organization.
- 2) Database configuration for real-time, historical, etc. databases.
- 3) Trends.
- 4) System security.
- 5) Formats for all reports, including all required calculations.
- 6) Intercommunications between software products required to implement system functions.
- 7) Equipment backup configuration and requirements.

I. Training Submittals

1. Training Plan Submittal: The training plan shall include:
  - a) Definitions of each course with necessary pre-requisites.
  - b) Specific course attendance.
  - c) Schedule of training courses including dates, duration and locations of each class.
  - d) Résumés of the instructors who will actually conduct the training.

J. Testing Submittals

1. Three levels of system testing shall be required: Unwitnessed Factory Testing, Operational Readiness Testing and Performance Acceptance Testing.
2. Test plans shall be submitted only after all hardware submittals have been approved by the Owner and/or Engineer.
3. The test plan shall demonstrate that the CSI has designed and configured a system that meets the design specifications. The documents for the test plan shall be structured so that the Owner understands what the inputs are, what the predicted outputs should be, and what the actual outputs are. The test plan should have sign-off and date block for the CSI, the Contractor and the Owner.
4. The complete test plan should include but not be limited to the following:
  - a) Test assumptions and methods
  - b) Test Equipment List
  - c) Test Personnel Staffing and Qualifications
  - d) Test Schedule with time allotted for each task
  - e) System hardware and software summary.

- f) Communications test to the various PLCs for Discrete and Analog I/O data transfer.
  - g) One hundred percent (100%) I/O point test including all spare points based upon the previously submitted System I/O list.
  - h) Functional and Control strategy tests.
- 5. Test Procedures: Submit the procedures proposed to be followed during the test. Procedures shall include test descriptions, forms and checklists to be used to control and document the required tests. Testing may not be started until all Testing Submittals have been approved.
- 6. Test Documentation: Submit a copy of the signed off test procedures upon completion of each required test.

K. Tools, Supplies and Spare Parts Lists Submittal

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

L. Operation and Maintenance Manuals

- 1. Prior to installation of any equipment onsite, preliminary O&M manuals shall have been submitted and approved. No installation of equipment shall be permitted without the Contractor maintaining an updated version of these preliminary O&M manuals onsite for the Owner's and Engineer's use.
- 2. After all field changes or corrections made during installation and field check out have been completed, all system supplier documentation, including drawings, shall be revised to reflect the "as installed, corrected and accepted" condition of the system and final record copies of O&M manuals for the system shall be provided to the Owner and Engineer for approval.
- 3. Final system documentation shall be provided in 3-hole type binders of archival quality (e.g. slant D or elliptical binding, vinyl with metal hinge or extra heavy weight vinyl, etc.) with a binding no larger than 3". Materials shall be printed on 8.5" x 11" or 11" x 17" tear resistant paper or ring reinforced paper where tear resistant is not available.

Drawings shall be either folded to fit within an 8.5" x 11" binder or in an 11" x 17" 3-hole binder. Each binder shall include fifteen percent (15%) spare space for the addition of future material. Tear resistant paper shall be Xerox Never Tear or equal.

4. Where electronic documentation is available, either by purchase through the manufacture or via Internet download, it shall be organized and provided on CD. All CAD drawings and word processing documents prepared by the CSI or one of their subcontractors shall be organized and provided on CD. Electronic documentation formats shall be Adobe PDF, AutoCAD, Microsoft Office documents, HTML, or as approved by the Engineer or Owner.
5. All electronic media (i.e. software, electronic documentation, configuration files/reports, device backups, etc.) shall be provided with two (2) backup copies, each organized into a separate binder. Media storage binders shall include but not be limited to the following:
  - a) Table of contents
  - b) Archival media holders (e.g. CD, DVD, floppy, tape disk, etc.)
  - c) Support contacts (i.e. company, phone, internet link, etc.)
  - d) Software system requirements and installation instructions
6. Laminated water/tear resistant copies of all applicable instrumentation and control system drawings shall be supplied in drawing pocket of each control enclosure after "as installed, corrected, and accepted" revisions have been made to the enclosure.
7. Operation and Maintenance manuals shall include but not be limited to the following:
  - a) Manufacturer standard O&M manuals for all equipment and software furnished.
  - b) Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.
  - c) The manuals shall contain all illustrations, detailed drawings, wiring diagrams and instructions necessary for installing, operating and maintaining the equipment.
  - d) All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable.
  - e) A functional description of the entire system, with references to drawings and instructions.
  - f) A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.

- g) A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.
- h) Full specifications on each item.
- i) Detailed service, maintenance and operation instructions for each item supplied.
- j) Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
- k) Complete parts lists with stock numbers and name, address and telephone number of the local supplier.
- l) References to manufacturers' standard literature where applicable.
- m) Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.
- n) 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.
- o) 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.

## 1.06

### MEETINGS:

- A. The Contractor shall be required to give the Owner, the Engineer and their representatives, at least three (3) weeks notice prior to any scheduled meetings. The notice may be shortened with Owner's and Engineer's consent.
- B. Preliminary Design Review Meeting: A preliminary design review meeting shall be conducted by the Contractor for the Owner and Engineer, to ensure design compliance, installation strategies and proper coordination between responsible subcontractors related to the ICS. The Contractor shall be responsible for arranging the on-site meeting no later than sixty (60) days after notice to proceed. The Contractor shall arrange for detailed meeting minutes to be recorded, approved and distributed to meeting attendees. Two (2) weeks prior to the meeting the Contractor shall submit the following for approval:
  - 1. A proposed list of meeting attendees including organization and phone number.
  - 2. A proposed meeting agenda.

3. A list of personnel to be involved in the project including their responsibilities, qualifications and phone numbers.
4. An overall system description.
5. An overall system block diagram.
6. A description of all numbering, lettering, color and format conventions that will be used including examples of loop drawings, interconnection diagrams, schematic diagrams, documentation table of contents, etc.
7. A project schedule and implementation plan that coordinates the ICS installation with the installation of the entire site project.

C. Preliminary Site Testing Meeting: A preliminary site testing meeting shall be conducted by the Contractor for the Owner and Engineer, to ensure site readiness, testing strategies and proper coordination between parties related or involved in testing the ICS. The Contractor shall be responsible for arranging the on-site meeting after the Site Testing Plan has been approved and no earlier than three (3) weeks prior to testing. The Engineer must be satisfied that the site is ready and that the testing will be performed to their satisfaction prior to any documented ICS testing being performed. The Contractor shall arrange for detailed meeting minutes to be recorded, approved and distributed to meeting attendees. Additional meetings may be required at the discretion of the Owner and Engineer to resolve specific action items not addressed in the preliminary site testing meeting. Two (2) weeks prior to the meeting the Contractor shall submit the following for approval:

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

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

#### 1.07 CONTROL SYSTEM INTEGRATOR:

- A. The Control System Integrator shall be regularly engaged in the detailed design, fabrication, installation and startup of instrumentation and control systems for water and wastewater treatment facilities in the state of Florida. Any CSI that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five (5) calendar years shall not be acceptable.
- B. Where specific manufacturers and/or models of major hardware or software products (PLC, software, network equipment, wireless equipment, etc.) are

specified to be used on this project, the CSI shall have completed at least one (1) 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.

- C. Control System Integrators shall meet the following minimum qualifications:
1. A minimum of seven (7) years experience with at least five (5) years in water / wastewater projects
  2. References for three (3) completed projects of like size and application to the project specified herein
  3. Project bonding capacity of two million dollars (\$2,000,000)
  4. UL 508 certified control panel manufacturing shop
  5. On staff licensed professional engineer registered in the state of Florida, if required to perform engineering services as specified to implement this project.
- D. The listing of acceptable Control System Integrators in this specification in no way relieves the Control System Integrator from meeting the qualifications specified herein. Acceptable Control System Integrators shall be as follows:
1. Revere Control Systems: 3810 Drane Field Road, Suite 16, Lakeland, FL 33811; (205) 824-0004; [www.reverecontrol.com](http://www.reverecontrol.com)
  2. Curry Controls Company: 1019 Pipkin Road, Lakeland, FL 33811, (863) 646-5781; [www.currycontrols.com](http://www.currycontrols.com)
  3. DCR Engineering: 502 CR 640 E.; Mulberry, FL 33860, (863) 428-8080; [www.dcreng.com](http://www.dcreng.com)
  4. Commerce Controls: 9216 Hollyridge Place, Tampa, FL 33637, 941-301-9991; [www.commercecontrols.com](http://www.commercecontrols.com)
- E. The Owner shall have the right of access to the CSI's facilities and the facilities of their equipment suppliers to inspect materials and parts, to witness inspections, tests and work in progress, and to examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The CSI and their equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

#### **1.08 QUALITY ASSURANCE:**

- A. The listing of specific products in this specification in no way relieves the Contractor of furnishing equipment which shall meet the performance and quality criteria specified herein.
- B. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.
- C. For uniformity, only one (1) manufacturer will be accepted for each type of product.



- D. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation and erection as well as during continuous or intermittent operation. Equipment shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.
- E. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble free service.
- F. Electronic equipment shall be suitable for the specified environmental conditions.
- G. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these specifications and drawings, shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

## 1.09 DEFINITIONS AND ABBREVIATIONS:

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

CSI.....Control System Integrator  
 ICS.....Instrumentation and Control System  
 OIT.....Operator Interface Terminal  
 HMI.....Human-Machine Interface  
 OWS.....Operator WorkStation  
 PID.....Proportional-Integral-Derivative Control  
 SCADA.....Supervisory Control and Data Acquisition  
 SSP.....SCADA System Programmer  
 TVSS.....Transient Voltage Surge Suppression  
 RTU.....Remote Telemetry Unit  
 PLC.....Programmable Logic Controller

## PART 2 PRODUCTS

### 2.01 GENERAL REQUIREMENTS:

- A. All materials, equipment and devices shall, as a minimum, meet the requirements of UL, where UL Standards are established for those items, and the requirements of NFPA-70. All items shall have the U.L. seal where possible

and all control panels shall be U.L. labeled. All items shall be new unless specified or indicated otherwise.

- B. Properly store, adequately protect and carefully handle equipment and materials to prevent damage before and during installation. Handle, store and protect equipment and materials in accordance with the manufacturer's recommendations. Replace all damaged or defective items.
- C. All equipment shall be the latest and proven design. Specifications and drawings call attention to certain features, but do not purport to cover all details entering into design of the instrumentation system. The completed system shall be compatible with functions required and the equipment furnished by the Contractor.
- D. All electrical components of the system shall operate on 120 volt, single phase, 60 Hz power source, except as otherwise noted in the Specifications. Drawings and Specifications indicate the energy sources that will be provided. Any other devices necessary to obtain proper operation of the instrumentation and control system from these energy sources shall be furnished with the system.
- E. All necessary fuses or switches required by the instrumentation manufacturer for his equipment shall be provided with the equipment. All instruments requiring internal power supply shall have internal on-off switches.
- F. The mechanical, process and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The CSI shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the ICS. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.
- G. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines and electrical equipment.
- H. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 °C; relative humidity forty to eighty percent (40% - 80%) 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).
- I. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 °C with relative humidity between forty and ninety-five percent (40% - 95%).
- J. 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 °C and relative humidity from ten to one hundred percent (10% - 100%). All supports, brackets and interconnecting hardware

shall be aluminum, 316 stainless steel, or as shown on the installation detail drawings.

## **2.02 TOOLS, SUPPLIES, AND SPARE PARTS:**

- A. Provide special tools, other than those normally found in an electronic technician's toolbox, required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance (i.e. connector pin insertion and removal tools, wire crimping tool, special wrenches, special instrument calibrators, indicator lamp insertion and removal tools, etc.).
- B. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for checking field operation of equipment supplied under this Section.
- C. The CSI shall provide supplies as needed or as required by the Owner during the specified warranty period. All fuses consumed during installation, testing, startup, the system availability demonstration, and the warranty period shall be replaced by the Contractor.
- D. Provide spare parts for items of ICS equipment as recommended by the manufacturer and in accordance with the Contract Documents.
- E. Furnish all spares in moisture-proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.
- F. Refer to individual product specifications for additional requirements specific to those devices.

## **2.03 SIGNAL TRANSMISSION:**

- A. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the ICS equipment.
- B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, the HVAC subcontractor and the CSI.
- C. The CSI shall provide 24 VDC power supplies for signals and instruments where applicable and as required inside control panels, etc. Where two-wire instruments transmit directly to the instrumentation and control system, the CSI shall provide power supplies at the PLC-equipped control panels for those instruments. Where four-wire instruments with on-board loop power supplies transmit directly to the instrumentation and control system, the CSI shall provide necessary signal isolators or shall otherwise isolate the input from the ICS loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator or single loop controller with integral loop power supply is included in the loop.

- D. Analog signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 mA and shall operate at 24 VDC. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels and appurtenances.
- E. Non-standard analog transmission systems such as pulse duration, pulse rate and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with non-standard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 mA signal prior to transmission to other devices.
- F. All discrete inputs to equipment and PLC's, from field devices, starters, panels, etc., shall be dry contacts in the field device or equipment, powered from the PLCs, unless specified otherwise. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC.
- G. All discrete outputs from local control panels and Instrumentation and Control System PLCs to field devices, starters, panels, etc., shall be 120 VAC / 28 VDC 5A dry contacts. Output contacts may be powered from the field equipment or powered from 24 VDC / 120 VAC sourced from PLCs cabinet power system, as required to interface with field equipment. Outputs to solenoid valves, horns, and strobe lights shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.
- H. Discrete signals between starters, panels, etc. where 120 VAC is utilized shall be clearly identified in the starter, panel, etc. as being powered from a different power supply, than other starter/panel components. Where applicable, warning signs shall be affixed inside the starter, panel, etc., stating that the panel is energized from multiple sources. Output contacts in the starter, panel, etc. which are powered from other locations shall be provided with special tags and/or color coding. Disconnecting terminal strips shall be provided for such contacts. The above requirements shall apply to all starters and panels, regardless of supplier.

## 2.04

### NAMEPLATES:

- A. All items of equipment listed in the instrument schedule, control panels and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the Engineer's approval.
- B. Control panel nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.

- C. Field mounted nameplates shall be engraved 316 stainless steel with 22 gauge minimum thickness.
- D. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless steel wire.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION:**

- A. The CSI shall provide the Contractor a periodic written report detailing progress of startup. This report shall include specific tabulations of devices on which startup has been completed.
- B. Equipment shall be located so that it is accessible for operation and maintenance. The CSI shall examine the Contract Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of ICS equipment.
- C. Instrumentation and Control System equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control work, and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- D. The CSI shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the CSI shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The CSI shall also investigate, and make any field modifications to, the allocated space for each cabinet, enclosure and panel, to assure proper space and access (front, rear, side).
- E. Two (2) complete sets of approved shop drawings shall be kept at the job site during all on-site construction. Both sets shall be identically marked up to reflect any modifications made during field installation or startup. All markings shall be verified and initialed by the Engineer or his designated representative. Following completion of installation and the operational readiness test, one (1) set of the marked up drawings shall be provided to the Engineer, the other retained by the CSI for incorporation of the mark-ups into final as-built documentation.
- F. All work shall be in strict accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the CSI shall bear full responsibility for such violations and assume all costs arising there from.

- G. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.
- H. The Contractor shall take steps to keep electrical and control enclosures clean and free of contaminants throughout installation. Cleaning after installation only is not acceptable. Under no circumstances are electrical and control enclosures to be cleaned using compressed air to blow out dust, causing contaminants to be forced into sensitive electronics.
- I. Provisions shall be made to completely capture filings (metal, etc.) when drilling into enclosures, to prevent contamination of electrical equipment.
- J. Upon completion of the instrumentation and control work, the Contractor shall thoroughly clean all soiled surfaces of installed equipment and materials and remove all surplus materials, rubbish and debris that has accumulated during the construction work. The entire area shall be left neat, clean and acceptable to the Owner.

### **3.02 WIRING AND GROUNDING:**

- A. The following wiring practice guidelines shall be used in order to minimize ground loops, to minimize electromagnetic interference/radio frequency interference (EMI/RFI) to this equipment, and to provide maximum practical immunity from damage resulting from lightning-induced transients.
- B. Common wires or conductors shall not be utilized (either within panels or external to panels or for grounding of field devices) for signal shield or signal grounding, and for safety grounds.
- C. Exposed wire lengths extending from within shielded signal cables shall be minimized to reduce pick-up of EMI/RFI by signal circuits. Exposed lengths of less than one inch are preferred, and a maximum exposed length of two inches may be permitted where necessary. No splicing of signal wires is permitted.
- D. All signal wiring shall be shielded, both within panels and external to panels. Unless otherwise specified, all signal wiring shall be No. 16 AWG stranded tinned two-conductor twisted pair, with one hundred percent (100%) coverage aluminized Mylar or aluminized polyester shield and tinned copper drain wire.
- E. Signal wiring within outdoor or indoor field device enclosures shall conform to the same requirements as panel wiring.
- F. The shield on each process instrumentation cable shall be continuous from source to destination, and grounded at one end only. In general, grounding of signal cable shields shall be done at the control panel end. The signal cable for no signal shall share a common cable shield grounding wire with the signal cable shield for any other signal, and shall not share a common grounding wire with any other circuit. The length of no signal cable shield grounding wire shall not exceed two (2) inches, with less than one (1) inch maximum length preferred.
- G. All outdoor instruments and all outdoor enclosures shall be grounded using the practice defined in Section 800.40 of the National Electric Code.

### 3.03

#### TESTING, GENERAL REQUIREMENTS:

- A. The CSI shall test all equipment hardware and software at the factory prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the CSI shall be tested at the factory as a single fully integrated system.
- B. The ENGINEER and the OWNER reserve the right to attend the factory acceptance testing in its entirety. Two (2) weeks notice shall be given prior to the start of testing.
- C. As a minimum, field testing shall include the following:
  - 1. Factory Acceptance Test (FAT).
  - 2. Operational Readiness Testing (ORT).
  - 3. System Acceptance Testing (SAT).
- D. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.
- E. All tests shall be conducted in accordance with prior Engineer approved procedures, forms and checklists. Each specific test to be performed shall be described and a space provided after it for sign off by the appropriate party after its satisfactory completion.
- F. Copies of these sign off test procedures, forms and checklists will constitute the required test documentation.
- G. Provide all special testing materials and equipment. It is intended to perform tests using actual process variables, equipment and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation. Define these simulations techniques in the test procedures, subject to the approval of the Owner and Engineer.
- H. The Contractor shall require the CSI to coordinate all of his testing with all affected Subcontractors and the Owner.
- I. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved test procedures.
- J. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.
- K. The CSI shall furnish the services of technicians, all special calibration and test equipment, and labor to perform the field tests.

### 3.04

#### FACTORY ACCEPTANCE TESTING (FAT)

- A. The entire system except for primary elements, final control elements, and field mounted transmitters, shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not

interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.

- B. All panels and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, specifications, and Contract Drawings.
- C. Factory acceptance testing shall take place over a contiguous time period after all factory fabrication has been completed.
- D. The test shall verify the functionality, performance, and stability of the hardware and software. The system must operate continually for 96 hours without failure before the test shall be judged successful. All deficiencies identified during testing shall be corrected and retested prior to the beginning this continuous operation test.
- E. Successful completion of this test, as determined by the ENGINEER, shall be the basis for approval of the system to be shipped to the site. No equipment shall be shipped until the ENGINEER has reviewed all test results, and approved the system as ready for shipment.
- F. The ENGINEER and the COUNTY reserve the right to attend the factory acceptance testing in its entirety. Two (2) weeks notice shall be given prior to the start of testing.

### **3.05 OPERATIONAL READINESS TESTING (ORT):**

- A. The entire system shall be certified (inspected, calibrated, tested and documented) that it is ready for operation. Each specified function shall be verified on a paragraph by paragraph and loop by loop basis.
- B. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or startup activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein, shall not relieve the Contractor of his responsibility for meeting all specified requirements.
- C. The CSI shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.
- D. Each instrument shall be calibrated at zero, twenty-five, fifty, seventy-five and one hundred percent (0%, 25%, 50%, 75% and 100%) of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Institute for Standards and Technology (NIST).



- E. The CSI shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.
- F. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.
- G. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to over-voltage, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.
- H. After completion of instrumentation installation and calibration, the CSI shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.
- I. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated and adjusted on a loop by loop and component by component basis to ensure that it is in conformance with related submittals and the Contract Documents.
  - 1. The Loop/Component Inspections and Tests shall be implemented using Engineer approved forms and check lists.
  - 2. The Contractor shall require the CSI to maintain the Loop Status Reports and Components Calibration sheets at the job-site and make them available to the Engineer/Owner at any time.
  - 3. These inspections and tests do not require witnessing. However, the Engineer will review and initial all Loop Status Sheets and Component Calibration Sheets and spot check their entries periodically and upon completion of the Operational Readiness Tests. Any deficiencies found shall be corrected.

### **3.06 SYSTEM ACCEPTANCE TEST (SAT):**

- A. Successful completion of the operational readiness test, as determined by the Engineer, shall be the basis for starting the witnessed system acceptance test. The Engineer shall approve the ORT test results and the Engineer and Owner shall be given two (2) weeks notice prior to the start of the System Acceptance Test.

- B. The system acceptance test shall repeat loop and functional testing done during the operational readiness test in order to demonstrate to the Owner and Engineer that the system has been started up, is operating, and is in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph by paragraph and loop by loop basis.
- C. The following documentation shall be made available to the Engineer during the test:
  - 1. All Contract Drawings and Specifications, addenda, and change orders.
  - 2. Master copy of the test procedure.
  - 3. One (1) copy of all O&M Manuals shall be made available to the Engineer at the job-site both before and during testing.
- D. Any malfunction during the tests shall be analyzed and corrections made by the CSI. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- E. After all functions have been tested and all corrections made, the system shall operate continuously for fifteen (15) days without failure before this test will be considered successful.
- F. The total availability of the system shall be greater than ninety-nine and one-half percent (99.5%) during this test period. Availability shall be defined as "Avail. = (Total Time-Down Time,) / Total Time x 100%". Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided, shall not contribute to the availability test times above.

### **3.07 TRAINING:**

- A. The CSI shall provide project specific classroom training at the Owner's site or designated location. Training shall be provided for the operation and maintenance of all equipment provided, as well as site specific installation configuration training for the system as a whole.
- B. Each student shall be provided with training materials. All training materials shall be provided in hardcopy as well as on a training CD, with all materials in Microsoft Office or Adobe PDF file format. When a large volume of training materials is to be provided (i.e. software documentation, etc.), only electronic copies need to be provided per Engineer's approval. When providing training materials as electronic copies only, the CSI must ensure that the training attendees will be able to use computers during the training to access information, whether provided by the Owner or not. All training CD's shall be updated with final configurations and resubmitted for approval. Final CD media shall be archival quality.
- C. Scheduling for the training sessions shall be specified by, and at the convenience of, the Owner. The CSI shall coordinate the scheduling, and shall provide written notice of available training dates, with a minimum of two (2) weeks prior notice. Candidates for training will be selected by the Owner.

- D. Operator training shall be provided to familiarize operators with the system as a whole and to instruct on the function and operation of each component of the system. Training shall consist of the day-to-day operation of the system and all other operator site specific functions for this project. Instruction shall include a site walkdown of installed equipment. Two (2) courses lasting a minimum of two (2) days, with six (6) hours of instruction per day, shall be provided by the CSI.
- E. Maintenance training shall be provided to maintenance personnel so that each component may be maintained without the assistance of outside organizations. The training shall be extensive so that after training, personnel shall be able to identify component malfunctions and repair components to the board replacement level. One (1) course lasting a minimum of three (3) days with six (6) hours of instruction per day shall be provided by the CSI.
- F. Under the scope of this project, the CSI will not be responsible for providing PLC and HMI control programming and logic. Specific training should therefore include, but not be limited to the following: system architecture and interconnection; wiring; fiber optic systems, including maintenance and repair; field panels and equipment; radio systems; and field instrumentation and PLC hardware, including maintenance and troubleshooting.
- G. Refer to related specification sections for additional training requirements.

### **3.08 WARRANTY:**

- A. During this warranty period, the CSI shall provide, at no additional cost to the Owner, the services of a trained, competent, field service engineer who shall arrive on site within thirty-six (36) hours of notification by the Owner or Engineer, to repair and/or replace any faulty device or equipment supplied by the system supplier as part of this Instrumentation and Control System.
- B. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed, and list materials used. A copy of all service reports shall be delivered to the Owner on or before the next business day.
- C. The CSI shall be capable of providing, after the warranty period for this system expires, a renewable service contract as specified in Section 01740 - Warranties and Bonds, whereby a trained, competent field service engineer shall arrive on site within thirty-six (36) hours of notification by the Owner. Information relative to charges for such service and availability of service shall be submitted to the Owner and the Engineer.
- D. Components shall be furnished to the manufacturer's standard for service intended, unless otherwise indicated in the Specifications or on the Contract Drawings.

**END OF SECTION**