TECHNICAL SPECIFICATIONS
PART 1 GENERAL

1.00 GENERAL

A. This section establishes a general summary of the “Scope of Work” covered under SCADA SYSTEM UPGRADE – PHASE 2. The summary of work covered in this section provides a general overview of the project requirements and is not intended as a detailed scope of work, equipment list or control description of the required functionality specified in the contract plans and specifications.

B. The Contractor shall be qualified to provide the equipment and services covered within the contract plans and specifications. Reference Section 16010 and 13300 for Contractor and Control System Supplier (CSS) qualification requirements. The Contractor shall submit their qualifications with the bid documents.

C. The project requires that the Contractor interface with, modify, wire, install equipment and commission systems on an operating control system. The Contractor shall coordinate with the Owner, and its representatives, all work effort involved in modifying, connecting to, replacing, relocating and decommissioning existing control systems.

D. The Contractor shall provide temporary monitoring and control during installation and switchover where station downtime will exceed 4 hours.

E. The Contractor shall include in its bid, the equipment, materials, and technical services to be provided by a qualified Control System Supplier (CSS).

F. The Contractor shall contract with CSS to provide for all instrumentation and control system services including the integration of the PLC and SCADA systems.

G. The project is broken out into four phases, with Phase 2A being the primary bid and the remaining phases; 2B, 2C and 2D being optional bid items.

H. The Contractor shall furnish and install all materials necessary to mount and interconnect the control systems specified.

1.01 SYSTEM OVERVIEW

A. The project is broken out into four phases, with Phase 2A being the primary bid and the remaining phases; 2B, 2C and 2D being optional bid items.

B. Determination of what Bid Items are to be included as a part of the Contract will be determined by the Owner based on available funding for project implementation.

C. Phase 2A is required for the SCADA system upgrade and will be awarded with any of the other Bid Items selected to provide for the overall SCADA system upgrade project.
1.02 PHASE 2A - SCADA System Upgrade (Bid Item #1)

A. The project consists of system modifications and upgrades to the Owner’s existing SCADA system. The general project scope covers the following areas:

1. Installation of new SCADA and Master Communications PLC hardware and software at the Wes Brown Water Treatment Plant.
2. Replacement of existing Motorola Moscad RTU’s with Modicon Momentum Based RTU control systems and instrumentation.
3. Replacement of existing radio antenna systems including coax cable, antennas, and antenna masts and mounting hardware.
4. Furnish and installing new RTU equipment and field instrumentation.
5. Furnishing and installing all materials, including but not necessarily limited to conduit, wire, boxes, terminations and supplemental materials to provide for a complete system installation.
6. Furnishing all technical services for submittals, field services, PLC programming, SCADA programming, testing and commissioning services.

B. PUMP STATIONS

1. Provide hardware and software modifications to existing Modicon Quantum and Momentum controllers located at the following sites:
   a. Zone 2/3 Pump Station – Radio, Configuration and Software Modifications
   b. Zone 3/3A Pump Station – Radio, Configuration and Software Modifications
   c. Zone 5 Pump Station – Modify the existing Allen Bradley, PLC to communicate with the local Momentum PLC via a serial Modbus communications network for SCADA monitoring and control. Provide firmware upgrade and program/configure a Modbus communications register set for read/write operation via Modbus connection to the SCADA system.
   d. Holly Pump Station – Furnish and install radio equipment and modify the PLC logic to support Modbus communications with the SCADA system.

C. Owner furnished sites

1. Owner furnished PLC equipment to be configured, programmed and tested by the Contractor. The Contractor shall assist the Owner with all testing and commissioning efforts to verify SCADA monitoring and control via the master PLC configuration. The following site RTU’s will be provided by the Owner for programming, configuration and testing by the Contractor:
   a. Site #1 – Fox Run
   b. Site #14 - North Glen PSA
c. Site #28 – 112th Metering Vault

d. Site #20 – Steele Street Meter

e. Storage Tank/Security Sites

1) The storage tank/security sites shall be programmed by the Contractor based on the standard tank site/security program furnished by the Owner.

2) The Contractor shall download the standard program; realign/rewire the I/O to match the standard I/O configuration.

3) The Contractor shall commission and test the PLC and SCADA system to verify SCADA communications and display.

4) The following sites shall be configured with the standard tank site program:

   a) Site #2 – South 5MG Tank
   b) Site #6 – Zone 5, 102 Elevated Tank
   c) Site #16 – Cherokee 4MG Tank
   d) Site #17 – 85th Avenue Elevated Tank
   e) Site #18 – Western Hills 3MG Tank
   f) Site #19 – 6MG Tank

D. LIFT STATIONS

1. Installation of new RTU and Communications Hardware to replace the existing Moscad RTU’s.

2. The Contractor shall furnish and install new RTU cabinets, backpans and equipment as indicated on the contract drawings. The Contractor shall modify the existing wiring, pump control panels and instrumentation to meet the standard I/O configuration and programming functionality indicated in the Contract Documents.

3. Existing PLC based lift station sites shall be upgraded to include the following:

   a. Furnish and install new operator interface panel.
   b. Furnish and install new CPU hardware.
   c. Download and modify standard lift station program. Make site specific program modifications as required.
   d. Modify, rewire and reconfigure the existing control panel to match the standard I/O. The Contractor shall furnish and install all necessary interposing relays, contact blocks and components necessary to meet the standard I/O functionality to provide for DC control at the PLC.
   e. Modify the existing pump control panels to provide for but not necessarily be limited to the following I/O status:

      1) Pump Running
2) Pump In Auto
3) Pump Failure (Overload and Thermal)
4) Pump Moisture
5) Pump Current

f. Fully test and commission the site to verify SCADA communications, monitoring and control functionality.

g. The following existing PLC sites include:
   1) Site #3 Haven Lift Station
   2) Site #4 Remington Lift Station
   3) Site #5 Grange Creek Lift Station
   4) Site #8 Todd Creek Lift Station
   5) Site #21 Riverdale Lift Station
   6) Site #24 Skylake Lift Station
   7) Site #32 Thornton Crossing Lift Station

E. WES BROWN WATER TREATMENT PLANT

1. Master Communications PLC
   a. The Wastewater treatment plant SCADA upgrade consists of two areas of modification; the existing SCADA system upgrade and the conversion of the existing radio system communications to a new Master Communications PLC.
   b. The communications network shall be configured to provide for two separate networks; a PLC control network and a SCADA information network. The Contractor shall provide all network hardware, software and configuration to provide the information and control network functionality specified.
   c. A Master Communications PLC shall be supplied by the CSS and installed at the control room to interface with the SCADA system, provide local equipment monitoring, and provide for future expansion within the plant environment.

2. Radio Communications
   a. Installation of a spread spectrum radio system, antenna mast with all associated antennas, cabling, conduit, wire and installation materials. The masts shall be installed as indicated. The Contractor shall provide all materials and labor including antenna mounting hardware, coring, and installation and bracing materials.

3. SCADA SYSTEM
   a. Modify SCADA system to include new graphics for all sites configured in conformance with the SCADA methods, procedures and tagging elements specified in the contract drawing. All existing tagname,
graphics, pop-ups and associated screens, trends, alarms etc shall be replaced and configured to match the tagging format specified.

b. Modify the Historical Database, TWTP Server, Terminal Server and associated communications equipment as required to implement the new systems.

c. Provide SCADA system report generation.

4. RADIO COMMUNICATIONS

a. Communications System Installation

1) Furnish, configure, install and test master Redundant Radios for 900 MHz and 450 MHz Frequency pairs at the Wes Brown WTP communications room. Furnish and install radios, power distribution unit and conversion modules in existing radio equipment rack.

2) Provide radio system testing and commissioning services.

3) Furnish new radio equipment at all sites.

4) Configure radio system and associated diagnostics to provide for remote diagnostic monitoring via the Wes Brown WTP. Load and configure diagnostic software on a workstation designated by the owner.

5) Provide a communications test at each site to determine the best available communications for radio connectivity. Field verify the path and signal strength from the site to the 900 MHz Repeater, 450 MHz Repeater and the 900 MHz master.

5. Zone 5 102 Elevated Tank Modifications

a. Furnish and install a new communication equipment rack assembly with UPS power.

b. Relocate existing radio repeater and filters into the new communications rack.

c. Retune, configure and modify radio repeater to work with new 900 MHz radio communications equipment specified.

F. REMOTE TELEMETRY SITES

1. Existing Moscad Remote Telemetry Units located at the Owner’s sewage pump stations shall be modified and/or replaced as follows:

a. Typical Lift Station

1) Replace Existing Moscad RTU system with new Lift Station Control Panel and Motor Control Panels as indicated on the Contract Documents.

2) Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

3) Install antenna, mast, mounting hardware and associated installation materials.
4) Modify existing electrical, instrumentation and control systems to meet the functional requirements specified. Remove existing Moscad RTU and turn over to the Owner.

b. Metering Stations

1) Replace Existing Moscad RTU and existing control system with new Control Panel and control system components as indicated on the Contract Documents.

2) Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

3) Install antenna, mast, mounting hardware and associated installation materials.

4) Modify existing electrical, instrumentation and control systems to meet the functional requirements specified. Remove existing Moscad RTU and turn over to the Owner.

c. Storage Tanks

1) Reconfigure/program existing Momentum RTU with standard reservoir control program and modify existing control system with new control system components as indicated on the Contract Documents.

2) Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

3) Install antenna, mast, mounting hardware and associated installation materials.

4) Modify existing electrical, instrumentation and control systems to meet the functional requirements specified. Remove existing Moscad RTU and turn over to the Owner.

d. Burlington Ditch Diversion Structure

1) Replace Existing Moscad RTU and existing control system with new Control Panel and control system components as indicated on the Contract Documents.

2) Install spread spectrum antenna system and peripheral hardware for radio based communications to the Wes Brown WTP.

3) Install antenna, mast, mounting hardware and associated installation materials.

4) Remove existing loop controllers, converters and recorders. Reconfigure instrument loops to directly interface with the PLC control system. Modify control loops to provide for 4-20mA control as required to interface the filed devices with the PLC control system.

5) Modify existing electrical, instrumentation and control systems to meet the functional requirements specified. Remove existing Moscad RTU and turn over to the Owner.
e. Brannan Lakes Pump Station

1) Replace Existing Moscad RTU and existing control system with new Control Panel and control system components as indicated on the Contract Documents.

2) Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

3) Install antenna, mast, mounting hardware and associated installation materials.

4) Remove existing loop controllers, converters and recorders. Reconfigure instrument loops to directly interface with the PLC control system. Modify control loops to provide for 4-20mA control as required to interface the filed devices with the PLC control system.

5) Modify existing electrical, instrumentation and control systems to meet the functional requirements specified. Remove existing Moscad RTU and turn over to the Owner.

f. Big Dry Lift Station

1) Replace Existing Moscad RTU system with new Lift Station Control Panel and revise existing control systems as indicated on the Contract Documents.

2) Install licensed radio, antenna system and peripheral hardware for radio based communications.

3) Install antenna, mast, mounting hardware and associated installation materials.

4) Modify existing electrical, instrumentation and control systems to meet the functional requirements specified. Remove existing Moscad RTU and turn over to the Owner.

5) Remove existing loop controllers, converters and recorders. Reconfigure instrument loops to directly interface with the PLC control system. Modify control loops to provide for 4-20mA control as required to interface the filed devices with the PLC control system.

6) Modify existing VFD electronics to provide for a switch selectable second speed control signal to be controlled by the new PLC system. The existing pump controller shall be modified and rewired to provide for back-up control in the event of a PLC failure.

g. ZONE 3/4 PUMP STATION

1) Replace Existing Moscad RTU system with new Quantum PLC and revise existing control systems as indicated on the Contract Documents.
2) Install fiber optic communications equipment at the control panel and the Thornton WTP to communicate via existing fiber optic cabling to the SCADA system based communications.

3) Modify existing electrical, instrumentation and control systems to meet the functional requirements specified. Remove existing Moscad RTU and turn over to the Owner.

4) Add additional monitoring and control provisions to include the VFD monitoring and control for the newly installed VFD motor controller.

1.03 PHASE 2B PRESSURE REDUCING STATIONS (Bid Item #2)

A. The pressure reducing stations consist of 2 controller types; 1). A momentum PLC, 2) a remote I/O configuration.

B. The Contractor shall furnish and install the RTU, Antenna Mast, Instrumentation and all materials associated with providing remote telemetry access to the SCADA system as indicated on the Contract Drawings.

C. The Contractor shall modify the Master Communications PLC, SCADA and the overall SCADA Wide Area Network servers and workstations to provide for SCADA monitoring and control.

D. Modify SCADA system to include new graphics for all sites configured in conformance with the SCADA methods, procedures and tagging elements specified in the contract drawing. All existing tagname, graphics, pop-ups and associated screens, trends, alarms etc. shall be replaced and configured to match the tagging format specified.

E. Modify the Historical Database, TWTP Server, Terminal Server and associated communications equipment as required to implement the new systems.

F. Provide SCADA system report generation.

1.04 PHASE 2C DIVERSION STRUCTURES (Bid Item #3)

A. The pressure reducing stations consist of 2 controller types; 1). A momentum PLC, 2) a remote I/O configuration.

B. The Contractor shall furnish and install the RTU, Antenna Mast, Instrumentation and all materials associated with providing remote telemetry access to the SCADA system as indicated on the Contract Drawings.

C. The Contractor shall modify the Master Communications PLC, SCADA and the overall SCADA Wide Area Network servers and workstations to provide for SCADA monitoring and control. Modify SCADA system to include new graphics for all sites configured in conformance with the SCADA methods, procedures and tagging elements specified in the contract drawing. All existing tagname, graphics, pop-ups and associated screens, trends, alarms etc. shall be replaced and configured to match the tagging format specified.
D. Modify the Historical Database, TWTP Server, Terminal Server and associated communications equipment as required to implement the new systems.

E. Provide SCADA system report generation.

F. Diversion Structures

1. LCC @ West Gravel Lakes
   a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.
   b. Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.
   c. Install antenna, mast, mounting hardware and associated installation materials.
   d. Furnish and install conduit to the existing utility meter (currently disconnected) and coordinate power connection and service with the utility.

2. Colorado Ag @ West Gravel Lakes
   a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.
   b. Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.
   c. Install antenna, mast, mounting hardware and associated installation materials.
   d. Furnish and install conduit to the existing utility meter (currently disconnected) and coordinate power connection and service with the utility.

3. Farmers High Line
   a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.
   b. Furnish and install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.
   c. Furnish and install antenna, mast, mounting hardware and associated installation materials.
   d. Furnish and install solar power panels and distribution system in conformance with the contract documents.

4. Thorncreek GC
   a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.
   b. Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.
c. Furnish and install antenna, mast, mounting hardware and associated installation materials.

d. Furnish and install solar power panels and distribution system in conformance with the contract documents.

e. Furnish and install a radio/repeater on the lighting pole located on the corner of Washington and 36th Street, to repeat communications data from the RTU to the Thornton WTP or IMC spread spectrum network via the lighting pole. Contractor shall furnish the radio, enclosure and an antenna the pole. Contractor shall coordinate routing of conduit to the nearest available 120 VAC power source, not to exceed 100 ft. Installation shall include coring, cutting, patching and resealing the sidewalk to provide power to the radio repeater from the traffic control panel. Conduit shall be a 1” conduit with 2-14, 1#14 Gnd and CAT 6. Contractor shall install power supply, and fiber converter modules in the existing traffic control panel. Contractor shall coordinate the programming and router configuration requirements to provide for a secure connection of the data via the City’s fiber optic network.

5. Union Lateral

a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.

b. Furnish and install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

c. Furnish and install antenna, mast, mounting hardware and associated installation materials.

d. Furnish and install a utility meter and panel in conformance with the local Utility requirements to provide for 120 VAC power to the RTU enclosure.

e. The Contractor shall coordinate the conduit trenching, routing, size and termination requirements with the serving utility. The Contractor shall assist the Owner with the application requirements based on the actual installation requirements for connection to the nearest utility service transformer.

f. Furnish and install a radio/repeater on the roof of the IMC, to repeat communications data from the RTU to the Thornton WTP spread spectrum network via the rooftop of the IMC building. Contractor shall furnish the radio, enclosure and a 10’ antenna mast on the roof of the IMC building. Contractor shall coordinate routing of conduit to the nearest available 120 VAC power source, not to exceed 100 ft. Installation shall include coring, cutting, patching and resealing the conduit roof penetration as required to provide power to the radio repeater. Rooftop penetration shall include 2-3/4” conduits and conductors (2-14, 1#14 Gnd and CAT 6). Repeater and mast shall be grounded in accordance with Motorola R56 standards to the City lightning protection system.
1.05 PHASE 2D RAW WATER MONITORING (Bid Item #4)

A. The pressure reducing stations consist of 2 controller types: 1) A momentum PLC, or 2) a remote I/O configuration.

B. The Contractor shall furnish and install the RTU, Antenna Mast, Instrumentation and all materials associated with providing remote telemetry access to the SCADA system as indicated on the Contract Drawings.

C. The Contractor shall modify the Master Communications PLC(s), SCADA and the overall SCADA Wide Area Network servers and workstations to provide for SCADA monitoring and control. Modify SCADA system to include new graphics for all sites configured in conformance with the SCADA methods, procedures and tagging elements specified in the contract drawing. All existing tagname, graphics, pop-ups and associated screens, trends, alarms etc shall be replaced and configured to match the tagging format specified.

D. Modify the Historical Database, TWTP Server, Terminal Server and associated communications equipment as required to implement the new systems.

E. Provide SCADA system report generation.

F. Raw Water Monitoring Sites:
   1. South Tani Lake
      a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.
      b. Install spread spectrum or licensed radio, antenna system (Omni) and peripheral hardware for radio based communications.
      c. Install 20’ antenna, mast, mounting hardware and associated installation materials.
      d. Furnish and install conduit, wire, materials and supplemental devices to connect to and interface with the interconnection gates, stilling well and hydraulic gate as indicated in the Contract Documents.
   2. West Gravel Lakes #1
      a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.
      b. Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.
      c. Install antenna, mast, mounting hardware and associated installation materials.
      d. Furnish and install solar power panels and distribution system in conformance with the contract documents.
   3. West Gravel Lakes #2/#3
      a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.
b. Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

c. Install antenna, mast, mounting hardware and associated installation materials.

d. Furnish and install solar power panels and distribution system in conformance with the contract documents.

4. West Gravel Lakes #2/#3

a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.

b. Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

c. Install antenna, mast, mounting hardware and associated installation materials.

d. Furnish and install solar power panels and distribution system in conformance with the contract documents.

5. South Dahlia

a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.

b. Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

c. Install antenna, mast, mounting hardware and associated installation materials.

d. Furnish and install solar power panels and distribution system in conformance with the contract documents.

6. North Dahlia

a. Furnish and install RTU and Level Monitoring system as indicated on the contract drawings.

b. Install spread spectrum or licensed radio, antenna system (Omni) and peripheral hardware for radio based communications.

c. Install antenna, mast, mounting hardware and associated installation materials.

d. Furnish and install conduit and trench from the existing well pump station to the RTU location.

7. Well Pump Station

a. Furnish and install RTU and modify existing well pump controls to allow for control of the well pump from the PLC.

b. Install spread spectrum or licensed radio, antenna system and peripheral hardware for radio based communications.

c. Install antenna, mast, mounting hardware and associated installation materials.
d. Relocate existing equipment and reroute conduit and wire to new equipment locations.
e. Modify existing panelboard and provide conduit and wire as required to power the RTU.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.00 GENERAL
A. Project implementation and execution requires that the Contractor coordinate with the owner specific project requirements for implementation of the SCADA upgrade. The Contractor shall coordinate specific project requirements as follows:
1. Pre-design and software development meetings
2. System programming demonstration meeting
3. Comprehensive factory testing of the complete system configured and operational at the Contractor’s facility. Testing may occur as phased approach (grouped in their respective phases) or as a comprehensive factory test.
4. Installation and modification for temporary control systems. All sites shall be provided with temporary control systems to maintain operation of the station during the site switch-over.
5. System pre-commissioning of equipment to verify operation prior to removal and switchover of the existing systems.
6. System commissioning and final system testing.
7. Final acceptance testing and training.
8. System As-built drawing development for all modified systems.

3.01 SCHEDULE
A. The schedule for the Phase 2A portion of the Contract shall be 365 days from the notice to proceed. Phase 2A shall be complete and operational, excluding punch lists and minor corrective items, within the 365 day period.
B. Project completion, all phases of construction, shall be 545 days from notice of completion.

3.02 EXISTING CONDITIONS
A. The Contractor is required to install equipment, conduit and wire within existing operational systems.
B. The Contractor shall field verify existing conditions prior to modification and retrofitting of equipment.
C. The Contractor shall coordinate all field modifications with the Owner and Owners Representatives. The Contractor shall make available a
technician/electrician to assist in the verification off all existing digital and analog loop functions prior to removal and modification of electrical systems during the switch over and commissioning of each site and phase of construction.

D. The technician/electrician shall provide control wiring modifications during switchover and commissioning as required to interface existing equipment with new equipment required for operation. This includes the installation of all interposing relays, termination equipment, materials and wiring required to convert the signals to be compatible between the new PLC and existing field devices.

3.03 TEMPORARY CONTROLS

A. The Contractor shall furnish and install temporary controls as required to maintain operation where outages will exceed 4 hours. Temporary controls shall include furnishing and installing switches, controllers, instruments and wiring as required to maintain station operation during the extended outage period.

3.04 TECHNICAL SERVICES

A. In addition to the specified and implied requirements for programming and configuration of the system to meet the required functionality for operation, SCADA monitoring and control, reporting, networking and database implementation, the Contractor shall provide additional hours for Technical Professional Services as specified in the applicable specification sections.

1. Technical Services defined during the course of the contract are to provide additional field technical services, RTU/PLC programming, SCADA configuration, Report Generation and Database functions. These additional hours are to be assigned on a task item basis.

2. The hours shall be provided on site and logged according to the allotted hours for implementation. The hours shall be provided as directed by The Owner.

3. At contract completion remaining hours shall be incorporated into a service contract to be provided during the warranty period for modification, adjustment and configuration tasks.

3.05 ACCELERATED CONSTRUCTION (Bid Item #5)

A. To take advantage of the seasonal downtime associated with the Burlington Ditch operation, the Burlington Ditch control system shall be installed first. The Burlington Ditch, Master Spread Spectrum Antenna and Master PLC programming shall be constructed and online within 90 days of the award of the Contract.

3.06 MATERIALS AND LABOR ALLOTMENT (Bid Item #6)

A. The Contractor shall provide in his bid the lump sum value listed in the Bid Schedule, Bid item # 7, for additional materials and technical (electrician/technician) labor. The labor allotment of this bid item does not include the Technical Services referenced in Article 3.03 above which are to be provided as a part of the base bid. The materials and labor allotment shall
be utilized only as directed by the Owner to procure, install and commission materials.

B. The Contractor shall furnish and install materials funded from the allotment at the direction of the Owner or their representative.

C. Materials and labor “Work Tasks” shall be based on field directives issued to the Contractor on a task basis. The Contractor shall submit a cost proposal for each task with an itemized materials and labor breakout. The Contractor shall not perform any services until so directed by the Owner.

D. The materials and labor allotment budget shall be provided as fixed lump sum per the bid item schedule. Method of payment shall be in conformance with the general provisions costs, profit and overhead.

END OF SECTION
PART 1 GENERAL

1.00 SCOPE

A. Payment for the various items of the Bid Schedule, as further specified herein, shall include all compensation to be received by the Contractor for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work being described, as necessary to complete the various items of the WORK all in accordance with the requirements of the Contract Documents, including all appurtenances thereto, and including all costs of permits and cost of compliance with the regulations of public agencies having jurisdiction, including Safety, Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA), and the Reclamation Safety and Health Standards (RSHS).

B. No separate payment will be made for any item that is not specifically set forth in the Bid Schedule, and all costs therefore shall be included in the prices named in the Bid Schedule for the various appurtenant items of work.

C. Payment to the Contractor shall be made for purchased equipment and fabricated equipment assemblies as “Materials On-Hand”. Payment for Materials On-Hand shall not exceed 30 percent of a given bid item. Value shall be based on the materials invoice plus 10 percent profit and 5 percent overhead.

D. The Contractor shall provide sufficient evidence in the form of invoices, photographs and shipping receipts to substantiate that the materials have been received. The City at its discretion may inspect all Materials On-Hand prior to issuing Materials On-Hand payments.

1.01 MOBILIZATION AND PREPARATORY

A. No measurement shall be made for this item.

B. Payment for mobilization shall be made at the lump-sum price named in the Bid Schedule. Payment shall constitute full compensation for furnishing all planning, labor, materials, tools, equipment and doing all work necessary for mobilization, providing bonds and insurance.

C. Mobilization shall not exceed five (5) percent of the total awarded contract amount.

1.02 WATER TREATMENT PLANT (Wes Brown)

A. Furnish, program, configure, install and commission ready for use a SCADA operator interface workstation and PLC control system upgrade at the Waste Water Treatment Plant.
B. Payment of the work shall be based on the percentage of work complete. The percentage of work complete shall be based on the following:

1. Approved Submittals 25 %
2. Approved Factory Acceptance Test 25 %
3. Installation of Equipment 25 %
4. System Testing and Commissioning 15 %
5. Final Acceptance Test 05 %
6. Final Documentation 05 %

C. Payment for this item will be made at the percentages listed and applied to the lump-sum named in the Bid Schedule.

1.03 RTU INSTALLATION (Per Phase)

A. The Contractor shall furnish, install and commission ready for use the RTU control systems.

B. Payment of the work shall be based on the percentage of work complete. The percentage of work complete shall be based on the following:

1. Installation of Equipment (percent complete) up to 60 %
2. System Testing and Commissioning 20 %
3. Final Acceptance Test 10 %
4. Final Documentation 10 %

C. Payment for this item will be made at the percentages listed and applied to the lump-sum named in the Bid Schedule for each phase of installation.

1.04 PROJECT IMPLEMENTATION

A. Project implementation and execution to include factory testing materials and services for set-up and execution of factory test, services for pre-commissioning, operational testing, final acceptance, training and final documentation.

B. Payment of the work shall be based on the percentage of work complete and shall not exceed 15 percent of the project. The percentage of work complete shall be based on the following:

1. Approved Factory Test Submittals 10 %
2. Approved Functional Demonstration Test 10 %
3. Approved Factory Test 30 %
4. Approved Site Testing Submittals 10 %
5. Approved Site Testing 15 %
6. Approved Operations and Maintenance Manuals 15 %

C. Payment for this item will be made at a completion percentage listed and applied to the lump-sum named in the Bid Schedule. This payment Item shall be 15 percent of the Awarded Contract Amount.
1.05 ADDITIONAL TECHNICAL SERVICES

A. Technical Services defined during the course of the contract to provide additional Field Technical Services, Field Engineering, PLC programming, SCADA configuration, Report Generation and Database functions are to be provided on a task basis.

B. Payment of the work shall be based on the hours completed per task order initiated by the Owner. The hours shall be provided on site and logged according to the allotted hours for implementation.

C. Payment for this item will be made at the hourly rate provided not to exceed based on the given Task Order.

1.06 MATERIAL AND LABER ALLOTMENT (Bid Item #6)

A. Measurement of work shall be based on a task item basis.

B. Work shall be formed and tracked, materials and labor, by Contractor and submitted to the Owner for payment.

C. Payment for each task shall be made on a task basis.

1.07 CONTROL SYSTEM SUPPLIER

A. The Contractor shall furnish, install, and commission ready for use equipment, materials and services provided by the Control System Supplier.

B. The Contractor shall breakdown the Control System Supplier portion of work and include payment items and percentages for the following:
   1. RTU and Instrumentation System (60 Percent)
   2. Master PLC System (15 Percent)
   3. SCADA System Configuration (25 Percent)

C. RTU and Instrumentation System
   1. Payment of the work shall be based on the percentage of work complete. The percentage of work complete shall be based on the following:
      a. Approved Submittals  15 %
      b. Approved Factory Acceptance Test  25 %
      c. Installation of Equipment  25 %
      d. System Testing and Commissioning  25 %
      e. Final Acceptance Test  05 %
      f. Final Documentation  05 %
   2. Payment for this item will be made at the percentages listed and applied to the lump-sum named in the Bid Schedule for each RTU location.
D. Master Communications PLC

1. Master PLC provided at the Wastewater Treatment Plant.

2. Payment of the work shall be based on the percentage of work complete. The percentage of work complete shall be based on the following:

   a. Approved Submittals 15 %
   b. Communications Demonstration Test 15 %
   c. Approved Factory Acceptance Test 20 %
   d. Installation of Equipment 25 %
   e. System Testing and Commissioning 15 %
   f. Final Acceptance Test 05 %
   g. Final Documentation 05 %

3. Payment for this item will be made at the percentages listed and applied to the lump-sum named in the Bid Schedule.

E. SCADA SYSTEM CONFIGURATION

1. The Contractor shall furnish, program, configure, install and commission ready for use the SCADA Programming and Configuration services.

2. Payment of the work shall be based on the percentage of work complete. The percentage of work complete shall be based on the following:

   a. Approved Programming Submittals 15 %
   b. Approved Functional SCADA Demonstration 15 %
   c. Approved Factory Acceptance Test 20 %
   d. System Testing and Commissioning 35 %
   e. Final Acceptance Test 10 %
   f. Final Documentation 05 %

3. Payment for this item will be made at the percentages listed and applied to the lump-sum named in the Bid Schedule.

END OF SECTION
SECTION 01200
TECHNICAL GENERAL PROVISIONS

PART 1 GENERAL

1.00 CONTRACT DOCUMENTS

A. The Contract Drawings and Specifications are intended to be descriptive of the type of system to be provided; any minor details missing in either shall not relieve the Contractor from the obligations there under to install in correct detail any and all materials necessary for a complete operational system at no additional cost.

B. The Contract Drawings are not manufacturer, model or part # specific. The Contractor shall provide submittals and installations based on project specific manufacturer's equipment specified and selected for the project. Equipment installation and wiring shall be coordinated with specific equipment manufacturers and equipment suppliers to ensure system connectivity and cohesive system operation.

C. The Contract Drawings are generally diagrammatic; exact locations of electrical products shall be verified in the field with the Engineer. Except where special details on Drawings are used to illustrate the method of installation of a particular piece or type of equipment or materials, the requirements or descriptions in related specification sections shall take precedence in the event of conflict. The Contractor shall make allowances in the Bid to allow for indicated installations to be shifted up to ten feet without cost credit or adders to the Contract.

D. The Contract Electrical elementary, elevation and one-line diagrams are the basis of the electrical system to be provided and are for reference only. It is the Contractor's responsibility to adjust and make minor revisions to the diagrams as necessary for operational system at no additional cost to the Owner. Additional isolators, relays, wiring, terminal blocks, etc., shall be provided necessary to meet the functional requirements.

E. Locations at facilities for new equipment, inserts, anchors, panels, pull boxes, conduits, stub-ups, and fittings for the electrical system are to be determined by the Contractor and Engineer at time of installation. Contractor shall make adjustments to locations (assume a maximum 10 feet) of electrical equipment required by existing conditions and coordination with other trades at no additional cost. Minor adjustments are defined as those adjustments required due to equipment size changes, existing obstructions or variations between different equipment suppliers, maintenance consideration and methods of installation.

F. The conduit and wire routing, wire fill, and number of conduits are based on the best information available. It is the Contractor's responsibility to modify the conduit schedule based upon existing conditions and shop drawings for the actual equipment, routes and loads. Such modifications in conduit sizes
and numbers of conductors shall be at no additional cost to the Owner, if such changes are the direct result of the equipment selected by the Contractor.

G. Electrical & instrumentation, conduit & wire lengths shown on circuit drawings are approximate. The Contractor is responsible for determining actual lengths for bidding and installation purposes.

H. All equipment shall be installed and located so that it can be readily accessed for operation and maintenance. The Engineer reserves the right to require minor changes in location of equipment, without incurring any additional costs. These minor changes are changes that would provide adequate clearance and work areas in front of and around equipment.

I. Where conduits are shown as "home runs" on the Contract Drawings or stated to be furnished, but not explicitly shown as part of the scope of work, the Contractor shall provide all fittings, boxes, wiring, etc., as required for completion of the raceway system in compliance with the NEC and the applicable Specification Sections.

J. No changes from the Contract Drawings or Specifications shall be made without written approval of the Engineer. Should there be a need to deviate from the Contract documents, submit written details and reasons for all changes to the Engineer for review within thirty days after the award of the contract.

K. The resolution of conflicting interpretation of the Contract documents shall be as determined by the Engineer.

L. The Contractor shall maintain a separate set of neatly and accurately marked set of spreadsheets and full-size blue-line Record Contract Drawings specifically used for recording the as-built equipment conditions, locations and layout of all electrical, controls and instrumentation equipment, routing of raceways, junction and pull boxes, and other diagram or document changes. These Record Drawings and spreadsheets shall be kept up-to-date during the progress of the job, and stamped with "As-Built" at end of job. These Record Drawings and spreadsheets shall not be used for daily construction use and shall not contain any mark-ups that are unrelated to as-built corrections.

1. Show the following on the Record Drawings by dimension from readily obtained base lines:

   a. Exact location, type and function of concealed control equipment and devices.

   b. Precise routing and locations of underground conduits, pullboxes, junction boxes, etc. that make-up the raceway system.
c. Show the dimensions, location and routing of electrical work which will become permanently concealed.

d. Show complete routing and sizing of any significant revisions to the systems shown.

2. Prior to acceptance of the work, the Contractor shall deliver to the Engineer one set of record full-size Drawings and spreadsheets neatly marked accurately showing the information required above.

1.01 PRE-BID CONFERENCE

A. It is required that the Contractor and CSS attend the pre-bid conference and job walk to become thoroughly familiar with the project requirements. The pre-bid job walk and conference shall allow the Contractor and CSS to:

1. Thoroughly examine existing conditions before submitting bid proposal to perform any work. Contractor shall compare site conditions with data given on the plans or in these specifications. Allowances shall not be made for any additional costs incurred by the Contractor's failure to have examined the site or report any discrepancies to the Owner prior to bid.

2. The Contractor shall be responsible for meeting all local requirements and regulations.

3. Verify all measurements and conditions and shall be responsible for the correctness of same. No extra compensation will be allowed because of differences between approximated measurements shown on the drawings and actual measurements at the site.

4. Verify existing conditions, equipment location, wiring, control panel assemblies, working space and locations for equipment installation.

B. The term "Engineer" used throughout the Specifications is "The City Engineer" or their designated Engineering representative. The term "Owner" in the Specifications is "The City". When "Contractor" is listed in these documents without further definition it is to mean the "Prime or General Contractor" and their associated Sub-Contractors, CSS and Equipment Suppliers.

1.02 COORDINATION

A. The Contractor shall coordinate the work with the Owner, other trades, code authorities, utilities, and the Engineer, with due regard to their work, towards promotion of a rapid completion of the project. If any cooperative work must be altered due to lack of proper supervision of such, or failure to make proper provisions, then the Contractor shall bear expense of such changes as necessary to be made in the work of others.
B. The Contractor shall examine the architectural, mechanical, structural, electrical, and instrumentation equipment provided under other Sections of this Contract in order to determine the exact routing and final terminations for all ducts, supports, conduits and cables. The exact locations and routing of ducting, cables and conduits shall be governed by structural conditions, physical interferences, and the physical location of wire terminations on equipment. Conduits shall be stubbed up as close as possible to equipment terminals.

C. All Contract Documents are related to project implementation. Listed related sections are provided as additional and supplemental to the specification section and do not relieve the Contractor from meeting the requirements of the specification for any Sections or Divisions not listed within a given Section.

D. Manufacturer's directions and instructions shall be followed in all cases when they have more restrictive requirements than that shown on the Contract Drawings or have stipulations in order to meet warranty requirements.

E. The Contractor shall cease work at any particular point, temporarily, and transfer his operations to such portions of work as directed, when in the judgment of the Owner it is necessary to do so.

1. Prior to commencing construction, the Contractor shall arrange a conference with the Owner as well as equipment suppliers and shall verify types, sizes, locations, requirements, controls and diagrams of all proposed equipment.

1.03 PROJECT MEETINGS

A. The Project Manager shall attend monthly progress meetings to address project status and schedule. At each meeting, the project manager shall submit a revised schedule that address's long term scheduling and a short term four week working schedule that address's installation schedules, start-up and switchover tasks, commissioning and final testing. All scheduled shutdowns and work that affects operation shall be coordinated with Owner operations.

B. The Contractor's project manager shall coordinate and attend all scheduled project meetings.

C. The Contractor shall schedule mandatory coordination meetings during the initial submittal and implementation phases of the project. The meetings shall be held at the jobsite and include, as a minimum, attendance by the Engineer, Prime Contractor, Electrical Contractor, CSS Project Engineer, Systems Engineer and Construction Services Engineer.

1. The first meeting shall be held in advance of the first comprehensive submittal and no later than 30 days after Contract award. The purpose of the meeting shall be for the Contractor and Control System Supplier to:
a. Summarize their understanding of the project.

b. Discuss any proposed substitutions or alternatives.

c. Review the project schedule.

d. Explain format of Drawings and submittals.

e. Discuss any other topics deemed necessary for project coordination.

2. The submittal review meeting shall be held after the Owner has completed the review of the first comprehensive submittal. The purpose of the meeting is to discuss comments made on the submittal package, to update the project schedule, and coordinate the testing, training, and installation phases of the project.

3. Start-Up and Commissioning Meeting. The Contractor shall attend a start-up and commissioning meeting scheduled prior to commissioning each treatment plant. The meeting shall address testing, switchover procedures, commissioning, downtime and final acceptance testing.

D. RTU/PLC and Graphics programming meeting. The Contractor shall coordinate and attend RTU/PLC applications programming meetings (workshops) to address SCADA configuration and RTU/PLC control logic development and clarification of the control strategies on a site by site basis. The meetings shall include the RTU/PLC and SCADA programmers. The meetings shall be conducted as follows:

1. General Application RTU/PLC Programming

2. General Graphical Screen Development Requirements

E. SCADA Programming Development meeting(s). The CSS’s SCADA development engineer shall attend all SCADA development meetings and coordinate the programming phase of the project. SCADA programming development meetings shall address the following:

1. General SCADA Development Meeting (Networking, Client Access System Operation)

2. Historical Database Configuration Meeting

3. Report Generation Meeting

4. Preliminary Graphical Development Meeting

5. Graphical Submittal Review Meeting

6. SCADA Alarming, Security and Access Meeting

7. SCADA Functional Demonstration Meeting
1.04 SUPERVISION

A. The Contractor shall schedule all activities, manage all technical aspects of the project, coordinate submittals and drawings, and attend all project meetings associated with this Section.

B. The Contractor shall supervise all work in this Section, including the Electrical Contractor’s general construction work from the beginning to completion and final acceptance.

C. The Contractor shall supervise and coordinate all work in this Section to insure that each phase of the project, submittal, delivery, installation, and acceptance testing, etc., is completed within the allowable scheduled time frames.

D. The Contractor shall be responsible for obtaining, preparing, completing, and furnishing all work specified, including that of the Electrical Contractor and CSS, which shall include transmittals, submittals, forms, documents, manuals, instructions, and procedures.

E. Construction Supervision:

1. Prior to the start of any project site installation, the Contractor shall provide the Owner with an expected manpower schedule as well as a list of applicable job site supervision personnel, their scheduled job site appearance, and the expected duration of their presence on the job site.

1.05 INSPECTIONS

A. All work or materials covered by the Contract documents shall be subject to inspection at any and all times by the Engineer. If any material does not conform to the Contract documents, or does not have an "approved" or "approved as noted" submittal status; then the Contractor shall, within three days after being notified by the Engineer, remove the unacceptable material from the premises; and if said material has been installed, the entire expense of removing and replacing same, including any cutting and patching that may be necessary, shall be borne by the Contractor.

B. Work shall not be closed in or covered over before inspection and approved by the Engineer or the Engineers designated representative. All costs associated with uncovering and making repairs where noninspected work has been performed shall be borne by the Contractor.

C. The Contractor shall cooperate with the Owner and provide assistance for the inspection of the electrical system under this Contract. The Contractor shall remove covers, provide access, operate equipment, and perform other reasonable work that, in the opinion of the Engineer, will be necessary to determine the quality and adequacy of the work.

D. Before request for final inspection is made, the Contractor shall submit to the Owner in writing, a statement that the Contractor has made his own thorough
inspection of the entire project enumerating punch list items not complete and that the installation and testing is complete and in conformance with the requirements of this Division.

1.06 JOB CONDITIONS

A. The Contractor shall make all arrangements and pay the costs thereof for temporary services required during construction of the project, such as temporary electrical power and telephone service. Upon completion of the project, remove all temporary services, equipment, material, and wiring from the site as the property of the Contractor.

B. The Contractor shall provide adequate protection for all equipment and materials during shipment, storage, and construction. Equipment and materials shall be completely covered with two layers of plastic and set on cribbing six inches above grade so that they are protected from weather, wind, dust, eater, or construction operations. Equipment shall not be stored outdoors without the approval of the Owner. Where equipment is stored or installed in moist areas, such as unheated buildings, provide an acceptable means to prevent moisture damage, such as a uniformly distributed heat source to prevent condensation.

C. The normal, unconditioned ambient temperature range of the job site will vary between 10° to 110 °F. All equipment shall be rated to operate at continuous full load under these temperature ranges. Any additional provisions for cooling or heating shall be provided to meet these requirements at no additional cost.

1.07 PROJECT DOCUMENTATION

A. Operating and maintenance manuals covering instructions and maintenance on each type of equipment shall be furnished per section 01300.

1.08 AREA CLASSIFICATION

A. Lift Stations are classified as Class 1, Division 1 within the wetwell and Class 1, Division 2 in the dry well areas of non-ventilated areas or 18” from penetrations into the wetwell area. All installations shall be made in accordance with NEC and NFPA requirements for the area classification.

B. Where equipment ratings are not specifically called out on the drawings, they shall be supplied with the following ratings:

1. Wet and Corrosive Areas shall be NEMA 4X

2. Outdoor and Indoor Wet Locations shall be NEMA 4

3. Indoor Dry Areas shall be NEMA 12
C. Wind Loading

1. All antenna masts and solar panel arrays shall be designed for 75 mph wind loading and 100 mph wind gust.

D. Seismic Classification:

1. The site is within Seismic Zone 1. All electrical equipment and construction techniques must be designed and braced for Seismic Zone 1, based on latest UBC.

1.09 REQUEST FOR CONTRACT CHANGE

A. Work considered or construed to be additional to, or outside the contract shall be addressed with a contract change notification. The Contractor shall identify the work required; reference appropriate specifications and submit a qualified and quantified cost proposal.

PART 2 PRODUCTS (N/A)

PART 3 EXECUTION

3.00 WORKMANSHIP

A. All work in this Section shall conform to the applicable codes and standards for the given trade.

B. The Contractor shall employ personnel that are skilled and experienced in the installation and connection of all elements, equipment, devices, instruments, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. All work shall be performed in a workmanlike manner by craftsmen skilled in the particular trade. Work shall be performed in accordance with the Plans, Specifications, manufacturers' recommendations, and the best practice of the trade. Completed work shall present a neat and finished appearance.

D. The Contractor shall ensure that all equipment and materials fit properly in the installations and locations for which they are intended. The Contractor shall perform any required work to correct improper installations at no additional expense to the Owner.

E. The Engineer reserves the right to halt any work that is found to be substandard or being installed by unqualified personnel.

F. All cutting, trimming and notching shall be laid out in advance. Notching or cutting of any structural member or building surface shall not proceed without specific approval from the Engineer. Cutting, channeling, chasing, or drilling
of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment shall be carefully conducted. The Contractor shall restore surfaces neatly to new condition using skilled craftsmen of the trades involved at no additional cost to the Owner.

G. The Contractor shall maintain the premises free from accumulation of waste material or rubbish on a daily basis. Upon daily completion of work, remove materials, scraps, and debris from the premises and from the interior and exterior of all devices and equipment.

H. All equipment installed by the Contractor shall be in accordance with the Drawings and the manufacturer's recommendations and instructions and shall operate to the Engineer's satisfaction.

I. The Contractor shall follow and adhere to all manufacturers' instructions for handling, receiving, installation, and commissioning requirements prior to energization. After energization, the Contractor shall provide qualified technicians or manufacturer's services for programming, set-up and calibration of equipment.

J. The Contractor shall be responsible for, and shall correct by repair or replacement, at his own expense, equipment that, in the opinion of the Engineer, has been caused by faulty mechanical or electrical assembly by the Contractor. Necessary tests to demonstrate that the electrical and mechanical operation of the equipment is satisfactory and meets the requirements of these Specifications shall be made by the Contractor at no additional cost to the Owner.

K. The Contractor shall vacuum clean the interior of all work areas, motor control centers, panelboards, junction boxes and other enclosures supplied under this project containing electrical equipment to remove all dirt, metal chips, stripped insulation, etc., from the enclosure. This cleaning shall be done prior to energizing the device initially and a second time immediately prior to the final acceptance inspection.

L. Install equipment anchors and supports in accordance with the seismic calculations and manufacturer's recommendations. Properly torque all bolts to the required values.

M. Install all supports in plumb vertical position. Any support installed that is not plumb shall be removed and reinstalled by the Contractor at no additional cost to the Owner.

3.01 FACTORY TESTING

A. The Contractor shall conduct a comprehensive factory test of all computer, networking, communication and RTU control systems complete at the Control System Suppliers facility.
B. The factory test shall include all equipment, set-up and configured as if it were operating in the field with all equipment connected and operational to simulate field conditions.

C. The factory test shall include radio communications equipment with dummy loads to simulate actual radio transmission capability.

D. The Contractor shall furnish and provide all, labor, test cables, cabling, equipment, communications simulators, testing and diagnostics tools required to exercise the system to its full extent of operation.

E. The Contractor shall pay for all travel expenses of the Owner and its representatives’ if the factory test facility is greater than 90 miles from the jobsite. The Contractor shall include expenses for up to three individuals.

3.02 DELIVERY

A. The Contractor shall inspect all equipment items and materials delivered to the jobsite.

B. The Contractor shall unpack each item for inspection within two (2) days of arrival.

C. Complete written inventory shall be produced by Contractor and submitted to Owner within (2) days after arrival on jobsite for record keeping prior to any payment for the item.

3.03 DAMAGED PRODUCTS

A. Damage products will not be accepted. All damaged products shall be replaced with new products.

3.04 SCHEDULED SHUTDOWN AND WORK DISRUPTION

A. The electrical, instrumentation, and programming modifications and additions are made at operational plant facilities. The Contractor shall schedule all the required work with the Owner, including each shutdown period. Each shutdown shall be implemented to minimize disruption of the existing operations. The work to be provided under this Contract shall not disrupt any of the existing operations without prior approval.

B. Existing control systems shall not be shutdown or taken out of service without written approval from the Owner. Shutdown and out-of-service periods shall not exceed four hours.

C. The Contractor shall provide for temporary monitoring and control systems including hardware, software and temporary cabling for pump operation when shutdown or out-of-service conditions exceed 4 hours.
D. The Owner reserves the right to delay, change, or modify any shutdown at any time, at no additional cost to the Owner, when the risk of such a shutdown would jeopardize the operation of system.

E. Carry out scheduled shut downs only after the time, date, and sequence of work proposed to be accomplished during shutdown has been favorably reviewed by the Owner. Submit shutdown plans at least 2 days in advance of when the scheduled shutdown is to occur.

F. The Contractor is advised that during changeout of electrical equipment and demolition of existing conduits and installation of new conduits, Contractor is responsible to keep equipment running that is necessary for Plant or station operation during the shutdown and disruption period. The Contractor shall install temporary SO cords, signal cabling, temporary panels or other means to keep equipment powered and automatic controls functional.

G. Portable cords shall be provided and utilized by the Contractor to keep existing equipment operating when replacing conduit systems. No temporary portable cords shall be laid on the floor. All cords shall be suspended from walls or ceiling, clear from traveled areas.

H. Shutdown and commissioning of the lift stations shall be sequential such that a single plant is commissioned at a time. Overlapping start-up and commissioning phases between plants is not acceptable. Commissioning of additional plants shall not commence until a commissioned plant is operationally complete and has been accepted by the owner.

I. All control systems shall be installed in parallel with existing controls as indicated. Locations requiring the removal of existing control system prior to the addition of new systems shall be provided with temporary controls.

3.05 TRAFFIC CONTROL

A. Various sites are located in vaults that are in or near the street, that will require traffic control.

B. The Contractor shall provide traffic control in accordance with the requirements of the Owner and local jurisdictions.

C. The Contractor shall notify the City of all work requiring traffic control and submit a traffic control plan prior to system shutdown and installation. The traffic control plan shall be submitted and approved prior to any work effort.

3.06 INSTALLATION, GENERAL

A. System:

1. Install all products, materials and equipment per manufacturer's recommendations and the Drawings.
2. Contract Drawings are intended to show the basic functional requirements of the system and do not relieve the Contractor from the responsibility to provide a complete and functioning system.

3. Keep a copy of the manufacturer's installation instructions on the jobsite available for review at all times prior to any installation of the associated equipment.

B. Cutting and Patching:

1. Seal around all conduits, wires, and cables penetrating between walls, ceilings, and floors in all buildings with a fire stop material. Seal shall be made at both ends of the conduit with fire stop putty. Seal shall have a minimum two-hour rating. Fire stop sealing shall be International Protective Coatings Flamesafe, or approved equal.

2. Seal around conduits entering outside to inside structures and around bottom of freestanding enclosures to maintain watertight integrity of structure.

3. Place conduit type seal in each underground conduit riser into panels and enclosures to prevent entrance of insects and rodents.

C. Housekeeping Pads:

1. Concrete housekeeping pads are required for all freestanding electrical equipment. Housekeeping pads shall be 3-1/2" inches above surrounding finished floor or grade unless dimensioned otherwise and shall be 3 inches larger in both dimensions than the supported equipment including future units as shown on the Contract Drawings.

2. Housekeeping pad shall be high quality concrete with rebar woven into floor rebar network. Concrete shall be precisely leveled so that equipment set in place will not require shimming.

D. Cleaning and Touch up:

1. At the completion of the work, all parts of the installation, including all equipment, exposed conduit, and fittings shall be cleaned and given touch up by Contractor as follows:
   a. Remove all grease and metal cuttings.
   b. Any discoloration or other damage to parts of the building, the finish, or the furnishings, shall be repaired.
   c. Thoroughly clean any of his exposed work requiring same.
   d. Vacuum and clean the inside of all electrical and instrumentation enclosures prior to applying power and at end of project prior to final acceptance.
e. Clean all above and below ground pull boxes, junction boxes, and vaults from all foreign debris prior to final acceptance.

f. Paint all scratched or blemished surfaces with the necessary coats of quick drying paint to match existing color, texture, and thickness. This shall include all prime painted electrical equipment, including but not limited to enclosures, panels, poles, boxes, devices, etc.

E. DEMOLITION

1. The Contractor shall coordinate all demolition activities with the Owner.

2. The Contractor shall note that the demolition effort is to be conducted on an operational system. The Contractor shall protect all sensitive electronic equipment, computer workstations and materials from dust, damage, falling debris, overspray and moisture.

3. The Contractor shall field verify all component functions prior to removal. Equipment that is removed that directly affects the manual operation of equipment shall be modified to provide for temporary manual control during the switch over. No equipment shall be removed that will prevent the manual operation of any equipment.

4. The Contractor at the end of each workday shall remove all materials; clean-up the working area vacuum and dust.

5. Areas requiring operations access during demolition shall be isolated and partitioned to protect the operations area and allow operators to perform their duties.

F. PROTECTION DURING CONSTRUCTION

1. Throughout this Contract, provide protection for materials and equipment against loss, damage, and the effects of weather. Prior to installation, store items to be installed in indoor locations. Items subject to corrosion under damp conditions and items containing insulation, such as control panels and instruments, shall be stored in indoor, heated, dry locations.

2. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. Keep openings in boxes or equipment closed during construction.

G. SITE CLEAN-UP

1. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from the premises and from the interior and exterior of all devices and equipment. Refinish damaged surfaces to new condition using skilled craftsmen of the trades involved, at no additional cost to the City.

3.07 TRAINING
A. Training shall be as specified in Section 13300.

3.08 SPARE PARTS

A. Spare parts shall be provided as specified in Section 13300.

3.09 WARRANTY

A. Prior to "final acceptance", the Contractor shall furnish to the Engineer a listing of warranty information for all manufacturers of materials and equipment used on the project. The listing shall include the following:

1. Manufacturer's name, service contact person, phone number, and address.

2. Material and equipment description, equipment number, part number, serial number, and model number.

3. Manufacturer's warranty expiration date.

B. The Contractor shall warrant all work supplied under this scope of work for a period of one (1) year from date of final acceptance. Standard published warranties of equipment, which exceed the preceding specified length of time, shall be honored by the manufacturer or supplier.

C. The Contractor shall provide all labor and material to troubleshoot, replace, or repair any hardware that fails or operates improperly during the warranty period, at no additional cost to the Owner.

3.10 FINAL ACCEPTANCE

A. Final acceptance will be given by the Owner after the equipment has passed the "final acceptance trial period", each deficiency has been corrected, final documentation has been provided, and all the requirements of design documents have been fulfilled.

B. Upon completion of the project, prior to final acceptance, remove all temporary services, equipment, material, and wiring from the site as the property of the Contractor.

C. At the end of the project, following the completion of the field tests, and prior to final acceptance, the Supplier shall provide the following to the Owner:

1. Each "operation and maintenance" manual shall be modified or supplemented by the Supplier to reflect all field changes and as-built conditions.

2. Two (2) disk copies of all final documentation.
D. Keys: Submit all keys including duplicates. Wire all keys for each lock securely together. Tag and plainly mark with lock number or equipment identification, and indicate physical location, such as panel or switch number.

END SECTION
Not Used
PART 1 GENERAL

1.00 SECTION INCLUDES

A. Overview of transmittal of submittals, submittal requirements, definition of submittal types and submittal list.

1.01 TRANSMITTAL OF SUBMITTALS

A. Mailing addresses:

City of Thornton
Attn: Jason Pierce
12450 Washington Street
Thornton, CO 80241

JSP AUTOMATION
Attn: James Phillips
225 30th Street, Suite 305
Sacramento, CA 95816

B. Submittals for Review: Transmit four (4) copies for review to the City and two (2) copies for review to JSP Automation. Two (2) copies will be returned.

C. Submittals for Closeout

1. Operations and Maintenance Manuals

   a. Preliminary Submittal: Transmit two (2) copies of manuals, one (1) to the City and one (1) to JSP Automation, two weeks prior to beginning of Site Acceptance Test. These copies will be returned after Site Acceptance Test, with comments.

   b. Final Submittal: Revise manuals and submit six (6) copies two weeks after receipt of comments to Preliminary Submittal.

2. Project Record Documents: Submit Project Record Documents no later than four weeks prior to the Site Acceptance Test.

1.02 SUBMITTAL REQUIREMENTS

A. Submit complete submittals using the pre-defined submittal number given in Submittal Schedule and List of this section.
B. Include a cover sheet with submittals indicating the following information:

1. Submittal number
2. Specification section
3. Specification article
4. Submittal type
5. Resubmittal number (-R1 for the first resubmittal, -R2 for the second resubmittal, etc.)

C. Prepare submittals to show that the material, equipment, and processes being offered conform to the requirements of the specifications.

D. Review submittals prior to transmittal to determine and verify field measurements, field construction criteria, manufacturer's catalog numbers, and conformance of submittals with specifications. The contractor shall certify compliance with contract specification requirements.

E. Within four weeks after receipt of a submittal, itemized comments will be returned. Each comment will be assigned an “Action Code,” as defined below:

1. Action Code “A” indicates “Reviewed-No Comment.”
2. Action Code “B” indicates “Reviewed-Make Corrections Noted (No Resubmittal Required).”
3. Action Code “C” indicates “Reviewed-Revise and Resubmit (Resubmit Required Items Only).” Action Code “C” comments will outline the following deficiencies:
   a. Materials or methods were found to be at variance with specification requirements.
   b. Incomplete submittal information to judge the material or method suitability.
   c. Incomplete submittal information per the specification section requirements of Article 1.05/1.06 in this section.

F. Submittal Clarity:

1. Drawings:
   a. Prepare finished drawings so that prints, reproducibles, and reductions to half size will be clear and legible.
b. Make free-hand lettering no less than 5/32 inch high and typewritten notes no less than 1/8 inch high to allow for reduction. Do not crowd lettering.

c. Give careful consideration to the accuracy, style, and position of notations.

d. Use precise and consistent line value and weight to enhance clarity and accuracy of the drawings.

e. Submit items in reproducible form, the same sizes and scale as the Contract Drawings.

2. Manufacturer’s Literature:

a. Unless otherwise stated, submit a minimum of one original of manufacturer’s printed material. Remaining number of submittals may be reproductions. Ensure reproductions of original material are clear and legible.

b. Clearly mark the item(s) and/or information applicable to this project with arrows, bubbles, etc. Do not use high-lighted markings.

c. Provide the name and phone number of manufacturer’s local CA sales and service representative for each device submitted.

G. Do not procure material, fabricate products, or begin work that requires submittals before such submittals are approved.

1.03 PRESUBMITTAL CONFERENCE

A. The Contractor shall arrange and conduct a Predesign and Submittal Conference within [30] days after award of the Contract. The purpose of the Predesign and Submittal Conference is to review and approve the manner in which the Contractor intends to carry out his responsibilities for system implementation, design submittal submission, and shop drawing submittals on the WORK to be provided under this and applicable specification sections.

1. The Contractor shall allot one, 8-hour day for the Conference.

2. The Contractor shall prepare and submit the following for discussion at the Conference:

a. List of major equipment and materials for the instrumentation, computer, PLC, radio and networking systems, including proposed manufacturer names and model numbers, and names and qualifications of engineers, programmers, and technicians.
b. List of proposed clarifications to the indicated requirements plus a brief written explanation of each exception.

c. One complete example of each type of submittal proposed.

B. The Contractor shall furnish six (6) copies of all the items above to the City 7 days prior to the presubmittal conference.

C. The Contractor shall take formal minutes of the Conference, including all events, questions, and resolutions. Prior to adjournment, all parties must concur with the accuracy of the minutes and sign accordingly.

1.04 DESIGN AND SHOP DRAWINGS

A. General:

1. Preparation of final designs and shop drawings shall not commence until adjournment of the Presubmittal Conference.

2. In the Contract Documents, all systems, meters, instruments, and other elements are represented by symbology derived from the latest version of ANSI/ISA S5.1. The nomenclature and numbers indicated herein shall be used exclusively in all designs and shop drawings. No manufacturers or vendors standard symbology or nomenclature shall replace those indicated in the Contract Documents.

3. Equipment not tagged or referenced shall be tagged and referenced in the design phase by the Contractor. Equipment and instrument tagging shall adhere to ISA standard guidelines and the standards implemented by the City. The Contractor shall be responsible for obtaining the latest City standards for new equipment tagging and referencing. The Contractor shall verify that equipment tags are unique and not duplicated within the existing facility.

4. During the period of shop drawing preparation, the Contractor shall maintain a direct, informal liaison with Project Manager for exchange of technical information. As a result of the exchange, the Project Manager may authorize certain minor refinements and revisions to the indicated systems informally but these shall not alter the WORK or cause increase or decrease in the Contract Price. During informal exchanges, no statement by the City and its representatives shall be construed as approval of any component or method or exception to or variation from these Contract Documents.

B. Drawings:

1. All shop drawings shall include the letterhead or title block of the Contractor. The title block shall include, as a minimum, the Contractor’s registered business name and address, project name, drawing name,
1.05 SYSTEM COMMISSIONING

A. The Contractor shall prepare a comprehensive system commissioning submittal package that includes all testing and commissioning procedures listed in Divisions 13, 16 and 17.

B. Commissioning Submittals shall include sequence of work, test forms and procedures, work required by the City, and anticipated time required to fully test and commission each system.

C. Commissioning procedures shall be prepared for each plant and system individually, and submitted for review prior to system commissioning efforts.

1.06 PROJECT SCHEDULE

A. Submit Project Schedule and Updated Monthly Schedules in conformance with Section 01200 Technical General Provisions.

1.07 DEFINITION OF “SUBMITTALS FOR REVIEW”

A. Catalog Data: Manufacturer’s standard printed information on materials, products and systems, which shows performance characteristics, dimensions, material of fabrication, and other characteristics necessary to assure conformity with the design requirements. Where other items or information not related to the work of this project are included in the literature submitted, the item(s) and/or information applicable to this project shall be clearly marked.

B. Shop Drawings: Drawings necessary to show fabrication details to ensure compliance with Contract Documents.
C. Block Diagrams: Block Diagrams necessary to show system connections and details to ensure compliance with Contract Documents.

D. Wiring Diagrams: Drawings showing the point-to-point or schematic wiring of a piece of equipment or between pieces of equipment in a system.

E. Calculations: The methods and results of calculations in documented form where specified.

F. Material/Parts List: A Bill of Material (BOM) list of system components or material components.

G. Samples/Colors: Samples, including colors, of proposed materials.

H. Certifications: A written statement, signed by a qualified individual, attesting that items or services are in accordance with specified requirements. Typically, this written statement is accompanied by additional information to substantiate the statement.

I. Nameplate Engraving List: A submittal of all Nameplate and Indicator engraving lists indicating nameplates’s type, size, color, text height and description. List shall be submitted for review and approval.

J. Installation Instructions/Test Procedures: Manufacturer’s instructions, step-by-step if necessary, showing the field installation and testing of parts, components, equipment, and other similar items.

K. Test Reports: Results of specified test requirements.

L. Meetings: Schedule, agenda, attendees, and location for required meetings and meeting notes.

M. Other: Other submittal information as described in individual specification sections.

1.08 DEFINITION OF “SUBMITTALS FOR CLOSEOUT”

A. Operations and Maintenance Manuals

1. Size: 8-1/2” x 11”. Provide envelope-type plastic drawing holders for information larger than this format.

2. Binders

   a. Use commercial quality expandable post binders. The Loose Leaf House Binder Co. Style No.178097 or equal.

   b. Provide clear plastic spine and front cover pockets. Fill pockets and spine with off-white cardstock printed with the following information:
1) Operations and Maintenance Manual

2) Volume X of Y

3) Project Name and Number

4) Manufacturer/Supplier

5) Equipment type

c. Do not fill binders more than 75% full.

3. Indexed Tabs: Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

4. Table of Contents: Prepare a Table of Contents for each volume, with each product or system description identified.

a. Part 1: Directory listing names, addresses, and telephone numbers of contractors and major equipment suppliers.

b. Part 2: Operations and maintenance data as described in specified submittal sections. For each section, identify names, addresses, and telephone numbers of contractors and suppliers.

c. Part 3: Warranty Certificates/Software Licenses, as described later in this section.

d. Part 4: Containerized material, indexed with labels.

5. Contents

a. General: Provide operations and maintenance data for equipment described in the respective Sections of Specifications. Prepare and include additional data when the need for such data becomes apparent during training.

b. Description of System and Component Parts

1) System block and interconnection diagrams.

2) Control diagrams by controls vendor and as-installed control drawing by Contractor.

3) As-installed wiring diagrams; ladder diagrams, point to point diagrams, loop diagrams, circuit directories of panelboards, and similar items.
4) Manufacturer’s printed installation, operating, and maintenance instructions for the exact item of equipment supplied.

5) Catalog data containing information required for service, future additions or substitutions.

6) Function, normal operating characteristics, and limiting conditions.

7) Performance curves, engineering data and tests.

8) Complete nomenclature and commercial number of replaceable parts.

c. System Operating Procedures

1) Description of sequence of operation by control manufacturer.

2) Routine and normal operating instructions.

3) Sequences required.

4) Special operating instructions.

d. System Maintenance Procedures

1) Routine operations

2) Guide to “trouble-shooting”

3) Disassembly, repair and reassembly

4) Alignment, adjusting and checking

e. Electronic Data: Electronic files on diskette of any material created electronically by Contractor including but not limited to:

1) Drawing Files

2) Installation Instructions

3) Software Documentation

4) Operating and Maintenance Instructions

f. Spare Parts List: List of manufacturer’s spare parts provided with the job, manufacturer’s current prices for spare parts, and recommended quantities to be maintained in storage.

g. Containerized Material: Label each item, in addition to the boxes, containing material that does not fit into binders. Examples include:
1) 8 ½ x 6” 3-hole punched bound material.

2) Other data sheets which are 8 ½ x 6” or smaller.

3) Edge-glued books or manuals without 3-hole punched binding.

4) Compact disks in jewel cases.

5) Extra cables.

6) Extra DB-connector cable adapters.

B. Project Record Documents:

1. As-Built Drawings
2. Interconnection Drawings
3. Documented Program Listings
4. Signed Test Procedures and Test Forms

C. Spare Parts/Maintenance Materials

1. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification sections prior to Final Acceptance.

2. Deliver to Project site and place in location as directed by Placer County Water Agency. Obtain receipt.

D. Warranty Certificates/Software Licenses

1. For each item required by specific sections of this specification, provide a notarized warranty certificate.

2. For each item of copyrighted software provided under this contract, provide a software license certificate naming Placer County Water Agency as the licensee and stating the number of licenses provided.

3. Provide Table of Contents of software licenses and incorporate into Operation and Maintenance Manuals as described above.

E. Electronic Media

1. Provide complete approved Operations and Maintenance manuals in electronic format on CD-ROM.

2. Provide electronic manuals complete with interactive “Table of Contents” in PDF format on CD-ROM.
3. Provide all drawings in Autocad latest version supported by the Owner on CD-ROM.
1.09 SUBMITTAL SCHEDULE

A. Make submittals for the items indicated in the Submittal List and those indicated in individual equipment sections to indicate the materials and equipment to be supplied. Provide submittals required by individual specification sections.

B. The submittal schedule is a general tabulation of the requirements identified in other specification sections. Omission of an item from this list does not relieve the Contractor from the responsibility for submitting the item required by a specific Specification section.

C. Submittal Requirements Table

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PART 2  PRODUCTS
2.00  NOT USED

PART 3  EXECUTION
3.00  NOT USED

END OF SECTION
Not Used
PART 1 -- GENERAL

1.01 REQUIREMENTS

A. The WORK of this Section includes the general specification and requirements for the instrumentation and control systems under this and other applicable specifications.

B. The Contractor, shall furnish, install, and place into service the operating process instrumentation, control systems, and all appurtenant work, all in accordance with the requirements of the Contract Documents. The Contractor shall procure equipment and obtain the services from a qualified Control Systems Supplier.

C. Instrumentation and Control Systems specified in Division 13 and Information Systems included in Division 17 shall be furnished, manufactured, wired and tested as a complete system by a qualified Control Systems Supplier (CSS). The CSS shall provide all equipment, materials, instrumentation and assemblies complete. The CSS shall provide, but not necessarily be limited to, installation coordination, factory testing, instrument programming and PLC programming, test programs, SCADA configuration, system commissioning, testing and final acceptance.

D. The CSS shall be responsible for the detailed design, procurement, installation coordination, testing, commissioning, training, and documentation of instrumentation and control systems provided under this Contract. The CSS shall be responsible for coordination and interfacing with the Owner’s representative to provide a coordinated communications interface with the Plant Control Systems and the Owner’s existing SCADA system. The CSS shall provide all hardware, application software, programming services, configuration, installation, factory testing, commissioning and training.

E. The CSS shall note that the equipment loop, logic, system, PLC and elementary diagrams are not manufacturer, model or part # specific and are based on non-certified, owner, packaged system supplier and vendor information to indicate a general scope of supply from the Equipment Manufacturers. The specifications address functional requirements, features and operation that may require additional options or components from the CSS to provide for a complete and functional system.
F. The CSS shall coordinate all requirements with the equipment manufacturers and materials suppliers at bid time to provide for a complete and operable system and shall include all costs in its bid to add additional instruments, wiring, computer inputs/outputs, controls, conduit, interlocks, electrical hardware, drawing revisions etc., into the design based on Equipment Manufacturer’s requirements and final certified prints to meet the specifications. Such changes to instrumentation and electrical work to meet the specification requirements shall be incorporated into the scope of work at no additional cost to the Owner.

G. Per the specified submittal requirements the CSS shall be responsible for the generation of panel wiring diagrams, equipment interconnection diagrams, network diagrams and loop drawings which depict the interconnection between instruments, control panels, field panels, electrical equipment, control equipment, motorized equipment, packaged systems and Motor Control Centers (MCC).

H. The P&ID’s, wiring diagrams and PLC Input/Output Lists are complimentary and supplemental to each other, what is indicated in one may not necessarily be indicated in the other documents. The P&ID’s, wiring diagrams and Input/Output list comprise the requirements for PLC input and output wiring. The CSS shall generate a complete I/O list.

I. The CSS shall generate a complete analog and digital loop drawing for each measuring and/or control loop. The loop drawing shall include information as specified in the submittal requirements for loop drawing preparation.

J. All control system field tests including factory tests, loop tests, site commissioning, operational readiness testing, plant startup, and final acceptance shall be the responsibility of the Contractor and CSS. The Contractor shall be responsible for providing field and facility personnel to perform factory and field testing in conjunction with the CSS for all systems associated with the PLC and SCADA. The Contractor/CSS shall be responsible for providing all personnel and equipment (current drivers, jumpers, read out devices, oscilloscopes, voltage-resistance meters, etc.) required to perform the loop test simulations. All devices used shall be traceable to the National Institute of Standards and Technology (NIST).

K. The CSS shall perform field engineering as required for mounting and supporting all field mounted components. The CSS shall develop any additional schematic and interconnection diagrams required to interface with existing systems, PLC and instrumentation equipment, which may be required for a complete and operable instrumentation and control system.
The CSS shall procure, fabricate, assemble, and configure the instrumentation and control system based on the requirements of Divisions 17, 16, 13, and related Sections.

Instrumentation materials, process wetted parts and installations shall be designed to be compatible with the process media, area environment and area classification in which it shall operate.

Instrument installation shall provide for unobstructed access to the instruments for calibration, diagnostics and process display. Instrumentation displays shall be protected from direct sunlight exposure and shall be provided with sunshields as required to provide legible display viewing during daylight hours at a 36" viewing distance.

The CSS shall design, procure, program, configure for testing, factory test, install, commission and support a PLC hardware system that shall integrate all process controls required to provide for a complete and operational system. The PLC system shall be designed in accordance with the manufacturer’s requirements for SCADA and PLC system communications. The CSS shall coordinate the final I/O arrangement and configurations at the time of submittal with the Owner or their designated representative.

The CSS shall field verify all existing instrumentation and logic systems prior to implementing the specified systems. The operation of switches and interlocking logic shall be confirmed to operate in either the Normally Open or Normally Closed states. The CSS shall provide interposing relays and wiring modifications necessary to meet the operational requirements specified and to properly interface new equipment with the existing equipment.

1.02 QUALIFICATIONS

The instrumentation, control, PLC, SCADA and communications system shall be furnished by a Control System Supplier (CSS) supplier who shall assume responsibility for the satisfactory performance of the system. Only those suppliers who can demonstrate that they possess the prerequisite capabilities and experience will be considered. Any supplier wishing to qualify must apply in writing to the Owner a minimum of 21 days prior to the bid opening date. Each applicant will be thoroughly examined, investigated, and then judged as to capability to execute the Scope of Work required on this project within the time frame allotted. Each applicant will be notified as to his approval or disapproval at least seven (7) days prior to the scheduled bid opening. Each applicant will be evaluated for the following minimum criteria:
1. Demonstrate the company's ability to successfully complete projects of similar size and nature. Provide references (including contact name and telephone number) for at least five (5) projects where the following tasks were performed by personnel directly employed by your firm as a system supplier; system engineering and documentation including panel assembly, schematics, and wiring diagrams; software configuration and documentation; field testing, calibration, and start-up; and operating instructions and maintenance training.

2. Name the individual persons who will be responsible for office engineering and project management; software configuration; field testing, calibration and start-up; and operator instruction and maintenance training. References called for in the previous item shall include recent projects for these individual persons.

B. The Project Engineer shall be a Registered Control Systems or Electrical Engineer in the State of Colorado.

C. Document that the company is actively in the business of furnishing integrated instrumentation, telemetry, control and electrical equipment for the water and waste water industries.

D. Have a qualified service facility with permanent employees located within 100 miles of the job site. Facility to include all tools, spare parts, and test equipment to repair, calibrate, test and start-up the equipment to be provided on this contract.

E. The Control System Supplier shall have a certified ISA control systems technician.

F. The Control System Supplier shall have a valid Contractors License.

G. The Control System Supplier shall have a UL authorized manufacturing facility.

1.03 RELATED SECTIONS

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

B. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK with respect to interfacing electrical and control systems packaged under the mechanical and civil specification sections.
C. Related Divisions shall include but not be limited to the following:

1. Division 17
2. Division 16
3. Division 13
4. Division 01

1.04 CODES

A. WORK of this Section shall comply with the current editions of the following codes:

1. Uniform Fire Code
2. National Electrical Code

1.05 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. ISA-RP60.6 Nameplates, Labels, and Tags for Control Centers
2. ISA-RP12.6 Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
3. ISA-S5.1 Instrument Symbols and Identification
4. ISA-S5.4 Instrument Loop Diagrams
5. ISA-S20 Specification Forms for Process Measurement and Control Instrumentation; Primary Elements and Control Valves

1.06 SUBMITTALS

A. Submittals shall be supplied in accordance with section 01300 and as supplemented or modified by this and other related specification sections.

B. Control panel submittals

1. Control panel submittals shall be grouped by location, area and process. Bill of Materials and fabrication drawings shall be individually grouped by facility, area and control panel.

2. A separate technical brochure or bulletin shall be included for each instrument, and equipment item, system, and other element. The
brochures shall be indexed by systems or loops. If, within a single system or loop, a single item is employed more than once, one brochure may cover all identical uses of that item in the system. Each brochure shall include a list of tag numbers to which it applies. System groups shall be separated by labeled tags.

3. Schematic and wiring diagrams for control circuits shall be submitted in two stages. Initially, schematic control diagrams shall show complete details on the circuit interrelationships of all devices within and outside each Control Panel. Subsequent to acceptance of all schematic control diagrams by the Engineer, piping and wiring diagrams shall be submitted. The diagrams shall consist of component layout drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as pumps, valves, chemical feeders and local control panels. Wiring diagrams shall include MCC Panel, circuit, and breaker number for each power feed.

4. Assembly and construction drawings for each alarm annunciator, local indicating panel, process control panel and for other special enclosed assemblies for field installation. These drawings shall include dimensions, identification of all components, surface preparation and finish data, and nameplates. These drawings also shall include enough other details, including photographs, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.

5. Installation, mounting, and anchoring details for all field instruments and components and assemblies to be field-mounted, including conduit connection or entry details.

6. Complete control panel layouts, all drawn to a 1-1/2 inch=1 foot scale showing:
   a. Physical arrangements which define and quantify the physical groupings of PLC components, annunciators, hand stations, recorders, indicators, pilot lights and all other instrumentation devices associated with control panel sections, auxiliary panels, subpanels and racks.
   b. All cutout locations fully dimensioned.
   c. All outside panel dimensions shall be shown.
   d. Locations of back-of-panel stiffeners.
e. Backpanel equipment layout and terminal point locations for all panel and back-of-panel piping and wiring connections. Terminations shall be coded with identifiers for wiring and piping connections for all electric, hydraulic and pneumatic terminations.

7. Bill of Material

a. A complete and detailed bill of material (BOM) list shall be submitted for each field mounted device or assembly as well as cabinet assemblies and subassemblies. Bills of material shall include all items within an enclosure. An incomplete submittal shall be rejected and no further evaluation performed until a complete and detailed bill of material is submitted.

b. The BOM shall be prepared specific to each panel, with a separate listing for each panel, subsection and assembly.

8. Calculations

a. Panel Power: Provide power load calculations and determine the maximum power required. Power requirements shall state required watts, voltages, currents, and phases. Power supplies shall be supplied to provide for a minimum of 150 percent at maximum load.

b. Panel Heat Load Calculations: Provide panel heat load calculations and determine heat dissipation and operating temperature. Heat dissipation shall be at maximum load and shall be stated in BTU per hour or watts. Operating temperature shall be calculated at the specified ambient temperatures or at 40 degrees C if no other ambient temperature is specified. If ventilation fans are used, provide audible sound level for the fans.

c. Control Panel Anchoring requirements in accordance with seismic and wind loading requirements per Section 16010.

d. Panel wireway fill calculations.

C. FIELD INSTRUMENTATION

1. Instrumentation Summary/Schedule and Bill of Material.

2. Technical brochures, bulletins and data sheets containing:

a. Fully completed ISA S20 data sheets

b. Technical Specification Data Sheets
c. Component functional descriptions

d. Locations or assembly at which component is to be installed

e. Materials of a component's parts which will be in contact with process fluids or gases

3. Instrumentation Loop Diagrams per ISA S-5.4

4. Field Installation and Mounting Drawings

D. PLC CONFIGURATION

1. The CSS shall provide a SCADA I/O database referencing all PLC I/O points, internal registers accessed by the SCADA and associated PLC setpoints. The Database shall utilize the same format and structure provided by the Owner in an Excel Spreadsheet.

2. PLC Inputs/Outputs, control modules and PLC programming shall be provided in accordance with the methods, formats and procedures outlined in Section 13350, 13370, 13371, 13372, 13373 and Division 17.

3. The SCADA I/O database shall be submitted for review by the Owner's representative. The CSS shall coordinate all communications requirements with the Master PLC, and existing SCADA system. The CSS shall provide all required I/O registers for access by the SCADA system including internal registers, setpoints, timers and counters as required to provide for complete monitoring and control from the SCADA system.

4. The CSS shall provide a PLC applications programming submittal fully documented and annotated as specified in section 13350. Submittal shall be provided in a three ring binder and electronically as a Modicon Concept program file for momentum series controllers and Quantum PLC’s.

5. All equipment shall communicate MODBUS TCP for in-plant communications and Modbus RTU for all radio and serial based communications, no equal.

E. SCADA/OIP CONFIGURATION

1. The CSS shall provide SCADA graphic submittals for all systems to be reviewed by the Owner. SCADA graphic screens, Pop-ups, system development and navigation format submittals shall be provided in conformance with Division 13 and Division 17 requirements.
2. Local Operator Interface Panels (OIP) shall be programmed and configured to support both OIP and SCADA access. The OIP shall be configured to provide all access, monitoring, control, alarming and user interface functions as that which is specified for the SCADA system interfaces.

F. EXISTING CONTROL SYSTEMS

1. The CSS shall provide the services of a qualified Field Technician to field verify and document all existing conditions for the purpose of creating an As-Built wiring diagram that will represent all existing and new wiring, new and existing terminations and final as-built configurations.

2. These drawings shall be submitted for review prior to switchover and commissioning of any new systems.

G. FACTORY OPERATIONAL TEST

1. The CSS shall submit comprehensive factory testing procedures, forms and reports complete. Testing submittals shall address all the factory testing requirements.

2. Reference Section 13320 for additional requirements.

H. SYSTEM START-UP AND COMMISSIONING

1. The CSS shall submit comprehensive testing procedures, forms and reports complete. Testing submittals shall address the testing and commissioning requirements for instrumentation and control and those referenced in Divisions 16, and 17.

2. Start-up test forms shall be submitted as follows:
   a. Installation Verification Forms
   b. Point Testing Forms
   c. Loop Testing Forms
   d. Instrument Calibration Forms
   e. Equipment Operational and Configuration Forms
   f. Process and operational testing
   g. Communication Test

3. Reference Section 13320 for additional requirements.
1.07 PROJECT MEETINGS

A. The CSS shall attend all required meetings associated with the procurement, fabrication and commissioning of the control systems. At a minimum the CSS shall attend:

1. Preconstruction Meeting
2. Presubmittal Conference
3. Submittal Review Meetings (Until Submittals are Approved)
4. Programming Clarification Meeting
5. Programming Demonstration Meeting
6. Two Coordination Meetings in addition to those specified
7. Pre-Commissioning Start-up Meeting
8. Weekly start-up and commissioning meetings

1.08 PROJECT COORDINATION

A. The CSS shall assign a dedicated project manager to act as the liaison between the Contractor and the Owner to coordinate all requirements for instrumentation and control system interfacing. The CSS shall be responsible for, but not necessarily limited to, the following:

1. Coordinating communications interface requirements between the remote sites, the plant Master PLC and SCADA.
2. Updating and maintaining a master I/O list for all systems.
3. Coordinating existing hardwired interlocks and signal interface requirements.
4. Start-up and testing requirements.

1.09 OPERATIONS MANUAL

A. Information included in the OWNER’S MANUAL shall comply with the requirements of specifications with the following exceptions:

1. Two (2) copies of the OWNER’S MANUAL shall be submitted after acceptance of all submittals under Paragraph 1.5. One set will be returned to the CONTRACTOR with comments.
2. Final Six (6) copies of the OWNER'S MANUAL, after revision, shall be submitted to the ENGINEER 15 days prior to startup.

3. The following shall be included in the OWNER'S MANUAL:
   a. Installation, connection, operating, troubleshooting, maintenance, and overhaul instructions from the manufacturer.
   b. Exploded or details views of all instruments, assemblies, and accessory components.
   c. Parts lists and ordering instructions.
   d. Wiring diagrams.
   e. A list of spare parts for 1 year operation recommended by the manufacturers of all analog equipment.

B. AS-BUILT DRAWINGS

1. As-built drawings shall be prepared in accordance with Section XXXX with the following exceptions and changes:
   a. The Contractor shall keep current an approved set of complete analog and digital loop diagrams and schematic diagrams which shall include all field and panel wiring, all piping and tubing runs, all routing, all mounting details, all point-to-point diagrams with cable, wire, tube and termination numbers. These drawings shall include all instruments and all instrument elements for the complete instrument loop as provided under Divisions 16, and 17 of this Contract.
   b. One set of original drawings and two copies of each as-built drawing under this Section shall be submitted to the ENGINEER after completion of field checkout but before placing the systems in service for the OWNER'S use.
   c. Drawings shall also be submitted in electronic format as both an Autocad and PDF file.
   d. The operations manual shall be provided in PDF format with a user interactive table of contents (TOC) that navigates from the TOC to the selected document.

1.10 SERVICES OF MANUFACTURER

A. Calibration, Testing and Startup: The CSS shall provide the services of a technical service representative of the manufacturer who shall visit the site
and perform the following on all flow meters, DO Analyzers and Chemical System Analyzers:

1. Installation Inspection.
2. Instrument check-out and calibration.
3. Instrument programming and configuration.
4. Startup and field testing for proper operation.
5. Performing field adjustments to ensure that installation and operation comply with the Specifications.

B. Instruction of OWNER'S Personnel: The manufacturer's technical service representative shall instruct the OWNER'S personnel on:

1. Equipment Operation
2. Maintenance
3. System Diagnostics
4. Calibration

1.11 SPECIAL GUARANTEE

A. The Contractor shall guarantee the WORK of this section for one year following substantial completion of the WORK. In making any warranty repairs, the Contractor shall utilize technical service personnel designated by the manufacturer of the failed device. Repairs shall be completed within 5 days after written notification by the OWNER.

1.12 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Products delivered to the site for incorporation into the WORK of this Section shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

Installed Equipment: Equipment installed in place for periods exceeding 24 hours prior to the field wiring and commissioning of electrical and electronic equipment shall be protected from dust and exposure to the elements.

C. Shipment: Panels shall be crated for shipment using a heavy framework and skids. Panel sections shall be cushioned to protect the finish of the instruments and panel during shipment. Instruments, which are shipped with the panel, shall have suitable shipping stops and cushioning material
installed to protect instrument parts from mechanical shock damage during shipment. Each panel crate shall be provided with removable lifting lugs to facilitate handling.

D. The CSS shall coordinate the shipment, delivery and set-up equipment at the CSS facility for a comprehensive system factory test. The CSS shall coordinate the set-up and interconnection of equipment with the CSS supplied control systems for factory acceptance testing.

E. The CSS shall package and deliver all equipment after the approved factory test, to the jobsite. The CSS shall coordinate all packaging, crating and delivery requirements with the Contractor prior to delivery to the site.

1.13 ENVIRONMENTAL CONDITIONS

A. General: All instrumentation and control system components and associated wiring shall be suitable for use in an environment where there may be high energy AC fields, DC control pulses, and varying ground potentials between transducers and system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.

B. Field Situated Equipment: The system design shall be adequate to provide proper protection in the environment typically associated with these facilities. As a minimum, the instrumentation and control systems shall be designed and constructed for satisfactory operation and low maintenance requirements under the following environmental conditions:

1. Temperature Range: 0 through 60 degrees C (32 - 144 degrees F)
2. Thermal Shock: 0.55 degrees C per minute (1.0 degrees F per minute)
3. Relative Humidity: 20 - 95 percent (non-condensing)
C. Control Room Situated Equipment: Control rooms shall be air conditioned to achieve the environmental noted in item B herein. (No positive control of relative humidity is provided.) In the event of a failure of the air conditioning system, all components of the instrumentation and control system shall be rated to operate in an environment where the ambient temperature is 15 through 35 degrees C (59 through 95 degrees F) and the relative humidity is 20 to 95 percent (non-condensing).

D. Noise Tolerance: The instrumentation and control system components shall not exceed a db level of 55 when monitored 3-feet away from the devices. If upon testing it is found that this limit is exceeded at the option of the ENGINEER and at no additional cost to the OWNER, devices shall be replaced in order to achieve a maximum level of 55 db or sound absorption materials shall be added.

1.14 FIELD CABLE AND CONDUCTOR NUMBERING

A. All cables and conductors shall be provided with a unique cable identifier.

1. The cable identifier shall be consistent with the control system naming conventions for field device and PLC I/O tagging.

2. Multi-conductor cables shall have a cable number which signifies the equipment group, field device or component; each individual conductor shall have a unique wire label.

B. The wire label shall utilize the following example:

1. Wire Label (Example) 10-FIT1101-S1(+)

a. The first characters “10” shall denote the equipment #, facility or area number if an area number is utilized within the plant environment.

b. The second group of characters “FIT” identifies the field device being served by an ISA or equipment tag reference.

c. The third group of numbers “1101” is the loop or equipment number.

d. The fourth character(s) “p” uses one of the suffixes in the table below. Where multiple circuits of the same type are routed to the same endpoint, the suffix will be P1, P2, as required.
e. At each device or termination point, the circuit identification number is appended with the individual wire number “1”, “2”, “3” etc. For Direct Current (DC) circuits only, wire polarity is shown in parentheses as (+) or (-). Spaces are not allowed, and letters are case-sensitive, and written in the upper case.

<table>
<thead>
<tr>
<th>SUFFIX</th>
<th>CIRCUIT TYPE</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(S)</td>
<td>Analog (4-20 mA)</td>
<td>FIT2101-S1(+)</td>
</tr>
<tr>
<td>(C)</td>
<td>120 volt AC control</td>
<td>LSH2101-C1</td>
</tr>
<tr>
<td>(D)</td>
<td>24v dc digital status or control</td>
<td>YIM2101-D1</td>
</tr>
<tr>
<td>(P)</td>
<td>Power (480 v, 5 kv, 15 kv, etc.)</td>
<td>50F11FA-P1</td>
</tr>
<tr>
<td>(L)</td>
<td>Power (120 v, 208 v, 240 v)</td>
<td>RW2101-L1</td>
</tr>
<tr>
<td>(T)</td>
<td>Communications</td>
<td>20MCP01-T1</td>
</tr>
</tbody>
</table>

1.15 GENERAL

A. All meters, all instruments, and all other components shall be of the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise indicated.

B. Outdoor instrumentation shall be suitable for operation in the ambient conditions at the equipment installation locations. Heating, cooling, and dehumidifying devices shall be incorporated with the outdoor instrumentation in order to maintain it within its rated environmental operating ranges.

C. The Contractor shall provide all power wiring for these devices.

D. Outdoor enclosures suitable for the environment shall be provided at the specified locations. Sunshields shall be provided for all outdoor equipment with operator displays.

E. All instrumentation in hazardous areas shall be intrinsically safe or be approved for use in the particular hazardous classification in which it is to be installed.

F. Mercury switches and components containing liquid mercury shall not be used.

G. Analog measurements and control signals shall be electrical and shall vary in direct linear proportion to the measured variable, except as indicated.
Electrical signals outside control board(s) shall be 4-20mA DC except as noted. Signals within enclosures shall be 1-5 volts DC unless otherwise specified. Dropping resistors shall be installed at all panel side terminations in the control panels to ensure loop integrity.

H. The accuracy of each instrumentation system or loop shall be expressed as a probable maximum error; this shall be the square-root of the sum of the squares of certified "accuracies" of the designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual instrument shall have a minimum accuracy of ± 0.5 percent of full scale and a minimum repeatability of ± 0.25 percent of full scale unless otherwise indicated. Instruments that do not conform to or improve upon these criteria are not acceptable.

I. Each control loop shall be individually fused.

1.16 INSTRUMENTATION AND CONTROL PANELS

A. General:

1. Control panels shall be provided as specified in Section 13340.

2. Equipment Framework and Supports:

   a. The rear of each control panel section or Instrument wall panel shall have a steel framework for supporting conduit, tubing, wireways, switches, air piping and all instrument accessory items such as relay or terminal enclosures, transducers, pressure switches, valves and air relays.

   b. The main framework shall be constructed of standard structural shapes. Special shapes such as "Unistrut" may be used for secondary supports. Framework must not interfere with instrument connections or access needed for maintenance or adjustments.

   c. Equipment framework shall be 316 Stainless Steel in Corrosive Area and Wet Areas listed in the Area Classification drawings or schedules.

   d. Chemical system equipment framework in chlorine area shall be Fiberglass, PVC Coated or composite materials conducive to the chemical systems.

   e. Preparation: The front and rear face of the panel, both sides and the edges of all flanges, and the periphery of all openings shall be prepared as follows:
(1) All high spots, burrs, and rough spots shall be ground smooth.

(2) The surfaces shall be sanded or sandblasted to a smooth, clean bright finish.

(3) All traces of oil shall be removed with a solvent.

(4) All welds, grinds and filed surfaces shall be appropriately treated to prevent corrosion.

f. Finishing

(1) A 3-mils dry coat of Amercoat 185 or equal primer shall be applied over the entire panel surface immediately after solvent cleaning.

(2) Wet sand, dry, and then quick glaze spot putty on the front of the panel only. Dry, then wet sand again and dry.

(3) Apply a second 3-mils dry coat of alkyd enamel primer to the front of the panel.

(4) Wet sand to smooth clear finish, and then dry.

(5) At least two 3-mil dry coats of air-dry, satin finish, alkyd enamel shall be applied over the entire surface. Color to be as selected by Owner.

(6) The CONTRACTOR shall furnish two 1-pint containers of the enamel to the Owner.

1.17 INSTRUMENT MOUNTING

A. The Contractor shall provide field cut-outs, installation mounting racks, bracing, shelving and stanchions, and shall mount all instrument and control items indicated, including any instruments indicated to be furnished by the Owner, other manufacturers and packaged system suppliers.

B. Installation details are not manufacturer specific and provide for general installation requirements. Details shall be modified based per the actual field equipment, site requirements and methods to meet instrument tolerances and seismic restraint.

C. The Contractor shall also mount, behind existing panels or panels supplied by others, other instrument accessory items as indicated or necessary for interfacing with equipment.

D. Control Panel Requirements
1. Controls panels shall be wired and fabricated in accordance with section 13340.

2. Field modifications of existing panels or electrical equipment shall adhere to the requirements of Section 13340.

3. The Contractor shall provide all wiring, conduit, wireways, interposing relays, auxiliary contacts and switches required to make instruments and other panel electrical devices operational.

4. Conduit, wireways, junction boxes and fittings shall be installed for all instrument power, signal and control wire. Provide in accordance with Division 16.

5. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. All wiring shall be identified with machine stamped tubular heat shrink wire markers.

6. Unless otherwise specified, wiring methods and materials for all panels shall be in accordance with the NEC requirements.

7. Wire for 115-volt control circuits shall be No. 14 AWG stranded with Type THWN/THHN insulation. All terminals for external wiring connections shall be suitable for No. 10 AWG wire.

8. Flexible seal tight (SLT) conduit shall be utilized only for short transitions (36") from instrument or equipment.

9. Soldered or pressure crimped wire splicing in conduits, wireways, ducts, and pullboxes shall not be acceptable.

10. For case grounding, panels shall be provided with a 1/4-inch by 1-inch copper ground buss completed with solderless connector for one No. 4 AWG bare stranded copper cable. The Contractor shall connect the copper cable to a system ground loop.

E. Instrumentation Requirements

1. Instruments located on a single panel section that serve one process unit may be connected to a common branch power circuit. The number of branch circuits shall be such that no circuit load exceeds 10 amps. Different panel sections and instruments serving different process units shall not use common branch circuits. A 15-amp, two-pole circuit breaker shall be provided in each branch circuit.

2. When instruments not equipped with integral fuses, the contractor shall furnish and install fuses as required for the protection of individual instruments and equipment against fault currents. Fuses shall be
mounted on the back of the panel, in a fuseholder, with each fuse identified by a service name tag.

3. Each potentiometer type instrument, electronic transducer, controller or analyzer shall have an individual disconnect switch. Disconnect switches shall have metal or plastic tags listing the associated instrument tag numbers. Individual plug and cord set power supply connections may be used without switches when indicated.

F. Field Signal Wiring:

1. Analog Signal cable shall be constructed of No. 18 AWG copper signal wires with THWN insulation.

2. Control conductors shall be 14 AWG minimum routed in conduit or troughs. Control conductors shall be THWN insulation.

3. Field Signal/Control Wire color code for wiring shall be:
   a. Equipment Ground – Green
   b. DC Control – Dark Blue
   c. AC Control – Violet
   d. DC Common - Grey
   e. AC Power (not used for control) – Black
   f. AC Neutral – White

4. Analog Signal Wiring Color Code
   a. Signal Positive – Black or Red (+)
   b. Signal negative – White or Clear (-)

5. Multi-conductor cables where indicated shall consist of No. 18 AWG copper signal wires twisted in and shielded in pairs, with 600 volt fault insulation. A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield.

6. Multi-conductor cables, wireways and conduit shall provide for 20 percent allocation of spare, unused signal wires in addition to the indicated requirements. The overall bundle jacket shall be PVC.
7. Remote I/O (RIO) and Modbus Plus (MB+) cabling shall be provided, installed and terminated in accordance with the manufacturers cabling and termination procedures. The CSS shall furnish and install all necessary cable taps, termination devices and connectors required to provide for a complete communications interface. Field taps or terminators required to meet distance and interconnection requirements shall be furnished and installed by the CSS.

G. Color Conventions: Lens covers/LED’s for indicating lights on all panels will be colored as follows:

1. Red-ON when;
   a. Motor not running (STOPPED)
   b. Valve CLOSED (not opened)
   c. Device not energized.
   d. Circuit breaker OPENED

2. Green-ON when;
   b. Valve OPEN (not fully closed)
   c. Device energized
   d. Circuit breaker CLOSED

3. White-ON when;
   a. Power available
   b. System in AUTOMATIC mode
   c. Monitoring taking place

4. Amber-ON when;
   a. Malfunction trip
   b. Equipment locked out
   c. Alarm condition
1.18 NAMEPLATES

A. Nameplates shall be provided for instruments, function titles for each group of instruments, and other components mounted on the front panel(s) as indicated. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, and electronic trip mounted inside the panel(s). Nameplates shall be descriptive to define the function and system of such element. These nameplates shall be of the same material as those on the front of the panel(s). Adhesives shall be used for attaching nameplates. Nameplates shall be fabricated from black face white-center laminated engraving plastic. Painted surfaces shall be prepared to allow permanent bonding of adhesives. Colors, lettering, styles, abbreviations and sizes shall be in conformance with ISA_RP60.6 with an intended viewing distance of 3 feet to 6 feet.

B. Equipment Interior Nameplates - Nameplate material shall be clear plastic with black machine printed lettering as produced by a KROY or similar machine; except caution, warning, and danger nameplates shall have RED lettering. The size of the nameplate tape shall be no smaller than 1/2" in height with 3/8" lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on a clean surface using the adhesion of the tape. Add additional clear glue to hold the nameplate securely in place when necessary. For each device with a specific identity (relay, module, power supply, fuse, terminal block, etc.) mounted in the interior of a piece of equipment provide a nameplate with the inscription as shown in the Contract documents. Where no inscription is indicated in the Contract documents, furnish nameplates with an appropriate inscription providing the name and number of device used on the submittal drawings. Stamp the nameplates with the inscriptions as approved by the Engineer in the submittal.
PART 2 -- PRODUCTS

2.01 GENERAL

A. Equipment and materials shall be products of reputable, experienced manufacturers. Similar items in the project shall be the products of the same manufacturer. All equipment shall be of industrial grade, a standard of construction, shall be of sturdy design and manufacture, and shall be capable of long, reliable, trouble-free service.

B. The field equipment panels shall be fabricated to house, controllers, instrumentation and communications equipment specified elsewhere and as indicated on the contract drawings. Control panels shall be fabricated and wired in accordance with Section 13340 and applicable specification sections.

C. Instrumentation control equipment shall be UL listed.

2.02 FIELD INSTRUMENTATION

A. Provide Instrumentation in accordance with Section 13330, Instrumentation.

2.03 COMPONENTS GENERAL

A. Field Terminal Blocks: Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 25 amperes at 600 volts. White marking strips fastened securely to the molded sections, shall be provided. Wire numbers or circuit identifications shall be marked thereon with permanent machine printed labels.

B. Indicators: Indicators shall be provided at the locations specified and shall be rated for the voltage required. Indicators shall be full-voltage Push-To-Test LED.

2.04 GENERAL INSTRUMENTATION COMPONENTS

A. General instrumentation components shall be provided as specified in Section 13330 Instrumentation and 13340 Control Panels.

B. Signal Isolators, Converters, and Power Supplies: Signal isolators shall be provided in each measurement and control loop, wherever required, to match adjacent component impedances, provide signal amplification, or where feedback paths may be generated or to maintain loop integrity when the removal of a component of a loop is required. Signal converters shall be provided where required to resolve any signal incompatibilities. Signal power supplies shall be provided to supply sufficient power to each loop component.
C. Power supply and conversion modules shall be supplied as required to provide the required equipment operational voltage and current. Power supplies shall be sized to provide 150 percent of the maximum current requirements.

D. General Purpose Relays: General purpose relays in the Control Panels shall be plug-in type with contacts rated [10] amperes at 120 volts ac; quantity and type of contacts shall be as indicated. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover with LED status indicator. Sockets for relays shall have screw type terminals.

E. Industrial Control Relays: Industrial control relays shall be 20 Amp rated with four-pole convertible contacts. The coil voltage shall be as required to interface with the required control logic. The ICR shall be capable of providing eight contacts with the addition of a four-pole module mounted to the deck assembly.

F. Time Delay Relays: Time delay relays shall be electronic on-delay or off-delay type with contacts rated 10 amperes at 120 volts AC. Units shall include adjustable dials with graduated scales covering the indicated time range. Timers shall be provided with status and timing LED indication.

G. Slave Relays: Slave relays shall be provided when the number or type of contacts indicated exceeds the contact capacity of the indicated relays and timers.

H. Circuit Breakers: Circuit breakers shall be single pole, 120 volt, 15 ampere (minimum) rating or as required to protect wiring and equipment. Circuit breakers shall be mounted inside the panels as shown.
PART 3 -- EXECUTION

3.01 GENERAL

A. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all elements, all instruments, all accessories, and all assemblies provided under this Contract.

B. The CONTRACTOR shall install all instruments per specifications and in accordance with the CSS and manufacturer's installation instructions. The CSS shall provide the following:

1. Perform field engineering as required for mounting and supporting all field mounted components.

2. Prepare any additional schematic and interconnection diagrams required for installation.

3. Assemble and interconnect instrument components disconnected for shipping purposes.

4. Remove all temporary supports, bracing, and padding inserted in instrument control panels and other equipment to prevent damage during shipping, storage, or installation.

5. Adequately support and protect capillary and bubbler tubing. All extra tubing shall be carefully coiled, tied, and protected at the instrument location.

6. Furnish and install all required mounting hardware in accordance with the area classification.

C. Instrument tubing and conduit shall be installed level and parallel with, or at right angles to, the structural members of buildings and support systems. Vertical runs shall be straight and plumb and installed with adequate strain relief to prevent damage and separation of conduits and conduit support systems.

D. All tubing installations shall allow clear and unobstructed access to equipment, doorways, controls, control panels, and field devices. Tubing and conduit installations shall allow easy removal of components or equipment. Components on tubing and conduit runs shall not be supported by the conduit or tubing, but shall be separately supported by a specified wall, frame or stanchion equipment mounting system.
E. All installations of conduit, piping, tubing, mounting hardware and equipment enclosures shall be field measured prior to fabrication and erection. Any significant discrepancies between drawings and field conditions shall be reported to the Engineer. The Owner will not be responsible for any costs to the Contractor for rework because of Contractor failure to take measurements prior to fabrication.

F. It is the intent of the Contract Documents that all installation, conduit, and wiring external to Control Panels is provided under the requirements of Division 16. Further, it is the general intent that all 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, and Control Panel input and output wiring, be provided under Division 16. Wire terminations and installation integrity shall be verified and tested under Division 13 by the CSS.

G. The Contractor’s attention is directed to the electrical and mechanical schematics and details of this project. Referral to these portions of the Contract Documents shall be required in order to understand the full intent and scope of work required.

H. Monitoring and control system configurations are diagrammatic only. Locations of equipment are approximate unless dimensioned on the drawings. The contractor shall determine exact locations and routing of wiring and cables, which shall be governed by structural conditions, physical interferences, area classifications and locations of electrical terminations and stub-up requirements of equipment.

I. The CONTRACTOR shall provide all necessary conduit fittings, boxes, extensions and adapters as required to connect the instrument and equipment to the conduit raceway system.

J. The CSS shall provide for installation by the Contractor all necessary process connectors, fittings and adapters required to connect the instrument to the process piping or process stream.

K. The CONTRACTOR shall provide for all chemical sample piping and chemical analysis system piping installations, valving and appurtenances as required by the manufacturer of the analytical equipment.

L. All flow thru, tee and insertion instrumentation sensors shall be installed with hot-tap assemblies or valving systems that allow the instrument to be removed from the system without disruption of the process.
M. All instruments shall be located and installed for ready access by the OWNER'S operation and maintenance staff. Instruments shall be installed with due regard for servicing and maintainability. The Owner reserves the right to require minor changes in location of equipment prior to roughing without any additional cost to the Owner. The contractor shall coordinate all final instrument installation locations and orientations with the Owner.

3.02 FIELD SIGNAL AND CONTROL CIRCUIT WIRING

A. Where field wiring of equipment and components is necessary, the installations shall be in accordance with Section 13340 for equipment installation.

B. All wires shall be in plastic wireways except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing-out panel to components on the fixed structure, and (4) wiring to panel-mounted components. Wiring from components on a swing-out panel to other components on fixed panels shall be tied into bundles with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals.

C. Wiring to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using adhesive mounts.

D. Wiring to rear terminals on panel-mount instruments shall be in plastic wireways secured to horizontal brackets above or below the instruments in about the same plane as the rear of the instruments.

E. Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using white numbered wire markers which shall be permanently marked heat-shrink plastic.
3.03 HAZARDOUS CLASSIFIED AREAS

A. Instrumentation and control equipment specified is subject to the requirements for hazardous (classified) areas as specified in Division 16 and indicated on the Drawings.

B. Two-wire transmitters to be installed in a hazardous (classified) area shall be Factory Mutual approved intrinsically safe, and made safe by means of suitably rated Factory Mutual approved intrinsically safe barriers installed in a nonhazardous area.

C. Switches to be installed in a hazardous (classified) area shall be made safe by means of suitably rated Factory Mutual approved intrinsically safe barriers or intrinsically safe relays.

3.04 INSTRUMENT CABLE TESTS

A. General: The following tests shall be performed on each instrumentation and control system cable. All tests shall be end-to-end tests of installed cables with the ends supported in free air, not adjacent to any grounded object. All test data shall be recorded on forms which are available from the Engineer. Complete records of all tests shall be made and delivered to the Engineer. The Owner's Representative who witnessed the testing shall sign each form.

B. Continuity tests shall be performed by measuring wire/shield loop resistance of each signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall vary by more than plus or minus 2 ohms from the calculated average loop resistance value.

C. Insulation resistance tests shall be performed by using a 500 volt megometer to measure the insulation resistance between each channel wire, between each channel wire and the channel shield, between individual channel shields in a multi-channel cable, between each individual channel shield and the overall cable shield in a multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 1 megohms shall be unacceptable.

3.05 FACTORY TESTING

A. All systems shall be factory tested prior to shipment to the job site.

B. Reference Section 13320 for Factory Operational Readiness Testing requirements.
3.06 INSTALLATION

A. Installation and Connection

1. The Contractor shall install and connect all field-mounted components, equipment enclosures and assemblies under the following criteria:

   a. Process sensing lines and air signal tubing shall be installed to the installation of conduit indicated in Division 16. Individual tubes shall be run parallel and near the surfaces from which they are supported. Supports shall be used at intervals not longer than 3 feet of tubing.

   b. Instrument tubing parflex, nylon or other type plastic tubing shall be routed in conduits.

   c. Bends shall be formed with the proper tool and to uniform radii and shall be made without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before insertion into fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.

   d. All flexible cables and all capillary tubing shall be provided in flexible conduits. Lengths shall be sufficient to withdraw the cables and tubing for periodic maintenance.

   e. RTD/Thermocouple lead wire shall be provided in dedicated conduit or wireway from the thermocouple to the control panel. Conduit or wireway shall be sized in accordance with the capacity of the instrument.

   f. After all installation and connections have been completed, a technical field representative of the CONTRACTOR shall check the WORK for polarity of electric power and signal connections, leaks at all process connections, and conformance with requirements. The technical field representative shall certify in writing to the ENGINEER that each loop and system meets requirements.

   g. All wire and all cable shall be connected from terminal to terminal without splices, arranged in a neat manner and securely supported in cable groups. All wiring shall be protected from sharp edges and corners.
h. At least 30 days before installation testing begins, the Contractor shall submit to the Engineer a detailed description, in duplicate, of the installation tests to be conducted to demonstrate correct installation of the instrumentation and control system and the anticipated dates the testing will occur.

3.07 EXISTING SYSTEM OPERATION

A. The specified system modifications, upgrades and commissioning services are performed on an operational system. The CSS shall provide all necessary modifications, wiring and materials necessary to maintain local operation of the facility during switch-over and commissioning.

B. Temporary controls shall be provided by the CSS where facility shutdown requirements will exceed 4 hours.

C. The CSS shall coordinate on a site by site basis the allowable downtime, minimal control requirements hand control and any minimal temporary local automatic controls such as pump start/stop and interlocks that must be maintained during switchover.

D. CSS shall schedule all associated downtime and switchover requirements with the City 14 days in advance of any station shutdown.

3.08 SYSTEM COMMISSIONING

A. All systems shall be inspected, tested, configured, calibrated, pre-commissioned and commissioned by the CSS.

B. Control system testing for PLC and SCADA system operation shall be a joint effort between the Contractor and Owner to facilitate the start-up and commissioning effort.

C. The CSS shall coordinate all testing and commissioning efforts with the Contractor for systems supplied by the CSS and its interface requirements with the existing control systems.

D. Reference Section 13320 for System Commissioning requirements.
3.09 TECHNICAL SERVICES

A. In addition to the services required for start-up, commissioning, testing and other services described in these and other specifications necessary for a complete and operational system, the CSS shall provide additional field technical and configuration services to be utilized at the direction of the Owner. The services to be performed shall include but not be limited to the following:

1. Field Technical Services
   a. The CSS shall provide for an additional 100 hours of field technical services to include:
      (1) Instrument verification and calibration of equipment not shown, or existing or added during the course of construction by the Owner and Packaged System Suppliers.
      (2) Modification of control systems to interface desired options or additional interlocks with packaged system suppliers and motor control centers not indicated or required for operation of the system.
      (3) Additional technical services to be directed by the Owner.

2. Commissioning Technical Services
   a. Reference Section 13320

3. PLC Technical Services
   a. Reference Section 13350 and 13370.

B. Written tasks will be initiated by the Owner to identify the work to be performed as a part of the field technical services. The hours shall be directed by the Owner and tracked on a time basis. The time deducted shall be the actual field time provided to accomplish the required task.
3.10 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall furnish to the Owner, Six (6) complete sets of operation and maintenance manuals. The manuals shall include date, information drawings, etc., for the system, subsystem, and all components, and shall include names, addresses and telephone numbers of equipment suppliers, representatives and repair facilities.

B. This shall include a complete description of the recommended operating procedures, maintenance procedures, and spare/replacement parts list for equipment items with catalog data, diagrams, and drawings or cuts describing the equipment. Each set shall include full size assembly and wiring diagrams; drawings showing "as-built" conditions shall be furnished to the Owner.

3.11 TRAINING

A. Instruction: The Contractor shall train the Owner's maintenance personnel in the maintenance, calibration and repair of all instruments provided under this contract.

B. The training shall be performed by qualified representatives of the instrument manufacturers and shall be specific to each instrument model provided. Instructors shall have at least 2 years of training experience.

C. Each training class shall be a minimum of [2] hours in duration and shall cover Operational Theory, Maintenance, Trouble Shooting/Repair, and Calibration of the instrument.

D. Proposed training material, including resumes for the proposed instructors and a detailed outline of each lesson shall be submitted to the Engineer at least 30 days in advance of when the lesson is to be given. The Engineer shall review the submitted data for suitability and provide comments that shall be incorporated into the course.
3.12 FINAL ACCEPTANCE TEST (FAT)

A. After start up and commissioning has been completed, the System shall undergo a 30-day Final acceptance test (FAT).

B. The FAT shall not commence until all training is complete and the operations and maintenance manuals approved as-noted.

C. The System must run continuously for 30 consecutive days. During this period, all system functions shall be exercised by the Owner. Any System interruption and accompanying component, subsystem, or program failure shall be logged for cause of failure, as well as time of occurrence and duration of each failure.

D. When the cause of a failure has been corrected, a new 30-day acceptance test shall be started. Each time the Contractor’s technician is required to respond to a System malfunction, he must complete a report that shall include details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.

- END OF SECTION -
SECTION 13320
SYSTEM TESTING, COMMISSIONING AND QUALITY CONTROL

PART 1 -- GENERAL

1.01 REQUIREMENTS

A. The Control System Supplier (CSS) shall fully commission and test the entire SCADA, Instrumentation and Control System complete.

B. Factory, functional and operational testing shall be a collaborative effort between the CSS, the Owner and their designated representatives to verify all system operations related to the Instrumentation, SCADA and PLC control systems.

C. The CSS shall assign a project manager to the commissioning process for the coordination of and scheduling of system testing and implementation. The CSS project manager shall be the single point of contact for all start-up and commissioning efforts related to the instrumentation and control systems.

1.02 COORDINATION

A. The CSS shall coordinate all testing with the existing control systems, Owner’s representatives, construction manager and electrical Contractor to verify operation between all systems.

1.03 RELATED WORK IN OTHER SECTIONS

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

B. Reference Division 13, 16 and 17 for additional testing and commissioning requirements.
1.04 SUBMITTALS

A. The CSS shall prepare testing and quality control submittals specific for the project. The CSS shall submit the following:

1. Instrument Calibration Forms
2. Loop Commissioning Forms
3. PLC point testing forms
4. Testing Procedures
5. Test Reports
6. Checklists and Sign-Off Sheets
7. Equipment Set-up and Test Configuration

B. Factory Operational Readiness Test Procedure

1. The CSS shall submit comprehensive-testing procedures, forms and reports complete. Testing submittals shall address all the factory testing requirements.

2. Factory test forms shall be submitted as follows:
   a. Manufacturing and Assembly Verification Forms
   b. Point I/O Testing Forms
   c. Analog Loop Testing Forms
   d. Communications Testing Forms

3. Reference Section 13300 for additional requirements.

C. Commissioning Test Plan

1. The CSS shall develop and submit for approval a Commissioning Test plan which describes detailed test procedures, checklists, blank forms, and data to be recorded, including test equipment to be used with calculated tolerance limits.
2. Testing plan shall be broken out per the various test sequences to address:
   a. Digital Point Testing
   b. Analog Loop Testing
   c. Instrument Loop Tests
   d. Instrument and Equipment Calibration Forms
   e. PLC I/O Point Test Forms
   f. Functional equipment testing
   g. Communications System Testing
   h. Operational Readiness Testing
   i. Operational Testing

D. Commissioning Schedule
   1. A system commissioning schedule shall be provided. The schedule shall indicate the testing of each system, subsystem and component including the control systems of the packaged system suppliers.

E. Reference Section 13300 for additional submittal requirements.

F. Reference Section 13350 and 13370 for PLC and software testing requirements.

PART 2 -- TEST EQUIPMENT

2.01 GENERAL
   A. The CSS shall furnish all necessary test equipment to fully document and verify system operation.

2.02 TESTING AND DIAGNOSTIC SOFTWARE
   A. All instruments and equipment shall be provided with any available testing and diagnostic software.

   B. The testing and diagnostic software shall be turned over to the Owner with the Operations and Maintenance materials.
2.03 COMMUNICATIONS TEST EQUIPMENT

A. Not Applicable

2.04 DIAGNOSTIC EQUIPMENT

A. Diagnostic Portable Laptop: Provide a diagnostic laptop for system testing and control. The diagnostic laptop shall be provided with all test software and software modules loaded. The software modules shall be those products supplied by the various instrument manufactures for testing and calibration of their products. The Portable laptop shall be configured with the following:

1. Radio Diagnostic Software and Utilities
2. Microsoft Windows 7, Office Professional, Adobe Acrobat
3. Instrument Software Utilities
4. PV Charger and Inverter Utilities
5. I/O Module Utilities
6. PLC Programming Software

B. The CSS shall create a user interactive directory on the laptop which shall include all testing software modules, instrumentation operations manuals, in PDF, format and associated configuration software modules supplied with the equipment.

PART 3 -- EXECUTION

3.01 FACTORY OPERATIONAL READINESS TEST

A. General

1. It shall be the responsibility of the CSS to furnish all facilities, necessary testing devices and sufficient manpower to perform the tests required by the Engineer to determine conformance to the requirements of the Contract Documents.

2. The CSS factory test facility shall be located within 90 miles of the project. When approved by the Owner, for factory testing in locations outside the designated area, the CSS shall pay for and cover all cost for two Owner representatives to witness and participate in the factory testing.
3. The CSS shall coordinate the delivery of all designated packaged control systems to their facility for testing. The CSS shall receive, open, assemble, set-up, and test in accordance with the packaged system suppliers requirements.

4. The CSS shall coordinate the delivery of all packaged control systems from the CSS facility to the job site for installation.

5. The complete control systems shall be factory tested prior to installation of the control panels, PLC, communications and SCADA system. The Factory Operational Readiness Tests (FORT) for the entire system including any designated Packaged Control Systems shall be conducted at the CSS manufacturer’s facilities as a complete and operable system including the SCADA, OIP and PLC’s for all systems supplied and indicated on the Contract Drawings.

B. Factory Inspection

1. Instrumentation and control panels shall be inspected for compliance with specified requirements at the factory prior comprehensive system factory testing and before shipment to the CSS and from the CSS facility to the job site. The Contractor shall notify the Engineer six weeks in advance of the testing date. A representative of the Owner and Project Manager will visit the factory to make the inspection.

2. A preliminary factory test shall be provided by the CSS. The CSS shall perform the following inspection and tests prior to arrival of the Engineer:
   
   a. All air lines adequately tested for leaks.

   b. All alarm and interlock circuits rung out to determine their operability.

   c. Electrical circuits checked for continuity and where applicable, operability.

   d. Basic panel operation.

   e. Packaged system panels are wired and assembled per the contract requirements and approved submittals.

   f. Nameplates checked for correct spelling and correct size of letters.

   g. Other tests deemed necessary by the Engineer that are required to place the panel in an operating condition.
3. If the above tests have not been performed prior to the arrival of the Engineer, the Contractor shall reimburse the Owner for the cost of the extra time required for the inspector’s services and travel expenses.

C. Factory Testing

1. The CSS shall set-up, configure and interconnect all PLC panels and computer equipment in an environmentally controlled area with sufficient space and access for PLC and SCADA system testing by the Owner’s system programmer. The system shall remain set-up until the factory testing is completed by the system programmer.

2. The CSS shall coordinate the delivery of, set-up and configuration of any packaged system control panels to be included as a part of the overall test. The CSS shall allow for space, interconnection and power of equipment supplied by others.

3. The CSS shall coordinate all panel configuration and interconnection requirements.

4. The CSS shall furnish and install all temporary interconnection cables and terminations for loop testing, PLC and SCADA communications and analog signal tests.

5. Tests shall be conducted to exercise all process variables and confirm setpoint trip points, process permissives, process interlocks, alarming and control functions. The CSS shall provide the necessary personnel to operate, simulate, test and confirm all SCADA and PLC associated functions pertaining to graphical displays, setpoint interaction, PLC control strategies, alarm monitoring and manual control of the equipment with the Owner and Owner’s representative.

6. The CSS shall prepare a FORT test procedure in the form of I/O checklists, calibration sheets for analog I/O tests that exercise all normal, emergency and alternative control modes. I/O checklist shall reference each I/O by type, tag and description with a checkbox to verify PLC operation, Communication, SCADA Display, Alarm Function and Command function with a comment field for testing notes.

7. The CSS shall set-up and configure a programming workstation to display all PLC input and output registers being tested and verified.
3.02 SYSTEM PRE-COMMISSIONING

A. General

1. Pre-commissioning testing shall be conducted prior to any system commissioning efforts, to verify general equipment installation, instrument calibration and equipment configurations are per the specified requirements.

2. The CSS shall provide all necessary labor, tools, and equipment to field test, inspect and adjust each instrument to its indicated performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirement, or any published manufacturer performance specification for functional and operational parameters, whether or not indicated in the Contract Documents, shall be recalibrated, repaired or replaced, at the discretion of the Engineer at no additional cost to the Owner.

3. Prior to System Commissioning all cable testing shall be complete as follows:
   a. Continuity Tests
   b. Megger Testing
   c. Communications Cable Testing
   d. Field Conductors terminated and labeled

B. Equipment Installation Verification

1. The CSS shall confirm all equipment is installed and terminated in conformance with the contract drawings, approved interconnection drawings and manufacturers recommended procedures.

2. The CSS shall verify:
   a. Operational Voltages
   b. Fuse Sizes
   c. Equipment Terminations
   d. Ventilation
C. Basic Operational Testing

1. All equipment shall undergo a basic individual equipment operational test to confirm the following:

   a. Equipment Rotation
   
   b. Operator Switches are functional
   
   c. Indicators are operating correctly
   
   d. Equipment displays do not indicate failure

D. Communications Cabling Test

1. The CSS shall test all plant communications links utilizing communications test equipment and diagnostic software to verify that a viable communications link is established.

E. Instrument Calibration

1. All analog and discrete instrumentation and all control system equipment shall be field calibrated and tested after installation to verify that requirements are satisfied.

2. The CSS shall provide all necessary labor, tools, and equipment to calibrate and test each instrument in accordance with the manufacturer's instructions. Each instrument shall be calibrated at a minimum of three points, using test equipment to simulate inputs and read outputs.

3. All test equipment and all instruments used to simulate inputs and read outputs shall be suitable for the purpose intended and shall have accuracy better than the required accuracy of the instrument being calibrated. Test equipment shall have accuracies traceable to the NIST as applicable. All analog instruments shall be calibrated and tested in place without removal.

4. Test data, applicable accuracy requirements, all instrument manufacturer published performance specifications and all permissible tolerances at each point of calibration shall be entered on submitted test forms. These test forms shall verify compliance with all.

5. The Owners’ field representative shall witness all instrument calibrations.
6. A calibration report shall be delivered to the Engineer for each instrument, certifying that the instrument has been calibrated in the presence of the Owner’s designated representative and meets contract and system requirements.

F. Point Testing

1. Digital Loop Test: The CSS shall be responsible for loop checking and testing all digital instrument, device and equipment status loops including digital loops associated with the packaged system supplier’s equipment. The CSS shall coordinate all loop check functions with the PLC and SCADA system, final element, PLC logic and intermediate equipment to ensure that a single total loop check is conducted. The intent of the loop checks is to confirm and document each loop's component specification conformance up to and including all field-situated devices.

2. Analog Loop Tests: The CSS shall be responsible for loop checking and testing all instrumentation loops including instrument loops associated with the packaged system supplier’s equipment. The CSS shall coordinate all loop check functions with the PLC and SCADA system, final element, PLC logic and intermediate equipment to ensure that a single total loop check is conducted. The intent of the loop checks are to confirm and document each loop's component specification conformance up to and including all field-situated devices.

3. Programmable Controllers, Operator Interface Units, and Electronic Function Modules shall be tested and exercised by the CSS with the Owner's representative to demonstrate the correct operation; first individually and then collectively as functional analog networks.

G. Functional Loop Testing

1. Each hardwired analog control network shall be tested to verify proper performance within indicated accuracy tolerances. Accuracy tolerances for each analog network are defined as the root-mean-square summation of individual component accuracy tolerances. Individual component accuracy tolerances shall be as indicated by contract requirements, or by published manufacturer accuracy specifications, whenever contract accuracy tolerances are not indicated.

2. Each analog network shall be tested by applying simulated inputs to the first element(s). Simulated sensor inputs corresponding to 10 percent, 50 percent, and 90 percent of span shall be applied, and the resulting outputs read to verify compliance to network accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation of discrete devices. Temporary settings shall
be made on controllers, alarms, etc. during analog loop tests. All analog loop test data shall be recorded on test forms, which include calculated root-mean-square summation system accuracy tolerance requirements for each output.

3. When installation and loop tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the Owner’s representative as a witness, with test data entered, shall be submitted together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, fully inspected, and fully tested.

4. Functional loop test will be tested end to end with the SCADA/PLC system utilizing a diagnostic test screen to verify range, scale and I/O channel from the instrument to the PLC. The CSS shall coordinate PLC testing of the analog loops with the SP.

3.03 SYSTEM COMMISSIONING

A. General

1. System commissioning shall be a joint effort between the Contractor and Owner to facilitate the plant start-up.

2. The Contractor and CSS shall provide qualified start-up and testing representatives on-site, performing, assisting and participating in the testing full-time, for the duration of System Commissioning.

3. Provide additional staff as needed to operate equipment, provide safety, verify field signals, verify equipment operation, etc.

B. Functional Testing

1. All equipment shall be functionally tested to be ready for full operation as a part of the operational readiness test and prior to process testing.

2. General equipment items shall be functionally tested to be operational by the CSS and Contractor.

C. Operational Readiness Testing (ORT)

1. The CSS shall responsible for demonstrating the operability of all electrical controlled and monitored equipment provided under this and other related specifications. The ORT shall commence after acceptance of all wire, all calibrating and loop tests, and all inspections have been conducted. The ORT shall demonstrate proper operation of all sub-systems with process equipment operating over full operating ranges under actual operating conditions possible.
2. Operational readiness testing activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational.

3. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers, as required, to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments, as required, to eliminate excessive oscillatory amplitudes and decay rates.

4. All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset or rate setting(s) as required to achieve a proper response. Tuning shall be based on the ¼ amplitude response method.

5. Equipment functional testing
   a. All individual equipment items shall be functionally tested in hand, local auto and auto to verify proper equipment configuration and operating status.
   b. Functional tests shall include verification of hardwired interlocks with other equipment.

6. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 10 percent, 50 percent and 90 percent of span and the results checked against indicated accuracy tolerances. Accuracy tolerances are defined as the root-mean-square summation of individual component accuracy tolerances.
7. Individual component accuracy tolerances shall be as indicated in the Contract Documents or as specified by published manufacturer accuracy specifications whenever not indicated.

D. Process Control Testing (PCT)

1. Process Control Testing shall proceed after all equipment has been functionally tested and commissioned per the operational readiness testing requirements including those systems provided by the Packaged System Suppliers and the Control System Supplier to be operational.

2. Process Testing: The CSS and Contractor shall furnish his own personnel, electrical personnel, and any instrument manufacturer’s representatives as required during the testing period to produce and maintain a fully operational system.

3. Process testing shall be conducted by the CSS and Contractor in conjunction with the Owner to operate the system under various load and operational conditions. The operational testing shall include all normal modes of operation, alternate models of operations, demonstrate all back-up control systems, demonstrate all emergency power systems and operate the system under various control scenarios. The CSS and Contractor shall provide field personal to exercise all modes of operation and demonstrate the system to the Owner.

4. The Contractor shall submit instrumentation and control ORT completion report which shall state that all Contract requirements have been met and shall include a listing of all instrumentation and all control system maintenance and repair activities conducted during the pre-commissioning testing. The Engineer must accept the instrumentation and control system pre-commissioning testing before the 15 day Final Acceptance Test may begin. Final acceptance of the control system shall coincide with final acceptance of the WORK.

3.04 FINAL ACCEPTANCE TESTING

A. Upon completion of Operational Readiness Testing, the entire system shall undergo a Final Acceptance Test (FAT). The acceptance test shall be performed by the Owner to exercise all systems.

B. The FAT shall not commence until all Operations and Maintenance Manuals, As-Built Drawings and Field Interconnection Drawings have been submitted and approved the Owners personnel has been fully trained and all spare parts provided.
Not Used
13320-A

SAMPLE TEST FORMS
Process Input Test Form  
PLC Flow Trip Module

Project Name: American River Pump Station  
Loop Designation: FIT-1200  
Loop Description: Flow Monitoring

Description

When possible vary the actual process variable to establish the process control requirements necessary to confirm operation and the various setpoint parameters. Enable all alarms and setpoint trip modes of operation. Increase/decrease the process values above/below the setpoints and confirm each alarm setpoint trip and time delay on listed. Disable all alarms and confirm that the alarms are disabled by increasing/decreasing the process value above/below the setpoints indicated. Verify each trip point at the SCADA and Local OIP level.

Alarm verification

For each alarm listed confirm that the alarm is triggered at the process display, is indicated in the alarm summary and is logged to the alarm history file. Confirm that the alarm can be acknowledged and reset at the OIP and SCADA level. Change the setpoint values from the local OIP and SCADA to confirm that each setpoint changes accordingly.

Flow Totalization:

Set the process value at 50 percent and confirm that the flow totalizers are incrementing. Confirm that the cumulative and resettable totalizer match. Reset the resettable totalizer and confirm that it resets to zero.

<table>
<thead>
<tr>
<th>Tag #</th>
<th>Process Setpoint</th>
<th>Alarm Delay Setpoint</th>
<th>Alarm/Event Trigger</th>
<th>Control Action</th>
<th>Initials</th>
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Alarm Enabled Operation Verified: Initial:  
Alarm Disabled Operation Verified: Initial:  
Alarm Operation Verified: Initial:  
Signal Out of Range Alarm Verified: Initial:  
Setpoint Change Verified: Initial:  
Flow Totalization Verified: Initial:  

Comments:

Tested By: __________________ Date:_______________  
Witnessed By: __________________
Process Input Test Form  
PLC Setpoint Trip Module

Project Name: American River Pump Station  
Loop Designation: PIT-1000  
Loop Description: System Pressure

Description

When possible vary the actual process variable to establish the process control requirements necessary to confirm operation and the various setpoint parameters. Enable all alarms and setpoint trip modes of operation. Increase/decrease the process values above/below the setpoints and confirm each alarm setpoint trip and time delay on listed. Disable all alarms and confirm that the alarms are disabled by increasing/decreasing the process value above/below the setpoints indicated. Verify each trip point at the SCADA and Local OIP level.

Alarm verification

For each alarm listed confirm that the alarm is triggered at the process display, is indicated in the alarm summary and is logged to the alarm history file. Confirm that the alarm can be acknowledged and reset at the OIP and SCADA level. Change the setpoint values from the local OIP and SCADA to confirm that each setpoint changes accordingly.

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Alarm Enabled Operation Verified: Initial: 
Alarm Disabled Operation Verified: Initial: 
Alarm Operation Verified: Initial: 
Signal Out of Range Alarm Verified: Initial: 
Setpoint Change Verified: Initial: 

Comments:

Tested By: ___________________________  Date: ________________
Witnessed By: ________________________
Process Input Test Form
PLC Alarm Trip Module

Project Name: American River Pump Station
Loop Designation: AIT-1100
Loop Description: Chlorine residual

Description

When possible vary the actual process variable to establish the process control requirements necessary to confirm operation and the various setpoint parameters. Enable all alarms and setpoint trip modes of operation. Increase/decrease the process values above/below the setpoints and confirm each alarm setpoint trip and time delay on listed. Disable all alarms and confirm that the alarms are disabled by increasing/decreasing the process value above/below the setpoints indicated. Verify each trip point at the SCADA and Local OIP level.

Alarm verification

For each alarm listed confirm that the alarm is triggered at the process display, is indicated in the alarm summary and is logged to the alarm history file. Confirm that the alarm can be acknowledged and reset at the OIP and SCADA level. Change the setpoint values from the local OIP and SCADA to confirm that each setpoint changes accordingly.

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Alarm Enabled Operation Verified: Initial:
Alarm Disabled Operation Verified: Initial:
Alarm Operation Verified: Initial:
Signal Out of Range Alarm Verified: Initial:
Setpoint Change Verified: Initial:

Comments:

Tested By: ___________________________ Date: ________________
Witnessed By: ___________________________
## DISCRETE INPUT TEST FORM (1-1)

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<th>CONTROL ACTION (3)</th>
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<th>ETM/START COUNTER (6)</th>
<th>SCADA ALARM (7)</th>
<th>SCADA EVENT FILE (8)</th>
<th>SCADA ALARM FILE (9)</th>
<th>SCADA ALARM RESET (10)</th>
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<td>Control</td>
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1. Jumper or trigger input at field wiring terminal and verify PLC input trigger
2. Verify Time Delay and Setpoint Change From 5 to 10 Seconds
3. Verify associated control action per control descriptions i.e. (Start, Stop, Event, alarm)
4. Verify appropriate input trigger at SCADA diagnostic display.
5. Verify appropriate input trigger at SCADA process Display.
6. Verify run timer is operational and start counter increments
7. Verify alarm display, alarm summary and alarm logging for each alarm event.
8. Verify event logging.
9. Verify appropriate input trigger at SCADA Display Pop-Up
10. Verify alarm management at SCADA

**TESTED BY:**

**DATE:**

**WITNESSED BY:**

**DATE:**
<table>
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<tr>
<th>TAG REFERENCE</th>
<th>TAG DESCRIPTION</th>
<th>CONTROL</th>
<th>PLC OUTPUT</th>
<th>TIME-DELAY</th>
<th>PLC AUTO CONTROL</th>
<th>SCADA DIAGNOSTIC</th>
<th>SCADA PROCESS</th>
<th>SCADA MANUAL</th>
<th>SCADA POP-UP</th>
<th>SCADA OOS</th>
<th>COMMENTS</th>
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<td>YCS-1010</td>
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</table>
**TAG REFERENCE** | **TAG DESCRIPTION** | **SIGNAL RANGE** | **ENGINEERING UNITS** | **PLC INPUT (RAW)** | **PLC INPUT (SCALED)** | **SCADA DIAGNOSTIC** | **SCADA PROCESS** | **SCADA TREND** | **SCADA POP-UP** | **COMMENTS** | **VERIFIED BY** | **INITIALS**
---|---|---|---|---|---|---|---|---|---|---|---|---|---
PIT-1001 | Station Discharge PSI | 4-20 mA | 0 – 100 PSI | | | | | | | | | |
LIT-6001 | Storage Tank Level | 4-20 mA | 0 – 32 FT | | | | | | | | | |
SIT-1010 | Pump #1 VFD Speed | 4-20 mA | 0 – 100 % | | | | | | | | | |

**TESTED BY:**

**DATE:**

**WITNESSED BY:**

**DATE:**
### ANALOG OUTPUT TEST FORM (2-2)

**TAG REFERENCE** | **TAG DESCRIPTION** | **SIGNAL RANGE** | **ENGINEERING UNITS** | **COMMENTS** | **VERIFIED BY** | **INITIALS** |
--- | --- | --- | --- | --- | --- | --- |
SCT-1010 | Pump #1 VFD Speed | 4-20 mA | 0 – 100 % |  |  |  |
ZCT-4010 | FTW #1 Valve Control | 4-20 mA | 0 – 100 % |  |  |  |

**PLC ADDRESS:**

**PLC RACK:**

**PLC SLOT:**

**TESTED BY:**

**DATE:**

**WITNESSED BY:**

**DATE:**
PART 1 -- GENERAL

1.01 REQUIREMENTS

A. This section includes provisions for all field instruments and devices to be supplied by the Control System Supplier (CSS) as a complete and operational field instrumentation system.

B. Provide all devices, tubing, wiring, terminal blocks, mounting brackets, accessories, and enclosures as specified herein and as shown on the Contract Documents for the instrumentation system. The Contract Documents are intended as an outline for the work and are descriptive of the type of instrument hardware and software configurations to be provided.

C. Provide and install all process instrumentation including but not necessarily limited to analytical equipment, flow transmitters, level transmitters, process switches, temperature transmitters, pressure transmitters, intrusion switches, gas monitoring and control components. This includes all necessary piping and valves to complete the installation. Provide all miscellaneous devices such as signal isolators and interposing relays to maintain signal compatibility and integrity necessary to complete the wiring interface.

D. The contract documents are not intended to cover every detail for miscellaneous or incidental materials, software, hardware, configuration, or construction necessary to complete the instrumentation system. The Contractor shall furnish all tools, temporary utilities, materials, setup, parts, labor, and other incidentals necessary to fully complete the entire work, whether or not said details are particularly shown or specified, all at no additional cost to the Owner.

1.02 RELATED WORK

A. Electrical equipment interface and conduit for instrumentation is covered in Division 16 Electrical. All of the wiring and component requirements of Division 16 apply to this Section.

B. Instrumentation included and specified under other Divisions shall be coordinated with the equipment suppliers to insure compatibility with the PLC and SCADA control systems. The CSS shall coordinate the I/O monitoring and interface requirements with the equipment suppliers to provide for a complete and operational system.
1.03 SOFTWARE

A. All instruments that require software, or has software available to program, test and maintain the instrument, shall have their software provided as a part of the instrument supply.

B. The software shall be licensed to the owner and furnished on disk.

C. The software shall be loaded on the portable diagnostic laptop specified in Section 13320.

1.04 COORDINATION

A. The CSS shall coordinate the installation of all instruments with the contractor.

B. The CSS shall engineer, fabricate and furnish all mounting assemblies and brackets for installation of instruments by the contractor.

1.05 SUBMITTALS

1. Provide submittals and drawings as specified in Section 13300 Instrumentation and Control and as modified by this Section

2. Submit instrument manufacturer specific installation detail drawing for each instrument assembly and sensor connection point. Details shall be specific to the process and the manufacturer supplied components indicating all installation requirements and process connections.

3. Instrument Data Sheets per ISA requirements.

1.06 OPERATING INSTRUCTIONS

A. Provide operating instructions as specified in Section 13300 Instrumentation and Control and as required per the related General Conditions.
PART 2 -- PRODUCTS

2.01 QUALITY
   A. Quality including that specified in Section 13300 Instrumentation and Control.
   B. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting or operator interaction when power is restored. Instruments shall be provided with nonvolatile memory cards were required to maintain system configuration.
   C. Signal transmission from remote or field electric and electronic devices shall be 4-20 mA, sourced by externally powered equipment and/or by a 24 VDC loop supply from the panel that is to receive the signal. Nonstandard transmission methods such as impulse duration, pulse rate, and voltage regulated will not be permitted except where specifically noted.
   D. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission.
   E. All instrument outputs from 4 wire devices shall be isolated; the CSS shall furnish all necessary signal isolators to maintain loop integrity.

2.02 CONDUCTORS AND WIRE MARKERS
   A. Conductors and wire markers shall be as specified in Division 13 and Division 16.

2.03 LEVEL TRANSMITTER SUBMERSIBLE
   A. The level measurement system shall consist of a submersible transducer, electronic transmitter, support cable, and interconnecting cable. The submersible transducer shall be the piezoresistive strain gage type suitable for sensing pressure equivalent to the liquid level range indicated. The transducer shall have Titanium process wetted parts and shall be furnished with a waterproof corrosive resistant Teflon or Tefzel interconnecting cable. The transducer shall be suspended by a corrosion resistant cable strain relief as recommended by the manufacturer.
   B. The installation shall allow easy removal of the transducer and cable assembly for maintenance purposes. The electronic level transmitter shall produce a 4-20 mA DC signal linearly proportional to the level range indicated.
C. The level transmitter shall meet the following requirements:

1. Accuracy: 0.25 %
2. Operating Temperature: -5 to 140 degrees F
3. Relative Humidity: 0 - 100%
4. Overpressure Rating: 4X

D. The level measurement system shall be provided with a signal termination enclosure complete with lightning protection circuitry, vent tube break-out and moisture protection. The signal termination enclosure shall be mounted in the LCP. The cable vent tube shall be terminated in the enclosure as recommended by the manufacturer.

E. The submersible level transmitter shall be furnished with a perforated stilling well as indicated on the drawings and provided with all necessary hardware for mounting on the wetwell or channel wall.

F. The level sensor shall be provided with a vent tube aneroid bellows, Keller PSI Series 815, or equal.

G. The submersible level measurement system shall be Stevens SDT-II, Druck PTX1230, or approved equal.

2.04 PRESSURE INDICATING TRANSMITTER

A. The gage and differential pressure indicating transmitters shall be a two wire 4-20 mA linear transmitting device proportional to the applied direct pressure. Each transmitter shall have the following standard features:

1. Independent zero and span adjustments
2. Adjustable dampening 0.0 to 36.0 seconds
3. Integral solid state circuitry, RFI filtering and shielding
4. 100 to 1 turndown, elevated zero range of 100% upper limit, capability to drive 0 to 500 ohm loads at 24 VDC.

B. The transmitter shall have an accuracy of +/- 0.075% of span. Minimum operating temperature range shall be -40 to 185°F.

C. Process Connection

1. Process Wetted Parts shall be 316 Stainless Steel.
2. Process flanges and diaphragm seals shall be 316 stainless steel; except for use in chemical room applications.

3. Process connections shall be 1/2" NPT.

4. The transmitter shall be setup with the proper span and a zero suppression (or elevation).

5. The transmitter shall have instrument mounted 4-digit LCD meter with HART programming.

D. Pressure transmitters shall be supplied with 316 SS block and bleed valves for maintenance and calibration. Process wetted materials shall be 316 SS with viton seals. Block and bleed valves shall be Hex HB50 Series, Anderson Greenwood M25 Series or equal.

E. Chemical feed applications shall utilize Hastelloy C, with seats compatible with the connected process fluid.

F. Differential pressure transmitters shall be supplied with 316 SS, three way valve manifolds for maintenance and calibration. Process wetted materials shall be compatible for the service application specified. Three valve manifolds shall be Hex, Anderson Greenwood M1 Series or equal.

G. Pressure snubbers shall be provided for all air service transmitters. Snubbers shall be 316 stainless steel. Snubbers shall be Aschroft or equal.

H. Pressure Transmitter shall be Siemens Sitrans P DSIII, Rosemount 3051, Endress Hauser.

2.05 LEVEL TRANSMITTER (BUBBLER SYSTEM)

A. The bubbler system shall be manufactured and assembled as a part of the instrument and local control panels. Bubbler systems shall be fabricated in accordance with Section 13340.

B. Bubbler installation materials shall be provided by the CSS complete including all tubing, fittings and PVC sensor head installed at the wetwell and channel locations.

C. Bubbler system materials shall be 316 SS.

D. Furnish and install all valves, reducers and connectors as indicated on the drawings and required to complete the tubing connections between instruments sample lines and air system supplies. Compressors shall be provide with an alternation circuit, Hand-Off-Auto switch and pressure switch for starting/stopping to maintain the air receiver supply pressure. Provide an air receiver pressure switch for low air status.
E. Air flow constant differential regulators shall be provided with flow indicator for each sensing line to maintain constant air flow and pressure. Constant flow regulators shall be Moore Products (Siemens) 62 Series, or equal.

F. Air compressors shall be piston driven, oil less air compressors designed meet the air flow requirements of the system. Compressors shall operate to maintain the air receiver’s pressure. The air receiver shall be a two gallon minimum tank with gage and pressure switches mounted for monitoring and control. Compressor and tank systems shall be Gast XL series, or equal.

G. Provide panel with an air intake and filter for compressor air supply during operation.

H. Outputs
   1. Process Level (4 – 20 mA) for each system monitored
   2. Air Receiver Low Pressure (Dry contact)
   3. Loss of Power (Dry Contact)

I. Installation materials: All materials required for installation in the wetwells and channels shall be furnished by the CSS as a complete system for installation by the Contractor. The materials shall be packaged as systems complete with detailed installation instructions.

J. Tubing
   1. The instrument air tubing shall be furnished by CSS as required to extend existing tubing to the transmitter location.

2.06 ULTRASONIC LEVEL (FLOW) TRANSMITTER

A. The ultrasonic level transmitter shall be a continuous-reading instrument, suitable for the specified application. The ultrasonic level transmitter shall consist of two parts a transducer and an electronic unit. The transducer shall be capable of remote mounting up to 1000 feet from the electronic unit. When remotely mounted, the manufacturer shall supply all cables and weatherproof fittings required to connect the transducer to the electronic unit. The transducer shall generate an ultrasonic signal and shall receive the echo from the target surface. The electronics unit shall calculate the transducer to target distance, determine level, and calculate flow by means of an internal algorithm.

B. Field mounted electronics enclosure(s) shall meet the requirements of NEMA 4X (IP-65).
C. Panel mounted electronic enclosure shall be DIN rail mounted with remote panel mounted display. Control panel mounted electronics shall be installed as indicated and provided with all associated panel mounting hardware.

D. The electronic unit shall operate on 24 VDC, 60 Hz, and shall output an isolated 4 to 20-mA signal into 750 ohms, maximum.

E. The electronic unit shall perform automatic temperature compensation. It shall incorporate adjustable output signal damping.

F. Ultrasonic Level Measuring Systems: The meter shall be a non-contact, ultrasonic echo-time measuring device suitable for 120-volt, 60-Hz power supply. It shall consist of an ultrasonic transducer element assembly and a remote transmitter unit interconnected by manufacturer-supplied cable. Cable length shall accommodate the instrument locations shown on the Drawings.

G. The meter shall incorporate instantaneous sound velocity compensation and it shall utilize microprocessor circuitry to process echo times for elimination of stray echoes and, where indicated, to provide linearization functions. The transmitter shall have a multi-line backlit LCD display for level and alarm status indication, and shall produce an isolated 4 to 20 mA output signal into 750 ohms, maximum. The entire system shall be accurate within ± 0.1 foot of range.

H. The transmitter shall be provided with two analog outputs.

I. Meter shall have a minimum of three programmable Form C contacts. The contacts shall be programmed to provide the following alarm conditions:
   1. Transmitter Fault
   2. High Alarm
   3. Low Alarm

J. Provide instrumentation with handheld programmer and PC based configuration software.

K. The ultrasonic level sensor shall produce a narrow beam angle of not more than 7 degrees total included angle. The ultrasonic sensor system shall have temperature compensation circuitry operable over the range of -40 degrees C to +50 degrees C, and shall be encapsulated to ensure a Class 1, Division 1 hazard rating. The sensor shall be unaffected by condensation.

L. Ultrasonic sensor shall be Endress Hauser FDU-91, to match existing.

M. Provide wall/bracket mount for wetwell and flume level sensor installations bracket shall be Endress Hauser Cantilever with wall mount, or equal.
N. Ultrasonic transmitters shall be Endress Hauser Prosonic S FMU-90, to match existing.

2.07 LEVEL SWITCH

A. FLOAT BALL

1. Float switches shall be a snap action switch (SPDT) rated for 120 VAC at 5 amps. Float switch shall be encapsulated in plastic and NEMA 6 rated.

2. Float switch shall have narrow angle activation.

3. Float Switch shall be B/W Controls, DWYER FSW, Consolidated Electric, Or Approved Equal.

2.08 TEMPERATURE

A. TEMPERATURE TRANSMITTER

1. Temperature transmitters shall be provided complete with temperature sensor, thermowell, sensor housing and remote electronics as indicated on the contract drawings. The temperature sensor shall be installed in a thermowell sized to accommodate the sensor and process connection requirements.

2. The sensor shall be a Flexible RTD four wire spring loaded sensor 100 Ohm Pt.

3. Thermowell shall be 316 SS, heavy duty taper threaded 1” NPT.

4. Sensor head shall be NEMA 4X Moore Industries CH19, “Or Equal”

5. Temperature transmitter shall be provided with integral display and conversion electronics to provide for a linear 4-20 mA output. Output shall be isolated.

6. Provide remote mount sensor terminal block and RTD extension cable with associated cable and sheath for remote mounting of the transmitter from the sensor head.

7. Temperature Transmitter shall be Moore Industries TDY Series, SMAR TT301, “Or Equal”

2.09 CALIBRATION MATERIALS

A. Calibration materials shall be provided after successful start-up and acceptance of the equipment for operation. Calibration materials and one years supply of buffer solutions, calibration solutions and devices necessary to maintain and calibrate the instruments shall be provided.
PART 3 -- EXECUTION

3.01 WORKMANSHIP

A. All instrumentation work in this contract shall conform to the codes and standards specified in Division 16 – Electrical and Division 13 Instrumentation and Control.

B. The Contractor shall employ personnel who are skilled and experienced in the installation and connection of all elements, equipment, devices, instruments, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Ensure that all equipment and materials fit properly in their installations.

D. Perform any required work to correct improper installations at no additional expense to the Owner.

E. The Owner reserves the right to halt any work that is found to be substandard or being installed by unqualified personnel.

F. Rejected equipment or equipment without approved submittals shall be immediately removed from the delivery or job site by the Contractor.

3.02 INSTALLATION

A. Install and supply all products necessary to provide an operational system. This shall include the following:

1. Contract Drawings are intended to show the basic functional requirements of the instrumentation system and do not relieve the Contractor from the responsibility to provide a complete and functioning system.

2. Provide relays, signal converters, isolators, boosters, power conditioners, circuit cards, and other miscellaneous devices as required for a proper signal interface between the sensor, instrument, operator interface and PLC.

3. Provide analog loop isolators where required to eliminate "ground loops." All instruments that are not provided with isolated signals shall be supplied with an external isolator were required to interface with other equipment.

4. All field wires shall be identified with machine printed labels. Plastic wire gutters shall be used for routing of wire bundles. Wiring shall be neat and laced with plastic tie wraps.

5. The instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions and located as shown on the Drawings or as approved by the Engineer. When manufacturer's installation
literature specifies a particular location or orientation in a process line due to measurement accuracy considerations, the installation shall be in conformance with the manufacturer’s instructions.

6. Engineering scales and charts for all instruments shall be provided that match the range of instruments that monitor the process.

B. Instrument installation methods.

1. Install instruments at the location shown on the Plans or approved by the Owner. Instruments shall be NEMA rated for the installed location.

2. Install level and plumb.

3. All instruments shall be provided with process mounting assemblies, floor stands or wall brackets as shown or required to complete the installation.

4. Mounting hardware, stands, channels, and spacers shall be stainless steel. Chlorine or chemical room materials shall be PVC or FRP.

C. Wiring and raceway installation methods.

1. Instrumentation wiring shall be carried in conduits provided in compliance with Division 16. All analog circuits shall be run as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required. Triads are not to be formed by using two pairs.

2. Terminal blocks shall be provided at all instrument cable junctions and all wires shall be identified at such junctions. Instrumentation wiring shall be run without splices between instruments, terminal boxes, or panels.

3. The number of signal wires listed on the drawings is approximate only, and the Contractor shall determine the required number of signal pairs or triads to properly connect the system furnished, especially when substituting equipment.

D. Wiring, grounding, and shielding methods.

1. It is important to observe good grounding and shielding practices in the generally noisy environment in this application. The following practices shall be observed unless modified by manufacturer’s standards:

2. Each electronic equipment chassis shall be grounded to power ground.

3. All analog signals shall be transferred over shielded twisted pair cables.

4. All communication signals shall be transferred over shielded cables.
5. Status and alarm signals routed through noisy environment shall be transferred over shielded twisted pair cables.

6. Each shield which is not connected to ground shall be covered with a heat shrink insulating boot. Shields shall be connected together at each transition from one cable to another for a continuous effective shield circuit. All shields shall be connected on terminal blocks.

3.03 SUPPLIER SERVICES

A. The CSS shall be responsible for each supplier of equipment to provide the following minimum services for each type of instrument supplied. The CSS shall use a qualified instrumentation field technician to perform services listed herein.

1. Advise and instruct Contractor on installation requirements.

2. Inspect all instrumentation systems prior to start-up and verify each instrument is installed in accordance with the Specifications and manufacturers requirements.

3. Check, calibrate, and place equipment in operation.

4. All programmable instruments shall be programmed and tested prior to startup. Instrument configurations shall be adjusted or changed as directed by the Owner or Engineer for process tuning requirements at no additional cost.

5. Coordinate with the Owner and setup all instrument alarm, process, and operation setpoints. Program and configure instrument analyzer systems.

6. Coordinate signal and communication interface requirements with the existing SCADA and PLC control systems.

7. Perform operational and acceptance testing per Section 13300 and 13320.

8. Field calibrate and recalibrate all instruments to the required engineering units provided at start-up. Provide certified and witnessed calibration sheets.

9. Visit the job as often as required and spend as much time as necessary to tune, correct, calibrate and configure instruments to ensure an operational instrumentation system.

10. Be readily available by telephone to answer all questions on supplied equipment.

11. Provide 40 hours of additional calibration and configuration services in addition to those requirements outlined above. These hours shall be
directed to calibrate, tune or modify existing systems outside of the CSS scope of supply, referenced in the Specifications.

B. The Contractor shall insure each supplier of instrumentation assumes the responsibility for providing primary elements in a timely manner, for insertion into the process line, coordinating size and material type, overseeing the actual installation, calibration, and acceptance testing. The instrumentation supplier shall coordinate all process connections and provide all necessary options, fittings and connectors for installation into the process at no additional cost to the owner.

3.04 MAINTENANCE SOFTWARE

A. All instruments or equipment supplied with software for tuning, set-up and configuration shall have the software provided on disk, cataloged and stored in a multi-disk holder. The software shall be loaded and configured on the diagnostic laptop specified in Section 13320.

3.05 TRAINING

A. Each supplier shall provide a minimum of one (1) hour of training to instruct Owner personnel in the use, operation, calibration, programming, and maintenance on each different type of "field" instrument.

3.06 SPARE PARTS

A. Spare parts shall be provided before site commissioning and start-up.

B. A spare parts list shall be submitted for review and approval prior to shipment of the parts.

C. Spare parts shall be inventoried and crated in a box marked as “Spare Parts, Field Instrumentation”.

D. Provide the following spare parts:

1. Flow Meter and Ultrasonic Sensor Head
2. Submersible Level Transmitter one of each range
3. Two (2) Floats
4. Pressure Transmitter 0 – 15 psi
5. Pressure Transmitter 0 – 300 psi
6.

3.07 WARRANTY
A. Provide warranty as specified in Section 13300.

B. Each time the Supplier's repair person responds to a system malfunction during the warranty period, he or she must contact the designated Owner maintenance supervisor for scheduling of the work, to access the jobsite, and receive permission to make repairs. Operation of facilities necessary to test equipment shall only be performed by or under the direction of Owner staff. The Owner reserves the right at its sole discretion to deny operations requested by the Supplier.

3.08 FINAL ACCEPTANCE

A. Provide final acceptance as specified in Section 13300.

B. At the end of the project, following the completion of the field tests, and prior to final acceptance, the Supplier shall provide the following to the Owner:

1. Each "operation and maintenance" manual shall be modified or supplemented by the Supplier to reflect all field changes and as-built conditions.

- END OF SECTION -
Not Used
SECTION 13340

CONTROL PANELS

PART 1 -- GENERAL

1.01 REQUIREMENTS

A. The Control System Supplier (CSS) shall furnish and install all necessary control panels complete, assembled, tested and ready for use including all necessary control components, wiring, interconnecting cables, all accessories, and all appurtenances as indicated herein or as required for proper operation of the system. All major components of the system shall be of the same manufacturer.

B. Control panels shall be provided as specified herein and indicated on the Contract Drawings. Control panels shall be UL-508 listed. The Control panels shall be fabricated in a UL authorized labeling facility and all control panels shall bear the CSS UL 508 Label.

C. Where indicated, control panels shall be provided with all required taps, fittings, conduit entries, control wiring and alarm interlocks. Dimensions shall be in accordance with manufacturer’s requirements. Elevations and horizontal spacing shall be subject to the Owner’s approval.

D. Panels shall be fabricated, assembled, piped and wired by fully qualified workmen who are properly trained, experienced and supervised.

E. Control panels shall be provided as required to fully monitor and control each process specified.

F. All panel meters, all instruments, and all other components shall be of the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise indicated.

G. All materials and components making up the control panel shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state.

H. Panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one manufacturer.
I. Control panels shall be engineered, fabricated and tested by the CSS in accordance with these specifications.

1.02 RELATED SECTIONS

A. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project. Related Specifications apply to all sections and divisions, the following are part of the instrumentation and control systems.

1. Division 16 Electrical
2. Division 17 Information Systems
3. Section 13300 Instrumentation and Control
4. Section 13350 Programmable Control Systems
5. Section 13360 Radio Communications

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Section 13300.

1.04 CONTROL PANEL ASSEMBLY

A. Rear of panel mounted equipment shall be installed with due regard to commissioning adjustments, servicing requirements and cover removal. Components, terminal blocks and equipment items shall be mounted at 9” and above from the base of the control panel and a minim of 6” below the top of the panel wire top wireways are utilized.

B. Control panel components shall be arranged on sub-panels and within the panel to optimize weight distribution, heat dissipation and component spacing for wiring and maintenance. Components and terminal strips shall be vertically and horizontally segregated with wire gutters utilizing a 2.0” minimum spacing between the component terminal connections.

C. All fixed position components shall be mounted utilizing stainless steel screws, brackets and fasteners such that no exterior panel extrusions occur. Backpan components shall be individually identified with a unique identifier per IEEE and ISA recommended practices.

D. Component DIN rails shall be provided for snap on mounting of terminal blocks, fuse blocks, relays, timers, and signal conditioners. DIN rail shall be zinc plated, yellow chromate steel. Twenty five percent additional rail space shall be provided to allow for system expansion.
E. Nameplates for panel-mounted devices shall be laminated plastic, black on white, with engraving through the black surface to form 3/16” high white letters. Relays and other devices mounted inside the control panels shall be identified with permanent nonferrous tags. All tags shall match device numbers shown on contract plans.

F. Front panel components shall be arranged by function and group with a 2” minimum spacing for panel-mounted devices. Operator switches and pilot lights shall utilize a 2.5” on center minimum spacing for wire connections. Where future provisions are necessary control operator switch and pilot light positions shall be pre-punched and plugged for easy modification and expansion. All front panel mounted components shall be provided with a neoprene gasket seal.

G. To ensure proper grounding within the control panel a copper ground bus bar shall be provided. All grounding terminal blocks, equipment chassis and source grounds shall be connected to the ground bus bar to provide a common ground reference within the control panel.

H. All panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules and shall be manufactured by Northern Instruments Model Zerust VC, Hoffman Engineering Model A-HCI, or equal.

I. Freestanding and wall mount panels shall be provided with louvers and/or forced ventilation as required to prevent temperature buildup due to operation of electrical devices mounted in or on the panel.

J. Intake louvers shall be mounted on the lower side, rear or front section of an unobstructed panel face. Louvers shall be provided with removable and washable filter grills mounted on the interior side of the louver. Forced-ventilation exhaust fans, where used, shall be provided at an opposing elevated location from the intake louvers. Unless otherwise indicated, fan motors shall operate on 120-volt, 60-Hz power. For control panels located in control rooms, the total audible sound level of the fans shall be less than 45 dB(A).

K. Minimum wire bending space at terminals and minimum width of wiring gutters shall comply with latest revision of the NEC.

L. Future device and component mounting space shall be provided on the door, backpan, and subpanel where detailed on the Drawings. Where no detail is shown, provide a minimum of 15 percent usable future space.

M. Equipment provided with status and diagnostic displays, LED’s, programming pads, buttons or dials shall be mounted with the display and keypad facing the panel front. Shelving, brackets and associated mounting hardware shall be provided to mount the equipment in readily accessible and viewable location within the panel.
N. Each cabinet interior shall be equipped with a fluorescent lamp, 120-volt, one (1) 20-ampere GFCI outlet minimum, and two (2) single pole 120-volt, 20-ampere circuit breakers minimum for general power distribution.

O. Provide a dedicated 120 VAC control circuit breaker(S) for PLC control systems. Control circuits shall not share miscellaneous power distribution such as lights, heaters, fans and receptacles.

1.05 CONTROL PANEL WIRING

A. Control panel shall be wired per the latest revision of NEC, NEMA, IEEE and UL-508 standard wiring guidelines for electrical systems.

B. Wire Marking

1. Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using machine printed white numbered wire markers which shall be permanently marked heat shrink plastic.

C. Control Panel Wire

1. Panel wire size shall per the latest requirements of NEC or the specification, whichever is the most stringent, based on wire type and application. Unless otherwise specified typical panel wire size shall be:

   a. PLC Input/Output wiring #16 minimum
   b. AC and DC Control wiring #14 minimum
   c. 120 VAC general purpose, panel and equipment power #12 minimum
   d. DC analog signals #18 twisted shielded pair (TSP)

2. Instrumentation signal cables shall be of the type used for process control with shielded pairs or triads with polyvinyl jacket and overall shield over the multiple pairs or triads. The instrumentation cable shall be rated 300 volts at 90°C or better. The size of the instrumentation cable shall be AWG No. 18 minimum, unless otherwise specified elsewhere. All instrumentation cables shall meet all the requirements of IPCEA S-61-402 and shall be UL listed.

3. Control panel wiring shall be THHN or MTW.
4. A-C Power to all system power supplies, power units, CRTs, printer, and disk drives shall be accomplished using molded 3-wire plug cords.

D. Wire Color Code

1. Wires shall be color coded in accordance with the following table:

   a. BLACK L1 (hot)
   b. WHITE L2 (neutral)
   c. RED a-c control circuits
   d. BLUE DC Control
   e. GRAY DC Common
   f. YELLOW Interlock control circuits, Foreign Voltage
   g. GREEN Equipment ground

E. Wire Routing and Termination

1. All internal wiring shall be routed through plastic wire ways (panduit) and spiral wrapped when transitions to front panels or additional sections are required. Wire routing shall be separated and grouped by function, voltage and signal type to minimize noise and maximize maintainability.

2. A 60 percent plastic (panduit) wireway fill of that allowable by the NEC shall be maintained to allow for future expansion and panel modification. A minimum 1.5 inch clearance shall be maintained in front of each wireway cover to allow for easy access to panel wiring.

3. Wiring run from components on a swing-out panel to other components on a fixed panel shall be made up in tied bundles. These shall be tied with nylon wire ties and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at terminals.

4. Wiring run to control devices on the front panels shall be tied together at short intervals and secured to the inside face of the panel using Panduit adhesive mounts with Eastman No. 910 adhesive. Wiring to rear terminals on panel-mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

F. Wire Termination
1. All interfacing between the cabinets and the field shall be accomplished at a field connection terminal strip (TB). The terminal strip shall have a dedicated field wiring side; no internal panel wiring shall be connected to terminals on the "field side" of TB. Likewise, no field wiring shall be connected to terminals on the "panel side" of the TB.

2. Terminal strips or groups shall be arranged by signal type and voltage AC and DC signals shall not terminate on the same terminal strip or group.

3. No more than two conductors shall be terminated at a single termination point. A common terminal block shall be provided for every two common or neutral conductors contained within the panel.

4. When required precision (1%) 250-ohm resistors shall be installed at the panel wiring side terminal strip when each incoming 4-20 mA analog signal is converted to a voltage signal (1 to 5 volt d-c) as specified.

5. In addition to the spare power termination capacity, each panel shall be provided with two spare fused AC power and DC power terminations of each voltage type to power future equipment items and field devices.

6. Provide one spare 15 Amp circuit breaker.

1.06 ENVIRONMENTAL

A. The control shall be rated for continuous operation under ambient environmental conditions of 0°C to 60°C dry bulb and 5 to 95 percent relative humidity, noncondensing. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

B. The control panel shall be environmentally controlled with the use of exhaust fans, heaters and AC units as required to maintain the environmental conditions specified. The heating/cooling equipment shall be sized to maintain the temperature below a maximum of 122 degrees and above minimum of 38 degrees Fahrenheit within the control panel. Heating and cooling load calculations shall be provided for review and approval. Calculations shall utilize a maximum ambient temperature of 90 degrees F for indoor application and 120 degrees F for outdoor applications. Calculations shall include watt losses for all components and solar heat gain for the area of installation.

C. Intake louvers shall be mounted on the lower side, rear or front section of an unobstructed panel face. Louvers shall be provided with removable and washable filter grills mounted on the interior side of the louver. Forced-
ventilation exhaust fans, where used, shall be provided at an opposing elevated location from the intake louvers. Unless otherwise indicated, fan motors shall operate on 120-volt, 60-Hz power. For control panels located in control rooms, the total audible sound level of the fans shall be less than 45 dB(A)

D. Panel heaters, fans and air conditioning units shall be individually protected by a circuit breaker sized in accordance with NEC requirements.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Equipment and materials shall be products of reputable, experienced manufacturers. Similar items in the project shall be the products of the same manufacturer. All equipment shall be of industrial grade, a standard of construction, shall be of sturdy design and manufacture, and shall be capable of long, reliable, trouble-free service.

B. The control panels shall be fabricated to house PLC’s, controllers, instrumentation and communications equipment specified elsewhere and as indicated on the contract drawings. Control panels shall be fabricated and wired in accordance with this and applicable specification sections.

C. The manufacture of the control panels shall be UL recognized facility with current UL procedure files listed with UL. The final assembly shall carry a UL 508 listing. All equipment provided shall be UL Listed or Recognized for the intended service and application.

2.02 PROGRAMMABLE LOGIC CONTROLLER

A. Reference Section 13350.

2.03 OPERATOR INTERFACE PANEL

A. Reference Section 13350.

2.04 RADIO EQUIPMENT

A. Reference Section 13360.

2.05 PROCESS INDICATORS

A. Process indicators shall be provided as indicated on the Contract Drawings. Process indicator shall display the process variable in engineering units based on a variable input signal (4-20 mA/1- VDC). The indicator shall be provided with 4.5 digit LED display with adjustable zero and span calibration.
B. The display shall be panel mounted with a NEMA 4X rated display. The process display shall meet the following:

1. Accuracy: +/- 0.25%
2. Power: 24 VDC or 120 VAC
3. Operating Temperature: 0 – 50 degrees C
4. Retransmission Output: 4 – 20 mA (Isolated)

C. Process displays shall be Action Instruments, Red Lion, and/or Newport.

2.06 CIRCUIT BREAKERS

A. Control power and equipment disconnects shall be provided as indicated on the drawings. Circuit breakers shall be the energy limiting design and shall be UL rated for 120/240 VAC/65 VDC with an interrupting rating of 10 KAIC. Circuit breakers shall be DIN rail mounted. Circuit breakers shall be Allen Bradley 1492-CB, Merlin Gerin Multi 9, or equal

2.07 TERMINAL BLOCKS

A. General: Terminal blocks, fuse blocks and disconnects shall be specially designed for safety, installation ease, and ruggedness. Features shall include the following:

1. Finger safe
2. Nickel-plated terminals and stainless steel screws
3. High copper content copper-alloy
4. Four-sided wire funnel guides for easy wire insertion
5. Finger-safe housings to prevent accidental contact with live circuits
6. DIN Rail mountability shall allow terminal blocks to be placed on the same channel as, relays, timers, disconnects, signal conditioners and other DIN Rail-mounted control devices
7. Self-extinguishing, polyamide 6.6 housing material with UL 94-V2 flammability rating
8. Backed out screws for fast wiring

B. Terminal Blocks
1. Terminal blocks shall be Din rail mounted, compression clamp style, UL rated for 30 amps at 600 volts. Terminal blocks shall be high-density type molded plastic with barriers and box lug terminals. Terminal marking shall be white marking strips, fastened securely to the molded sections and shall be provided with printed wire numbers or circuit identifications. Terminal Block shall accept a minimum of 2 #12 THHN/TWLN conductors.

2. Terminal blocks shall be color coded for the voltage and signal type as follows:

   a. Foreign Voltage AC - YELLOW
   b. AC Control - RED
   c. DC Control - BLUE
   d. DC Common - GREY
   e. 120 VAC (HOT) - BLACK
   f. 120 VAC (NEUTRAL) - WHITE
   g. 480 VAC - ORANGE

C. Power Distribution Fuse blocks (250 Volt and below) shall be Din rail mounted, compression clamp style, rated for 15 amps at 300 VAC. Fuseblocks shall be provided to accept ¼ "x 1¼ " fuses. Fuse blocks shall be provided with a swing arm fuseholder for easy removal of fuses. The fuse block shall be provided with blown fuse indication.

D. Control outputs and foreign control voltages present within the control panel shall be identified and supplied with disconnecting means. Foreign control voltages shall be supplied with pull-apart or knife edged compression clamps or disconnect plug component terminal blocks, rated for 20 amps at 600 volts. Disconnect terminals shall be Din rail mounted, compression clamp style, rated for 20 amps at 600 volts. Terminal blocks shall be high-density type molded plastic with barriers and box lug terminals.

E. Ground termination blocks shall be provided for all signal grounding and shield connections. Ground terminals shall be Din rail mounted, compression clamp style, rated for 20 amps at 600 volts. Terminal blocks shall be high-density type molded plastic with barriers and box lug terminals. Ground terminals shall be color-coded green/yellow for grounding identification.

F. DC Signal and control circuits shall be supplied with pull-apart disconnect fuse plug component terminal blocks, rated for 20 amps at 600 volts. Disconnect terminals shall be Din rail mounted, compression clamp style,
rated for 20 amps at 600 volts. Fuse plug shall accept 5 x 20 mm fuses and shall be provided with blown fuse indication. Fuse blocks shall be high-density type molded plastic with barriers and box lug terminals.

G. Terminal and fuse block manufacturer shall be Sprecher and Schuh, Allen Bradley, Entrelec, or Phoenix Contact.

2.08 CONTROL RELAYS

A. Control relays shall be “ice cube” type general purpose relays utilizing 10 amp rated contacts at the specified control voltage. Relays shall be provided as DPDT or 3PDT to meet application requirements. Relay base configurations shall be DIN rail mount and selected such that AC and DC control relays are not interchangeable, thereby preventing accidental damage to relay coils as a result of incompatible voltages. Relays shall be provided with one spare NO/NC contact. Relays shall be provided with an operational status LED, providing positive status of relay energization. Relays shall be IDEC, RELECO or equal.

B. Control timers shall be solid state adjustable timer circuits supplied as time delay on energize, or time delay on de-energize, as indicated on the drawings. Timer control voltages shall be as indicated on the drawings and shall be provided with DPDT, form C contacts (a normally open and normally closed contact). Timers shall be 10-ampere, 240-volt, pin or blade style, plug-in type with dust cover, LED “on” and applicable “timeout” indication, and sockets. Timers shall have an adjustable time range and time setting with indication of the full time range and of the time setting. Time delays shall be provided with LED status indicators for energization and timer function status. Solid-state timers shall be IDEC, RELECO or equal.

C. Industrial Control Relays (ICR) shall be provided as indicated on the Contract Drawings and for loads that exceed the normal contact inrush and constant current capacity rating for “ice cube” type relays. Relays shall be provided with convertible cartridges for NO/NC configuration and shall be stackable to a maximum of eight (8) contacts with the addition of a top mounted expansion module. Contacts shall be 20 amp rated bifurcated spanner and nickel-silver plated. Industrial control relays shall be Allen Bradley 700, Type PK series or equal.

D. Intrinsically Safe Relays (ISR) shall be provided as indicated on the contract drawings and for all loads contained in designated hazardous locations. ISR components shall be provided and installed in accordance with UL and NEC requirements for component spacing and interconnection. Intrinsically safe relays shall be selected for the Class, Division and Group category application of the hazardous equipment location. Input resistance, inductance and capacitance shall be compatible with the switching device and meet the limits for application within the defined hazardous location.
Control circuit interface for non-hazardous equipment side terminations shall be voltage/current compatible with the control equipment. Intrinsically Safe Relays shall be Turck, GEMS, SAFE-PAK, or equal.

E. Moisture Sensing Relays (MSR) shall be provided for all submersible pump moisture sensing applications. The moisture sensing relay shall be provided with adjustable sensitivity and provide a 10 amp rated SPDT for equipment interlocking and alarming. Contact output shall be provided with a 30 second delay to activation. Relay shall be provided with LED to indicate control state. Moisture sensing relay shall be Warrick 2800, SSAC LLC4 Series or equal.

F. PLC control relays shall be provided when interfacing the PLC digital output with external devices such as starters, valve/gate controls and solenoids. Interposing relays shall be 24 VDC and provide a SPDT output rated at 5 amps for 120 VAC. The relay shall be provided with DIN rail mounted terminal base. Relay terminal blocks shall be Din rail mounted compression clamp style with wire terminal labeling provisions. Interposing relay shall be Phoenix PLC-RSC, or equal.

2.09 SIGNAL ISOLATORS AND CONVERTERS

A. Signal Isolators, Converters, and Power Supplies: Signal isolators shall be provided in each measurement and control loop, wherever required, to match adjacent component impedances, provide signal amplification, or where feedback paths may be generated or to maintain loop integrity when the removal of a component of a loop is required. Signal converters shall be provided where required to resolve any signal incompatibilities. Signal power supplies shall be provided to supply sufficient power to each loop component.

B. Components shall be DIN rail mount.

C. Conversion modules shall be Action Instruments, Moore Industries CPT Series, or equal.

2.10 OPERATOR CONTROLS AND INDICATORS

A. Operator controls and indicators (switches, pushbuttons, Potentiometers, pilot lights) shall be 30.5 mm, NEMA 4X rated.

1. Pushbuttons, selector switches, and indicating lights shall be heavy-duty oil tight, manufactured to the requirements of NEMA ICS.

2. Unless noted otherwise, pushbuttons shall be momentary contact and shall have the number and type of contacts as indicated or as required. One spare NO and NC contact shall be provided for each pushbutton.
3. Unless noted otherwise, selector switches shall be maintained contact, shall have the number of positions indicated, and shall have the number and type of contacts as indicated or as required. One (1) NO spare contact shall be provided for each switch.

4. Indicating lights shall be full voltage LED push-to-test.

5. Emergency Stop pushbuttons shall be provided with a mushroom head and support push-pull operation.

6. Lighting control switches shall be provided with On-OFF-Timed functions with the timed push configured as a momentary return to center operation.

7. Pushbuttons, selector switches, Potentiometers and indicating lights shall be Allen-Bradley Bulletin 800T; Westinghouse Industrial Type PB or equal.

2.11 EMI LINE FILTER AND SURGE SUPPRESSION

A. EMI/RFI Filter

1. Control panels shall be provided with power line filters that are effective in the control of line to line as well as line to ground EMI/RFI interference. The standard line filters shall be rated for 28 dB at 1 MHz. Line filters shall be Corcom, or equal.

B. Power Surge Protection

1. Surge protection shall be provided at the power input of the control panel.

2. The surge protectors shall be tested in accordance with the requirements of ANSI/IEEE C62.41 standards for Categories A, B, and C environments and shall be a UL 1449 listed component.

3. Surge protection components shall be as manufactured by Leviton 51020, Hubbell or Liebert LPM.

C. Telco/Data communications Line Surge Protection

1. Surge protection devices shall be supplied for the protection of all communications circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

2. Communication line surge protection shall be UL-497 Listed. The surge protection device shall be sized for voltage, current and frequency
requirements listed on the contract plans and shall provide independent conductor-ground surge protection. Surge protection shall be installed on the incoming communications for the control panel.

3. The protector module shall be failsafe and contain a three-electrode Maximum Duty gas tube, a failshort mechanism, and an air gap back-up device which converts the gas tube protector to an air gap protector in the unlikely event that the gas tube vents.

4. The surge protection shall be TII or equal.

D. Data Highway Communications (DH+, RIO, 485, Modbus)

1. Surge protection devices shall be supplied for the protection of all communications circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

2. Communication line surge protection shall be UL-497B Listed. The surge protection device shall be sized for voltage, current and frequency requirements listed on the contract plans and shall provide independent conductor-ground surge protection. Surge protection shall be installed on the incoming RIO communications for the control panel.

3. Data highway surge suppressors shall be Leviton 3803-Series, or equal.

E. Signal Surge Protection (4-20 mA)

1. Surge protection devices shall be supplied for the protection of all externally derived signal circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

2. Communication line surge protection shall be UL-497B Listed. The surge protection device shall be sized for voltage, current and frequency requirements listed on the contract plans and shall provide independent conductor-ground surge protection. Surge protection shall be installed on the incoming RIO communications for the control panel.

3. Data highway surge suppressors shall be Leviton 3420-9, or equal.

2.12 TELECOMMUNICATIONS EQUIPMENT

1. Fiber Break-Out
a. Fiber Optic Break-Out and Patch Panels shall be provided at all fiber optic cabling locations for break out and distribution of fiber within the control panels.

b. Fiber enclosures shall be provided with patch-panel (ST) and splice trays for fiber break-out and termination.

c. Fiber patch cords shall be manufactured assemblies with end connectors supplied as a part of the cable supplied by the manufacturer.

d. Patch panels shall be provided with a minimum of six (6) fiber connections and end caps for all unused terminations. Four (4) spare fibers shall be terminated in each panel.

e. Reference Section 16210 for fiber break-out box requirements.

f. Provide splice tray.

g. Fiber panels shall be Corning Lanscape WIC-04P.

2.13 POWER SUPPLIES

A. DC Power Supply

1. Control panel DC power shall utilize DC switching power supplies for primary control power. Standard power supplies shall be provided with automatic current limit and foldback. Power supplies shall be sized to power the equipment at maximum load with an additional 50 percent power capacity.

2. Power supply voltage shall be as required to power control panel equipment at their stated voltage and as indicated on the Contract Drawings.

3. Power supplies shall be IDEC, SOLA or approved equal.

B. DC/DC Power Supply

1. DC/DC converters shall maintain the required DC voltage to within the regulated output envelope. The DC conversion step up or step down shall be provided as indicated on the Contract Drawings and required to provide the supplied equipment input power.

2. The DC output shall be sized to provide 125% of load current required to operate the supplied equipment.

3. The converter shall be EMI/RFI shielded and provided with input filtering and reverse voltage protection. The converter shall be housed
in an enclosure with terminal connections for input, output and ground. The DC/DC converter shall be provided as follows:

a. Accuracy: +/- 1%

b. Regulation: +/- 0.5%

c. Isolation Voltage: 500 VDC

d. Operating Temperature: 25 to 85 degrees C

4. DC/DC converter shall be Kepco, Wall, or equal.

2.14 PANEL INTRUSION SWITCH

A. Intrusion switches shall be provided for all outdoor control panels. Each panel compartment shall be provided with a panel intrusion switch that provides entry notification to the panel PLC and intrusion notification system.

B. The switch shall activate whenever entry to the panel is made. The switch shall be a magnetic reed switch with 10 amp NO/NC rated.

C. The intrusion switch shall be Sentrol or equal.

2.15 EQUIPMENT ENCLOSURES (CONTROL PANELS)

A. The local control panel(s) shall be wall mounted or free standing with extension legs as indicated on the Drawings. Exterior panels shall be rated Nema 4X 316 SS.

B. Corrosive areas non-conducive to Stainless Steel shall be compatible with the surrounding environment, interior main or PLC control panels contained in noncorrosive areas shall be NEMA 12.

C. The access door shall have continuous hinges with neoprene gaskets and three-point key lock handle. The cabinet shall be constructed from formed 12-gauge steel minimum. All exposed edges and welds on the enclosure shall be ground smooth. Refer to the drawings for minimum enclosure size and installation details.

D. Panel ratings shall be based on NEMA standards for the location and environment in which the panel is installed. Panel materials shall be selected for corrosive environments based on standard chemical compatibility charts. Unless otherwise indicated on the Drawings, control panels shall be rated as follows:

1. Indoor Environments, Non-splashing or wash down, NEMA 12

2. Outdoor and indoor Corrosive, wash down, NEMA 4X, 316 SS
3. Outdoor Area Non Corrosive, NEMA 4

4. Chemical Room, NEMA 4X, FRP

5. Partial submergence, NEMA 6

E. The exterior of the NEMA 12 enclosure shall be ANSI grey painted with a rust-inhibiting primer and two coats of epoxy paint.

F. The interior shall be provided with a formed 12-gauge steel subpanel for attaching surface-mounted components. All components shall be attached with screws and the subpanel threaded. Rivets or back of panel nuts shall not be allowed. The interior shall be painted with two coats of white paint.

G. Enclosures shall be a manufactured item supplied by Hoffman, H.F. Cox, Gaylord or equal.

2.16 MOTOR CONTROL AND POWER DISTRIBUTION

A. General

1. Control panels incorporating motor control and power distribution for 480 VAC shall be provided in a separate compartment with barriers to isolate the 480 VAC components from the control panel components.

2. Panel distribution shall be provided with a circuit breaker disconnect and handle mechanism that protrudes the inner deadfront door or exterior door that is readily accessible to the operator.

3. The disconnect handle shall be clearly labeled as the control panel disconnect.

4. Panels with integral metering sections shall be manufactured and fabricated in accordance with the local utility service requirements. Panels shall be provided with pull section, meter section and CT compartment fabricated and configured per the indicated voltage and current requirements and in accordance with the serving utility requirements.

5. Consolidate power distribution; control and/or metering panels shall be fabricated as indicated on the Drawings.

B. Power Distribution

1. Power Distribution Blocks

   a. Power Distribution Blocks shall be provided to support conductor cable entry, cable reduction and cable fan-out as required to provide for power distribution within the control panel.
2. Circuit Breakers
   a. Circuit breakers shall be bolt-on sized per the Drawing and/or load requirements.

3. Control Power Transformers
   a. Control power transformers shall be sized per the load requirements plus 50 percent.

C. Motor Control

1. Manual Motor Starter
   a. Provide manual motor starter for 120 VAC sample and chemical feed pump applications. Manual motor starter shall be single phase 120/240 VAC operation with bell alarm contact.
   b. Manual starter shall be Sprecher and Shuh, ABB, Allen Bradley or equal.

2. Combination Motor Starters
   a. Combination motor starters shall be provided as indicated on the Contract Drawings.
   b. The starter shall be provided with a Motor Circuit Protector or Circuit Breaker sized in accordance with NEC to meet the motor load and starting current requirements.
   c. The starter shall be provided with two auxiliary run contacts.
   d. The starter shall be provided with solid state adjustable overload relay. The overload relay shall be provided with one isolated Normally Closed and one isolated Normally Open contact.

3. Motor current transmitters
   a. Motor current transmitters shall be provided as indicated on the Contract Drawing. Motor current transmitters shall provide a 4-20mA output current proportional to the motor current for monitoring and control. Unit shall be sized at 200 percent of actual motor load.
   b. Motor current transmitters shall be Veris Industries H721 Series, or equal.

4. Motor Current Switch
A. Current switch shall be 0 – 10 amp rated with adjustable overcurrent trip output relay contact. Contact shall be SPST rated for 120 VAC. Current switch shall have visual trip indication. Switch shall be split core.

B. Current switch shall be Veris Industries, SSAC, CR Magnetics, or equal.

2.17 UNINTERRUPTIBLE POWER SYSTEM (UPS)

A. This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty single-phase, solid state, uninterruptible power system. The uninterruptible power system, hereafter referred to as the UPS, shall provide high-quality AC power for electronic equipment loads.

B. The UPS shall be designed to operate as a line interactive system in the following modes:

1. Normal - The critical AC load is continuously supplied with filtered power. The battery charger shall maintain a float-charge on the battery.

2. Voltage Boost/Buck - During input power source abnormalities (sags and swells), the AC output power shall be corrected by means of boost (sag correction) or buck (swell correction) compensation taps.

3. Battery - When the input power source exceeds the parameters defined in section 1.3.3.1.A, the critical AC load shall be supplied power by the inverter, which obtains its power from the battery.

4. Recharge - Upon restoration of utility the input power source within specified parameters, the critical AC load shall be supplied with filtered power and the battery charger shall simultaneously recharge the battery.

5. Automatic Restart- Upon restoration of the input power source, after a complete battery discharge, the UPS shall automatically restart and supply filtered power to the critical load. The bi-directional converter shall simultaneously recharge the battery.

6. Design Requirements

a. Voltage Configuration: 120VAC; +23%, -25% (90 to 148 VAC), single phase, 2-wire-plus-ground.

b. Internal Battery: The battery shall consist of valve regulated, lead acid cells.
c. Backup Time: 20 minutes at full load with ambient temperature at 25 deg C (77 deg F).

d. Battery Recharge: The recharge time shall be 3 hours to 95% capacity after discharged into a full load.

e. Frequency: UPS shall auto sense input frequency and shall operate within 55 - 65 Hz. When the input frequency exceeds these parameters, the UPS shall operate from the battery.

f. Surge Protection: 120 VAC Nominal units shall withstand input surges without damage per criteria listed in ANSI C62.41-1991 (IEEE 58, Category A & B. 230 VAC nominal units shall withstand input surge without damage per criteria Listed in IEC 801 - 5, Level 3.

g. Voltage Output Configuration
   (1) Voltage Output: 103 - 132 VAC
   (2) Voltage Output Regulation: +10/-14%
   (3) Output Frequency Regulation: 60 Hz +/- 8%
   (4) Load Power Factor Range: 0.65 lagging to 1.0 unity
   (5) Overload Capability: 110% for 5 minutes; 200% for 2 cycles

h. Inverter Configuration
   (1) Voltage: 120 VAC
   (2) Voltage Regulation: +/- 7% RMS battery voltage range
   (3) Frequency Regulation: +/- 0.5 Hz
   (4) Frequency Sync. Range: +/-5 Hz
   (5) Frequency Slew Rate: 1 Hz per second
   (6) Load Power Factor Range: 0.5 lagging to 1.0 unity
   (7) Overload Capability:
      (a) 110% for 30 seconds
      (b) 120% for 5 cycles
(c) 150% for 1 cycle

(8) Voltage Transient Response:
  (a) +/- 7% maximum for 20%-100%-20% load step

(9) Voltage Distortion:
  (a) Resistive Loads: 10% before (2) minute warning; 15% after pre-alarm
  (b) Switching Mode Power Supply (SMPS): 16% before 2 minute warning, 20% after pre-alarm

(10) Transient Recovery Time:
  (a) To within nominal voltage within 30 milliseconds.

C. ENVIRONMENTAL CONDITIONS

1. Operating: 0 deg C to +40 deg C (+32 deg F to +104 deg F)

2. Relative Humidity:
   a. Operating: 0 to 95% non-condensing
   b. Audible Noise: Noise generated by the UPS during any mode of operation shall not exceed 45 dBA.

D. FABRICATION

1. The UPS shall be forced air cooled when required. Air intake shall be through the sides of the unit and exit out the rear.

2. The UPS shall have built-in protection against undervoltage, overcurrent, and overvoltage conditions including low-energy lightning surges introduced on the primary input power source. The 120 VAC UPS modes shall withstand input surges without damage per criteria listed in ANSI C62.41-1980; IEEE 587, Cat. A.

3. In the battery mode of operation, the bi-directional converter shall convert DC power from the battery to regulated and conditioned sine wave AC power for supporting the critical load.

E. Output Protection
1. For "Faults" indications within the UPS, including short circuits and overloads, the UPS shall employ the following overcurrent protection methods depending upon mode of operation:

   a. Normal Mode - The UPS shall employ a Fuse or circuit protector
   
   b. Battery Mode - Electronic Current Limit

2. The UPS shall be capable of supplying current and voltage for overloads exceeding 100% and up to 110% of full load current for 5 minutes in normal mode. A visual indicator and audible alarm shall indicate overload operation. The bi-directional converter (Battery operation) shall be capable of supplying current and voltage for overloads exceeding 100% and up to 110% of full load current for 30 seconds. For greater currents or longer time duration, the UPS shall shut down to prevent damage to components and the connected equipment.

3. This LED shall be used to provide operation mode status of the UPS. When operating from input AC power and the main On/Off switch is "on", this LED shall illuminate GREEN. In the absence of input AC power (battery mode operation) this LED shall flash on/off for 1.0 second, every second.

   a. Utility High/Low status indicator
   b. Fault status indicator
   c. Load/Battery Level Indicator
   d. An audible alarm shall be used in conjunction with the visual indicators to indicate to the operator a change in UPS operating status.

4. The UPS shall contain front panel mounted main On/Off and alarm silence/manual battery test switches. The UPS shall also contain a microcontroller based monitoring and controls for reliable operation

5. Output distribution shall be integral to the UPS, located on the rear of the unit. The unit shall contain a minimum of four (4) NEMA 5-15R receptacles.

6. The UPS shall contain a DB9F (9 pin female) connector on the rear panel to allow UPS status communications to the PLC or connected computer system. The DB9F shall contain photo couplers to signal on battery and low battery operational status. The UPS shall also be capable of receiving a signal from the connected host system to initiate a UPS shutdown. This signal shall be a +5 V to +12 V (RS232 level)
that must remain for > 0.75 second duration. UPS shall be provided with expansion slots for the addition of I/O modules and SNMP network interface modules. The UPS shall be provided with a relay option module to provide indication of UPS status to the PLC.

7. UPS shall be Eaton Powerware 9130 Series, Liebert GXT3 Series, APC SMART, or equal.

2.18 SPARE PARTS, CONSUMABLE ITEMS, AND TOOLS

A. Fuses: Provide 20 percent of each size and type used rounded to the next whole number, but no less than five of each size and type.

B. Indicating Light Bulb: Provide 10 percent of each color, size and type used rounded to the next whole number, but no less than 5 of each type. This requirement applies to annunciator light bulbs as well, if any are supplied under this Section.

C. Indicator switch cover plates, two (2) lens covers for each type of switch and color combination shall provided. Lens covers shall not be printed.

D. Spare contact blocks 5 spare NO and NC for each type of switch contact block utilized.

E. Corrosion-Inhibiting Vapor Capsules: Two-year supply.

F. Two of each type of relay.

G. Two LED Pilot Lights with two LED’s of each color.

PART 3 -- EXECUTION

3.01 GENERAL

A. The CSS shall furnish all installation materials, labor, wiring, cabling, and terminations, for the complete installation and operation of the control panels.

B. Craftsmen skilled in the particular trade shall perform assembly, wire and fabrication in a workmanlike manner. Work shall be performed in accordance with the Plans, Specifications, manufacturers’ recommendations, and the best practice of the trade. Completed work shall present a neat and finished appearance.

C. Qualified, experienced personnel who are technically skilled in their trades, are thoroughly instructed, and are competently supervised shall do all work including installation, connection, calibration, testing and adjustment. The resulting complete installation shall reflect professional quality work, employing industrial standards and methods. Any and all defective material
or inferior workmanship shall be corrected immediately to the satisfaction of the Owner's representative at no additional cost to the Owner.

D. Existing control panel modifications and additions shall conform to the control panel assembly and wiring specifications of this section.

3.02 MANUFACTURER SUPPLIED EQUIPMENT

A. The CSS shall install motor protective circuitry and components furnish by the pump and motor suppliers. Equipment for thermal and moisture sensing shall be installed in local control panels as indicated and/or as required by the motor manufacturer to protect the motor.

1. The CSS shall coordinate the installation requirements with the pump and motor suppliers. The CSS shall furnish and install power supplies, relays and converters as required to properly interface the control systems with the motor supplied protective systems.

3.03 FACTORY TESTING

A. Prior to shipment, the control panels shall be factory tested. The manufacturer shall notify the owner six weeks prior to testing for owner witnessing of the test to be conducted.

B. The factory test shall verify installation, conformance with plans, wiring continuity and operation of all panel displays and control components.

C. Programmed equipment and instruments shall be exercised to verify proper range, scale, trip points and control functions.

D. Submit factory test forms for review.

E. Certified factory test forms shall be provided prior to shipment.

3.04 INSTALLATION

A. Control panels shall be installed in accordance with the manufacturer's requirements as per section 13300 and all related electrical equipment installation specifications and requirements.
3.05 COMMISSIONING

A. Control panels shall be field tested and commissioned in accordance with Section 13300 and 13320.

3.06 WARRANTY AND CUSTOMER SUPPORT

A. All control panel assemblies and associated control components shall be provided with a one year service and replacement warranty from date of project acceptance.

- END OF SECTION -
SECTION 13350
PROGRAMMABLE CONTROL SYSTEMS

PART 1 -- GENERAL

1.01 REQUIREMENTS

A. This Section covers the requirements for Programmable Logic Control (PLC) based programmable control systems, including microcontrollers. The Control System Supplier (CSS) shall furnish, install, program, test, calibrate, configure and place into operation PLC’s, Microcontroller Units (MCU), Operator Interface Panel (OIP) and communications hardware as specified herein.

B. A standard PLC process application program shall be provided by the Owner. The CSS shall obtain the latest standard application program from the Owner and provide all PLC and OIP technical services to download, program, modify and configure the PLC and OIP for site specific operation.

C. The CSS shall furnish all necessary interconnecting cables, all accessories, and all appurtenances as indicated herein or as required for proper operation of the system. All major components of the system shall be of the same manufacturer.

D. Programmable control systems are a part of the instrumentation and controls system. In addition to the requirements in this Section, the supplier of the programmable control systems shall meet all the applicable requirements of installation covered in Section 13300, Instrumentation and Controls and Section 13340 Control Panels, except where those requirements are modified by this Section.

E. The CSS shall furnish, install and wire PLC modules, communications modules, processors and I/O modules in the control panels as indicated on the Contract Plans.

F. The CSS shall configure, test and provide start-up assistance for all hardware, and communications interface components as indicated herein or as required for proper operation of the system.

G. The CSS shall schedule and coordinate PLC and SCADA communications and configuration requirements with the Owner. The CSS shall configure the hardware to provide SCADA access monitoring and control via a Modbus serial radio communications link.

H. The CSS shall schedule and coordinate communications and configuration requirements with the existing SCADA system.
I. The CSS as a part of factory testing shall interconnect all PLC systems, including packaged system supplier PLC enclosures complete as a fully functional system. The CSS shall run diagnostics to verify hardware configurations, communications and compatibility between systems including the use of any testing programs necessary to verify operation.

J. The CSS shall provide the services of a field technician to assist with start-up, point testing, loop testing, operational testing, commissioning and final acceptance of the PLC hardware and software systems.

K. The input and output requirements for the PLC’s are contained in the wiring diagrams, Input/Output List/Schedules and P&ID drawings. The CSS shall prepare a consolidated project wide PLC Input/Output wiring list for all I/O represented in the various documents.

1.02 RELATED SECTIONS

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

B. The CSS shall provide hardware and software compatible with equipment, systems and services specified in the following sections:

1. Division 16, Electrical

2. Division 13, Instrumentation and Control
1.03 SUBMITTALS

A. Submittals shall be supplied in conformance with Sections 13300 and the following:

1. PLC Input/Output List
   a. List shall include all I/O on a PLC per PLC basis with all I/O points assigned to a specific module input or output. The List shall include:
      (1) Tagname and Number
      (2) Description
      (3) Function
      (4) Module Rack, Slot and Channel
      (5) Voltage
      (6) Type
      (7) Equipment Designator

1.04 REFERENCED STANDARDS

A. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE)
   1. C62.90.2, trial-use standard withstand capability of relay systems to radiated electromagnetic interference from transceivers.
   2. C62.41, IEEE recommended practice on surge voltages in low-voltage AC power circuits.
   3. C62.45, IEEE guide on surge testing for equipment connected to low-voltage AC power circuits.

B. Electronic Industries Association (EIA)
   1. TIA-232-E, interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange.
   2. 422-A, electrical characteristics of balanced voltage digital interface circuits.

C. International organization for standardization (ISO)
   1. ISO 9001, quality systems-model for quality assurance in design, development, production, installation and servicing.
D. National Electrical Manufacturers Association (NEMA)
   1. ICS 1, general standards for industrial control and systems.
   2. ICS 4, terminal blocks for industrial use.
   3. ICS 6, enclosures for industrial controls and systems.
   4. LS1, low voltage surge protection devices.
   5. Publication No.250, enclosures for electrical equipment (1000 V maximum).

E. National Fire Protection Association (NFPA)
   1. National Electrical Code (NEC)

F. Underwriters Laboratories, Inc. (UL)
   1. UL 1283, standard for safety-electromagnetic interference filters.
   2. UL 1449, standard for transient voltage surge suppressors.

1.05 COORDINATION
A. The CSS shall coordinate the PLC wiring and Input/Output assignments with the Owner. The Owner shall approve the I/O arrangement prior to fabrication and wiring of the PLC cabinets by the CSS.

PART 2 -- PRODUCTS

2.01 GENERAL
A. The PLC system shall operate in ambient conditions of 32 to 140°F temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.

B. Where the PLC is utilized to control multiple trains of equipment, the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of one component does not affect equipment of all trains. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.

C. The PLC program module shall dictate control outputs to a known and safe state prior to running of control program, under PLC fault conditions, and PLC runtime errors.

D. Access to the PLC program, downloading, uploading and diagnostic functions shall incorporate password protection or key lock operation.

E. PLC system shall be designed with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.
F. The controller shall be grounded to the panel ground bus with a separate ground conductor sized per the manufacturers grounding requirements the minimum ground connection shall be #12 awg.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Construction: The PLC central processing unit (CPU) shall be of solid-state design. All CPU operating logic shall be contained on plug-in modules for quick replacement. Chassis wired logic is not acceptable. The controller shall be capable of operating in a hostile industrial environment (i.e., heat, electrical transients, RFI, vibration, etc.) without fans, air conditioning, or electrical filtering, up to 60 degrees C and 95 percent humidity.

B. Processor shall be provided with integral communications ports and Hot Standby system coprocessor for monitoring and control of system redundancy.

C. The PLC shall be furnished as a complete assembly with I/O (input/output) modules and peripheral equipment suitable for the interface with the new and existing PLC equipment, components and field devices. The PLC design shall incorporate:

1. The PLC chassis shall contain all I/O modules, communications equipment, and power supplies required to provide the specified functions. PLC chassis shall be sized to house the required PLC modules plus an additional four slots for future expansion capability.

2. PLC Power Supply: The PLC power supplies shall be sized to provide power at the maximum total module load plus an additional 50 percent for future expansion. The PLC power supply shall provide the following operational characteristics:

   a. 120 VAC RMS plus or minus 15 percent continuously

   b. 120 VAC RMS plus or minus 30 percent maximum 30 seconds

   c. 120 VAC RMS plus or minus 100 percent maximum milliseconds

   d. Line spikes at 1000V ac (5000 micro-seconds duration; 0.05 percent maximum duty cycle)

3. Central Processor: The central processor shall contain all firmware logic, relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions. It shall be capable of interfacing sufficient discrete inputs, analog inputs, discrete outputs, and analog outputs to meet the specified requirements plus an additional 25 percent excess capacity. The power supply shall contain capacitors to provide orderly shutdown in the event incoming power does not meet specifications. If this occurs, the processor shall cease operation, forcing all outputs off. The processor shall have a key type memory protect switch to prevent unauthorized program changes. The central processor shall be 32-bit, minimum.
a. Memory: The programmable controller memory shall be Complementary Metal Oxide Semi-conductor (CMOS) based memory with battery backup or Erasable Programmable Read-Only Memory (EPROM) based memory. The CMOS memory shall be a minimum of 768K with sufficient battery backup to retain the program during power interruptions of up to 1 year. An indicator shall show the status of the batteries. A reference shall be available through the discrete outputs to alarm the operator that the batteries should be changed.

b. The PLC shall be supplied with sufficient memory to implement the specified control function plus a reserve capacity of 25 percent of the total provided. This reserve capacity shall be totally free from any system use. Memory size shall be 7MB with 768K user logic.

c. The PLC shall be provided with an 8 MB Flash Memory module for program storage and memory back-up.

d. The PLC shall provide internal fault analysis with a fail-safe mode and a dry contact output for remote location alarming, and a local indicator on the PLC frame in the event of a fault in the PLC.

e. The PLC shall support programming in IEC 61131 language using Modicon’s Concept Software. It shall be easily reprogrammed with a portable programming unit.

f. Communications Ports: The PLC Processor shall be equipped with a Modbus Plus and 1 Modbus Serial, 1 USB, and 1 TCP Ethernet interface ports. Additional communications modules (Ethernet 100BaseT) shall be provided as specified and indicated on the contract drawings.

g. The PLC processor shall be Modicon Quantum 140 CPU 534 14B Series.

4. Input/Output Modules: All I/O housings and I/O modules shall be of rugged construction with modules in place. Sufficient input and output modules shall be provided with the PLC to implement the specified control functions plus a reserve capacity of 25 percent of the total provided.

a. Discrete Input Modules: Defined as contact closure inputs from devices external to the programmable logic controller module. Input modules shall be shielded from short time constant noise and 60-Hz pickup. Individual inputs shall be optically isolated for low energy common mode transients to 1500 volts peak from user's wiring or other I/O Modules. The modules shall have LED lights to indicate a discrete input.

(1) AC Input modules shall be supplied with a maximum of 16 points per module. Input voltage rating shall be provided as indicated on the Contract Drawings. Discrete input module shall be Modicon Quantum Series 140 DAI 543 00.
(2) DC Input modules shall be supplied with a maximum of 32 points per module. Input voltage rating shall be provided as indicated on the contract drawings. Discrete input module shall be Modicon Quantum Series 140 DDI 353 00.

b. Discrete Output Modules: Defined as contact closure outputs for ON/OFF operation of devices external to the programmable logic controller module. The output modules shall be fused at with blown fuse indicator lights. The output modules shall be optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volt peak. All output modules shall have LED lights to indicate output has been cycled ON by the controller.

(1) Grouped relay outputs shall be utilized for DC switching and control applications. Output contact rating shall be 2 amps. Interposing relays shall be provided when controlled equipment current exceeds the contact output rating. Output module shall be supplied with a maximum of 16 points per module. Voltage shall be supplied as indicated on the Contract Drawings. Relay output module shall be Modicon Quantum Series 140 DRA 849 00.

(2) Isolated Contact Modules shall be provided for controlling external field devices such as solenoids, equipment requiring dry contacts, and switched AC control circuits. Relay contacts shall be individually isolated per channel and shall be provided with a maximum of 8 points. The Isolated Relay Output Module shall be Modicon Quantum Series 140 DRC 830 00.

c. Analog Input Modules: Defined as analog inputs for 1 to 5 VDC or 4 to 20 mA dc signals, where an analog to digital conversion is performed and the digital result is entered into the processor. New inputs shall be provided for every scan. Analog inputs shall be supplied with a minimum resolution of 14 bits. Each analog input shall be isolated from common. Analog input modules shall be 8 channel Modicon Quantum Series 140 ACI 030 00.

d. Analog Output Modules: Defined as analog output for 1 to 5 VDC or 4 to 20 mA dc signals, where a digital to analog conversion is performed and the analog result is produced on every scan. Analog output resolution shall be 14 bit minimum. Each analog output shall be capable of driving into a 1500 ohm load. Analog Output modules shall be 8 channel Modicon Quantum Series 140 ACO 130 00

5. Remote Input/Output Communications: The PLC shall communicate with remote chassis utilizing Remote Input/Output scanner and adapter modules as required between the PLC I/O racks. RIO shall be redundant dual channel configuration with all required connectors and cables.
D. Communications:

1. **Serial Communications**: The PLC shall be provided with a minimum of three (3) Serial RS-232/RS-485 Modbus RTU communications ports. Configured as follows:

2. **Data Highway**: The PLC shall be provided with One Modbus Plus communications interface for access from an Operator Interface Panel (OIP) and portable programming PC.

3. **Ethernet**: The PLC shall be provided with an Ethernet communications module port for Local Area Network access.

E. Provide additional PLC communications interface modules, cabling and adapters as required to meet the communications requirements specified.

F. The PLC system components shall be Modicon Quantum Series.

2.03 MICROCONTROLLER UNITS

A. The microcontroller system and subsystem components shall be Modicon Momentum M1E Series, “No Eaqual” to match the existing Owner standard.

1. **Construction**: The microcontroller shall be of solid-state design. All CPU operating logic shall be contained within an integral control chassis. Microcontroller terminal base units shall allow for the easy removal and replacement of the controller. The controller shall be capable of operating in a hostile industrial environment (i.e., heat, electrical transients, RFI, vibration, etc.) without fans, air conditioning, or electrical filtering (up to 60 degrees C and 95 percent humidity).

2. The CPU shall be Modicon Momentum Series M1E, 171CCC96030.

3. The I/O communications adapter shall support Interbus communications compatible with CPU.

4. Additional I/O modules shall be provided as required to interface with the process I/O.

B. **Power**: The Microcontroller and all associated equipment shall be 24 VDC powered. The power shall be conditioned and regulated as required to maintain the voltage within the operating limits of the PLC. A PLC power supply(s) shall be provided to supply 24 VDC power to the PLC system and shall be sized to accommodate the PLC system load plus an additional 50 percent.

C. **Design**: The I/O subsystem shall be furnished with I/O (input/output) modules, terminal base and termination blocks suitable for the interface with the specified field devices. The I/O base units shall be 4-20 mA signals for analog input and analog output channels. The discrete I/O shall accept dry contact closure for discrete inputs.
and relay dry contact for discrete outputs. The I/O processor shall provide internal
fault analysis with a fail-safe mode of operation.

D. Input/Output Terminals: All I/O terminal and I/O modules shall be of rugged
construction with modules in place. Sufficient input and sufficient output modules
shall be provided with the distributed I/O panel to implement the specified control
functions plus a reserve capacity of 25 percent of the total provided.

1. Discrete Inputs: Defined as contact closure inputs from devices external to
the microcontroller. Input modules shall be shielded from short time constant
noise and 60-Hz pickup. Individual inputs shall be optically isolated for low
energy common mode transients to 1500 volts peak from user's wiring or
other I/O channels. The input channels shall be True High and have LED
lights to indicate a discrete input status. The Discrete Input module shall be
Momentum Series 170ADI34000.

2. Discrete Outputs: Defined as dry contact closure outputs for ON/OFF
operation of devices external to the programmable logic controller module.
The outputs shall be integrally fused with form C output. The output modules
shall be optically isolated from inductively generated, normal mode and low
energy, common mode transients to 1500 volt peak. All output modules shall
have LED lights to indicate output has been cycled ON by the controller. The
Discrete Output module shall be Momentum Series 170ADO83030.

3. Analog Input Modules: Defined as analog inputs for 1 to 5 VDC or 4 to 20 mA
dc signals, where an analog to digital conversion is performed and the digital
result is entered into the processor. Inputs shall be differentially isolated. The
analog input channel shall have a minimum 12 bit resolution. The Analog
Input module shall be Modicon Momentum Series 170AAI14000.

4. Analog Output Modules: Defined as analog output for 1 to 5 VDC or 4 20 mA
dc signals, where a digital to analog conversion is performed and the analog
result is produced as an output. The Analog Output module shall be
Momentum Series 170AAO92100.

5. Combined I/O Module: Combined I/O modules shall be provided as indicated
on the contract drawings and shall be configured to meet the specified I/O
configurations indicated.

   a. Mixed I/O shall be provided with 4 AI, 2 AO, 4 DI and 2 DO for mixed
      low I/O count locations. The mixed I/O module shall be Modicon
      Momentum Series 170AMM09000.

   b. Discrete I/O shall be 16 DI and 16 DO. The DI/DO module shall be
      Modicon Momentum Series 170ADM35010.

E. Communications ports. The Microcontroller shall be provided with one serial
communications port (RS-232/RS-485) ports configurable for either Full or Half-
Duplex operation.
1. Port one RS-232 shall be configured for serial based communications as an RTU slave responding to polled queries from a PLC communications master.

2. Ethernet Port

3. The micro-controller shall support Interbus, Modbus RTU and MODBUS TCP communications for use in SCADA systems as a Remote terminal Unit (RTU) or Microcontroller. The protocol shall allow the RTU to communicate as a responder (slave) node on a MODBUS master/slave network or as a PEER node on an Ethernet network.

4. The communications adapter shall be provided with an integral Time of Day, Real Time Clock for time stamping and event scheduling. The communications module shall be Momentum Series 172JNN21032.

2.04 SERIAL REMOTE I/O

A. Serial remote I/O (SRI0) shall be provided as indicated on the Contract Drawings.

B. SRI0 modules shall support RS-232 and RS-485 communications utilizing the Modbus RTU protocol for SCADA system communications.

C. The SRI0 module shall support one analog input (4-20 mA) and one discrete input 24 VDC for SCADA monitoring.

D. The SRI0 module shall support serial communications for interfacing with standard RS-232 communications devices such as radios and modems.

E. The SRI0 module shall be DGH Series, or equal.

2.05 PLC DATA COMMUNICATIONS

A. General

1. The serial Modbus communications port shall be configured to provide optimized radio communications between the Micro-controller, and SCADA master PLC and SCADA server via a radio based communications network.

2. The Ethernet port shall be configured to provide communications to the local operator interface panel.

3. A communications I/O adapter module shall be provided to communicate input/output data via an Interbus communications network. The Interbus communications adapter shall be 170INT11000.

B. Fiber Optic Switch

1. The Ethernet/fiber transceiver switches shall be manufactured with a ruggedized industrial case; 24VDC powered, and DIN rail mountable.
2. The Ethernet/transceiver switch shall have the following capabilities:
   a. 24VDC input supplies, (10 to 30VDC)
   b. Operating temperature 32 to 158 Deg F
   c. Shock and Vibration: 200g @ 10ms, 1g, 10-500Hz, 3 axis
   d. 10/100BaseTx Auto Sense/Configure, plug and play with auto MDIX/ port
   e. Fiber supports Singlemode SC connectors
   f. Fiber supports 62.5/125um @ 850/1300nm multimode ST connectors

3. Each switch shall be configured with 2 Fiber Optic Ports and 6 Ethernet 10/100BaseT Ports.

4. The Ethernet/transceiver switch shall be N-Tron 500 series, no equal.

C. Ethernet Switch

1. The Ethernet/fiber transceiver switches shall be manufactured with a ruggedized industrial case; 24VDC powered, and DIN rail mountable.

2. The Ethernet/transceiver switch shall have the following capabilities:
   a. Operating temperature 32 to 158 Deg F
   b. Shock and Vibration: 200g @ 10ms, 1g, 10-500Hz, 3 axis
   c. 10/100BaseTx Auto Sense/Configure, plug and play with auto MDIX/ port

3. Each switch shall be configured with 4 Ethernet 10/100BaseT Ports.

4. The Ethernet/transceiver switch shall be B&B EIR20X, Series, N-Tron 500 series, no equal.

D. Ethernet to Serial Conversion

1. Ethernet to serial converters shall provide a standard RS-232 Serial interface to RJ-45 Ethernet connection and support full serial data handshaking compatible with the Modbus RTU protocol.

2. The Ethernet port shall be a RJ45 10Base-T/100Base-TX Ethernet port connection that supports Modicon TCP communications.

3. Minimum requirements:
a. Embedded, unmanaged, fully compliant 802.3u non-blocking Ethernet switch
b. Store and forward architecture with 1K MAC address lookup table
c. Automatic MDI/MDI-X crossover
d. Full duplex IEEE 802.3x flow control
e. Half duplex back pressure flow control
f. Baud rate selectable from 300 to 230 Kbps
g. LED indicators for TXD and RXD activities
h. IEEE 802.1d spanning tree Internal web server (standard tunneling firmware only)
i. SNMP, Serial login, Telnet login, Device Installer software

4. Serial to Ethernet converter shall be B & B Electronics MES900 Series, Lantronix Xpres-DR+, or equal.

E. Radio Communications

1. Radio communications shall be compatible with the radio communications network.

2. Reference Section 13360 for radio system requirements.

2.06 CABLING AND CONNECTORS

A. Cables and connectors shall be supplied by the PLC manufacturer and fabricated for the required interface connection. Cables shall be fabricated at the required length, unspliced with factory installed terminations at both ends.

B. Interbus, trunk, bus, drop and tap off cables and conductors shall be factory certified for use with the specified communication and interface media requirements.

C. Termination, Data segment and Tee boxes shall be certified by the manufacturer and installed in accordance with the manufacturer’s requirements.

D. Connectors and terminators shall be provided with the correct connection interface without the use of additional adapters or fittings. Terminators shall be installed by the factory at the appropriate cable ends.

E. All terminations shall be provided with screw type terminal connectors. Screw terminals shall be Modicon Momentum 170XTS00100.
F. Common Bus Bar connectors shall be utilized for ground and common connections for system power and grounding. Common bus bar shall be screw terminal series with number of rows to match the I/O base configuration. Bus bar shall be Modicon Momentum Series 170XTS00401, 501, 601.

G. The PLC system supplier shall furnish all communications connectors, adapters, terminating resistors as required to provide a complete communication cabling system. The CSS shall coordinate installation and terminate the Ethernet, Modbus, and Interbus communications cables.

2.07 PLC OPERATOR INTERFACE PANEL

A. Operator interface panels (OIP) shall be provided for local process monitoring and setpoint control.

B. The Microcontroller system shall be provided with a front panel mounted Operator Interface Panel (OIP). The interface panel shall be weatherproof and operate at 24 VDC.

C. The OIP shall be provided complete with all hardware, software, firmware and communications modules configured to operate with the specified system.

D. The OIP shall be a graphical based system configured to graphically display the process, alarms, trends and provide for operator control and interaction with the Microcontroller/PLC system.

E. The OIP shall be configured to communicate with the PLC system via an Ethernet communications interface.

F. Memory: The OIP shall be provided with sufficient memory to meet the I/O and configuration requirements specified plus an additional 50 percent.

G. The OIP shall be furnished complete with all software and development tools necessary for screen development and system configuration. The OIP shall be provided with the following:

1. 7" TFT Widescreen Color Scan Touchscreen
2. Resolution 800 X 480
3. Programming and Configuration Software EZ-Ware 5000
4. Diagnostic access port and interface cables
5. Ethernet Port
6. SD or Compact Flash Card Slot

H. The Operator Interface Panel shall be Maple Silver Series HMI5070TH.
2.08 SPARE PARTS

A. The CSS shall provide, in addition to the specified wired spares, the following packaged spare parts:

B. One I/O Module of Each type

C. One Momentum Processor

D. One Momentum Real Time Clock Expansion Module

PART 3 -- EXECUTION

3.01 GENERAL

A. The CSS shall furnish all configuration labor, communications wiring, cabling, terminations, equipment, modules, converters and interface components to provide for a complete and operational PLC control system.

B. The PLC, OIP and MCU shall be tested by the CSS as required to meet the specified control requirements and functions to provide cohesive operation between the PLC and SCADA workstations. The PLC system shall be configured to operate within the specified system infrastructure.

C. The PLC inputs/outputs shall implement the control functions and I/O specified within the process control strategies, shown on the drawings, indicated in the I/O list and specified under applicable specification sections.

D. PLC control systems shall be configured to operate independent of SCADA workstation and master PLC status. The PLC shall be configured to operate failsafe in the event of a Master PLC or SCADA failure.

E. Quantum PLC modules shall be arranged such that a single module failure does not result in the shutdown of a complete system or station with the plant. Where only a single type module is utilized in a PLC rack, such as AI or AO modules, a second module shall be provided to split the AI and AO into multiple channels. The minimum number of AI or AO modules per PLC shall be two (2).

F. All unused module inputs and outputs shall be wired to field terminal blocks.

G. Provide 25 Percent Spare I/O for each type and voltage. Add modules as required.

3.02 PLC APPLICATION PROGRAMMING

A. The CSS shall provide for all PLC applications programming as required per the specifications. Reference Section 13370, 13371, 13372, 13373 and Division 17 for application programming requirements.

B. All existing PLC’s communicating via the radio system shall have their Modbus register tables programmed and modified to support the new communications requirements. Register sets shall be optimized to support communications groups
associated with status and analog registers, setpoint registers and timer/counters. Registers shall be grouped by type to support various poll times of different register groups. Register programming shall be coordinated with the master PLC program to support optimized radio based communications.

C. The contractor shall provide one (1) copy of Modicon Concept software with the performance, functionality and configuration requirements as specified herein and within applicable specification sections.

D. One copy shall be provided to the Owner in its original box unopened and licensed to the Owner.

E. The PLC programming software shall be capable of the following

1. Supports the five IEC 61131-3 programming languages.
   a. LD: Ladder Diagram
   b. IL: Instruction List
   c. ST: Structured Text
   d. SFC: Sequential Function Chart
   e. FBD: Function Block Diagram
   f. Concept latest version compatible with the Owners existing program applications

3.03 FACTORY TESTING

A. Factory testing shall be conducted with the SCADA Equipment, Communications Systems, PLC’s and OIP mounted in their associated control panels fabricated in accordance with other sections as a complete system for comprehensive factory testing.

B. Reference Section 13320 for additional requirements.

C. The CSS shall provide the services of a factory trained PLC technician to provide the following:

1. Setup, configure and wire all control panels and operator interface panels.

2. Set-up, configure and verify all Serial, Ethernet and Fiber Optic communications modules.

D. The CSS shall provide the services of a factory trained PLC technician to test the system as follows:

1. Point Testing of all I/O systems with the PLC diagnostic graphic displays.
2. Analog testing of all I/O systems with signal generator to vary the signal from 0 – 100 percent at 10 percent intervals.

3. Test communications interface between PLC’s, PLC to SCADA and SCADA to SCADA communications.

4. Application program functional testing.

E. The CSS shall provide all necessary cables, connectors, simulators and testing equipment required to perform a complete system test.

F. Test equipment shall be provided to test and independently vary up four analog input values simultaneously via 4-20 mA signals.

3.04 IMPLEMENTATION

A. The CSS shall install and test all PLC and OIP components and communications equipment contained within their associated control panels. The CSS shall provide a test plan that will address field point testing of the PLC system and verify PLC communications from each node.

B. The test plan shall include sign off sheets that will verify operation of the system I/O and the PLC communications integrity. The following tests shall be conducted at each location:

   1. PLC system diagnostics
   2. I/O Point Testing
   3. Analog I/O Testing
   4. Control Loop Testing
   5. SCADA point testing and control operations

3.05 TRAINING

A. General PLC application, troubleshooting and diagnostics 16 hrs

3.06 WARRANTY AND CUSTOMER SUPPORT

A. All PLC hardware and software shall be provided with a 1 year replacement warranty from date of project acceptance.

B. The CSS shall purchase one year of support services from Modicon for the PLC programming software, Concept.

C. The CSS shall provide one year of warranty service for the correction of operational errors resulting from hardware failures.
3.07 EXISTING SYSTEMS

A. Existing PLC systems shall be reprogrammed to support the new communications structure and requirements for SCADA monitoring and control.

B. Existing PLC applications programs that require modification shall be coordinated with the Owner. The CSS shall notify the Owner prior to any program modifications or configuration changes.

C. The CSS shall record all current setpoints, upload the program and save it prior to any programming modifications.

3.08 PLC TECHNICAL SERVICES

A. In addition to the specified requirements for application programming and testing, the CSS shall provide an additional 120 hrs of on site PLC programming and technical support. These hours are not associated with any technical requirements specified for programming, start-up and commissioning efforts.

B. Allotted hours are in addition to the requirements of the specification to provide for a complete and operational system. Allotment hours are to be utilized to provide for interfacing with equipment not specified or implied in the contract documents, enhancement of operation and interfacing with new equipment added during the course of contract implementation.

C. Onsite service shall be defined and directed by the Owner on a task basis during the course of construction. Hours shall be applied in the field and logged accordingly by the Project Manager or Owner’s Field Representative.

- END OF SECTION -
Not Used
1.00 SCOPE OF WORK

A. This section covers wireless communications systems and components. The Control System Supplier (CSS) shall furnish, install, configure, test, set-up, commission and place into operation wireless communication systems as specified herein.

B. The CSS shall furnish all necessary interconnecting cables, antenna connectors, couplers, mating adapters, feedlines and appurtenances as indicated herein or as required for proper operation of the system.

C. The CSS shall install wireless equipment in the control panels as a part of the control panel fabrication process.

D. The CSS at the locations indicated on the contract drawings shall coordinate equipment interface requirements.

1.01 REGULATORY CODES, STANDARDS AND SPECIFICATIONS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

   1. Motorola Standard R56
   2. Federal Communications Commission – Title 47
   3. Telecommunications Industry Association (TIA) – Standard 222

1.02 SUBMITTALS

A. Submit in accordance with Section 13300.

B. Catalog Data: Submit catalog literature and data sheets for the equipment specified. Include complete manufacturer's part and model numbers.

C. Submit technical literature for radio system diagnostic tools and programs.

D. Submit manufacturer's calibration and test procedures for equipment provided under this section.

E. Submit a radio commissioning binder outlining all tests and procedures specified in Part 3. The radio commissioning binder shall contain:

   1. Test forms
   2. Test Procedure
4. Radio Configuration Sheet

5. List of test equipment utilized to perform the specified testing and configuration.

F. Operations and Maintenance Manuals: Submit manufacturer’s standard installation, operation and maintenance manuals for the non-warm standby radios, warm standby radios, and diagnostic software.

PART 2  PRODUCTS

2.00 RADIO TRANSCEIVERS

A. GENERAL

1. Licensed and Unlicensed Spread Spectrum MAS radios shall be provided at the locations indicated on the contract drawings.

2. The radio transceiver shall be a licensed radio in the 400-450 MHz or 900 – 950 MHz frequency ranges for incorporation into an existing multiple address system (MAS) the transceiver shall provide transparent and direct asynchronous real time communications using standard asynchronous protocols.

3. Radio Transceiver shall be provided with the radio diagnostics options.

4. Unlicensed radios shall be provided as indicated.

5. The radio transceiver shall be field configurable as a master station or remote radio and shall be capable of operation as a half-duplex or simplex radio. The radio shall support all splits in duplex frequencies. The radio shall be compatible with the existing radio network and shall be supplied with the radio diagnostic option for remote diagnostic access and radio tuning.

6. All radios shall be provided with programming and configuration software located on the SCADA system diagnostic portable computer.

B. 450 MHz LICENSED MAS RADIO TRANSCEIVER

1. OPERATION

   1) Operational Modes: Async. - Simplex, half-duplex,

   2) Data Interface: RS-232, DB-25 Female Connector

   3) Supports: TXD, RXD, RTS, CTS, DCD, RUS, AUX POWER, DSR, and GND

   4) Data Rate: 9600 bps (rf) 110 bps-38.4 kbps (data) BER 1x10-6 Network Wide @ 12.5 kHz Channel Spacing @ -110 dBm typical Diagnostic Option FCC E5MDS9710-1
b. TRANSMITTER

1) Transmit Frequency: Coordinate With the Owner
2) Frequency Stability: +/- 0.00015% 1.5 ppm
3) Carrier Power: 4.1 to 5 Watts Programmable
4) Carrier Power Accuracy: Normal +/- 1.5 dB
5) Duty Cycle: Continuous
6) Output Impedance: 50 Ohms

c. RECEIVER

1) Receive Frequency: Coordinate With the Owner.
2) Type: Double Conversion Superheterodyne
3) Frequency Stability: +/- 0.00015% (1.5 ppm)
4) Adjacent Channel (EIA): 60 dB nominal

d. POWER SUPPLY

1) Primary Power: Voltage 13.8 Vdc nominal (10.5 to 16 Vdc operating range)
2) Tx Current: 2A Typical at 5 Watts
3) Rx Current: <125 mA
4) Sleep Mode: 15 mA nominal

e. MODEM/DIAGNOSTICS

1) Modulation: Digital / CPFSK
2) CTS Delay: 0-255 msec programmable in 1 msec increments
3) PTT Delay: 0-255 msec programmable in 1 msec increments

f. PHYSICAL

1) Case: Rugged Die Cast Aluminum
2) Dimensions: (2.0 x 5.625 x 7.25 inches)
3) Weight: 1 kg (2.2 lbs)

g. ENVIRONMENTAL

1) Temperature Range: -30°C to +60°C (-22°F to +140°F)
2) Humidity: 95% at 40°C (104°F) non-condensing

h. The radio transceiver shall be MDS series 4710A, no equal
C. 900 MHz LICENSED MAS RADIO TRANSCEIVER

1. OPERATION

1) Frequency Programmable
2) Operational Modes: Async. - Simplex, half-duplex,
3) Data Interface: RS-232, DB-25 Female Connector
4) Supports: TXD, RXD, RTS, CTS, DCD, RUS, AUX POWER, DSR, and GND
5) Data Rate: 19.2 bps (rf) @ 12.5 kHz Channel Spacing

b. TRANSMITTER

1) Transmit Frequency: Coordinate With the Owner
2) Frequency Stability: +/- 0.00015% 1.5 ppm
3) Carrier Power: 0.1 to 5 Watts Programmable
4) Carrier Power Accuracy: Normal +/- 1.5 dB
5) Duty Cycle: Continuous
6) Output Impedance: 50 Ohms

c. RECEIVER

1) Receive Frequency: Coordinate With the Owner.
2) Type: Double Conversion Superheterodyne
3) Frequency Stability: +/- 0.00015% (1.5 ppm)
4) Adjacent Channel (EIA): 60 dB nominal

d. POWER SUPPLY

1) Primary Power: Voltage 13.8 Vdc nominal (10.5 to 16 Vdc operating range)
2) Tx Current: 2A Typical at 5 Watts
3) Rx Current: <125 mA
4) Sleep Mode: 15 mA nominal

e. MODEM/DIAGNOSTICS

1) Modulation: Digital / CPFSK
2) CTS Delay: 0-255 msec programmable in 1 msec increments
3) PTT Delay: 0-255 msec programmable in 1 msec increments
f. INTERFACE:
   1) RS-232
   2) RS-485
   3) Ethernet

g. PHYSICAL
   1) Case: Rugged Die Cast Aluminum

h. ENVIRONMENTAL
   1) Temperature Range: -40°C to +70°C (-22°F to +140°F)
   2) Humidity: 95% at 40°C (104°F) non-condensing

i. The radio transceiver shall be MDS series SD9, no equal

D. MASTER RADIO

1. Master Radio (Redundant)
   a. 19" Rack Mountable
   b. Front Panel LCD Display
   c. 450 and 900 MHz Master Radio
   d. Master radios shall be redundant radio transceivers with switch selectable radio’s A, B or auto transfer capability.
   e. Dual 120 VAC Power Supply
   f. Frequency Programmable
   g. 450 MHz Master Radio shall be MDS-4790, No Equal
   h. 900 MHz Master Radio shall be MDS-9790 with SDA Converter, No Equal

E. 900 MHz UNLICENSED SPREAD SPECTRUM RADIO TRANSCEIVER

1. REMOTE RADIO
   a. The radio transceiver Series shall be a licensed microwave radios in the 900 - 928 MHz ISM band frequency ranges for incorporation into an existing multiple address system (MAS) the transceiver shall provide transparent and direct asynchronous real time communications using standard asynchronous protocols.
   b. Self Healing Network Configuration
c. Radio Transceiver shall be provided with the radio diagnostics option.

d. Operating mode:
   1) Master
   2) Remote
   3) Repeater

e. Interface
   1) RS-232
   2) RS-485

f. Data Rate
   1) 115.2 kbps Max.

g. Power
   1) 24 VDC

h. The radio transceiver shall be MDS series TransNET 900, no equal

2.01 RADIO SYSTEM I/O

A. Point to Point Wireless I/O

   1. Point to Point wireless I/O shall be provided as a paired system with
      inputs and outputs configured for wireless I/O extension of process data.
      The I/O system shall communicate on the ISM band at 2400 MHz.

   2. The wireless transmitter and receiver shall be provided complete with
      omni-directional antenna and mounting bracket.

   3. The wireless I/O system shall transmit (1) analog and (2) discrete signals
      for remote I/O monitoring at the PLC.

   4. The wireless I/O system shall receive and output (1) analog and (2)
      discrete signals including an RF status output.

   5. Radio transceiver shall be DIN rail mountable.

   6. Power: 24 VDC

   7. Wireless I/O System shall be Phoenix RAD-ISM-2400-SET-UD-ANT

2.02 TRANSIENT SURGE PROTECTOR

A. COAXIAL SURGE PROTECTION:
1. Lightning surge suppression shall be provided at each radio location. The protector shall be a general coverage flange mount coaxial surge protection device with multi-strike capability. The surge protector shall meet the following:

   a. Response Time: 2.5 nanoseconds, maximum.
   b. Surge Current Test: (IEC 1000-4-5 8/20 us Waveform): 500 J.
   c. VSWR: 1.1 to 1, maximum.
   d. Insertion Loss: 0.1 dB, maximum.
   e. Characteristic Impedance: 50 Ohms.
   f. Mechanical: Type N female connector, flange mount.
   g. Turn-on Voltage: +/- 600

2. UHF and 900 MHz Applications:

   a. Frequency Range: 125 MHz to 1000 MHz.

3. Surge protector shall be Polyphaser IS-50NX Series.

2.03 ANTENNAS

A. GENERAL

1. Antennas shall be provide at the sites listed in the contract drawings

2. Antennas shall be selected for the specified frequency range and provided with all mounting hardware and grounding connections as required.

3. License frequency antennas shall be factory tuned for the specified frequency and center cut for dual frequency applications.

B. LICENSED 450 MHz REMOTE YAGI

1. The antenna shall be fabricated of 6061/T6 aluminum rod and seamless drawn pipe, anodized for maximum reliability and corrosion resistance. The hardware and fastenings shall be stainless steel. The internal balun, coax feed and connector shall be sealed in a foam potting system to prevent moisture penetration and assure long service life in severe environmental conditions. The heavy aluminum mounting casting shall allow installation for V polarization.

   b. Gain: 10.2 dB
c. VSWR: Less than 1.5:1.
d. Front-to-Back Ratio: 20 dB, minimum.
e. Maximum Power Input: 300 Watts, minimum.
f. Lightning Protection: Direct DC ground.
g. Input: Type N Female.


C. LICENSED 950 MHz and Unlicensed REMOTE YAGI

1. The antenna shall be fabricated of 6061/T6 aluminum rod and seamless drawn pipe, anodized for maximum reliability and corrosion resistance. The hardware and fastenings shall be stainless steel. The internal balun, coax feed and connector shall be sealed in a foam potting system to prevent moisture penetration and assure long service life in severe environmental conditions. The heavy aluminum mounting casting shall allow installation for V polarization.

a. Frequency Range: 930 - 980 MHz (Licensed).
b. Frequency Range: 900 – 930 MHz (unlicensed)
c. Gain: 9 dB
d. VSWR: Less than 1.5:1.
e. Front-to-Back Ratio: 15 dB, minimum.
g. Lightning Protection: Direct DC ground.
h. Input: Type N Female.


2.04 900 MHz Low Profile Antenna

A. Low profile pipe mount antenna shall be PCTEL BLMPV800HD, Or Equal

B. Low profile cover/access panel mount shall be Larsen LP800, Or Equal

2.05 900 MHz Omni-Directional Antenna

A. The omni-directional antenna shall be a base matched half wave antenna encapsulated in heavy duty fiberglass radomes with a thick walled aluminum mounting base for reliable long term use. The antenna shall meet the following:

1. DC Grounded
2. N Female Connection
3. 7 dB Gain
4. Factory tuned to 915 MHz
5. VSWR 1.5:1
6. 50 Ohm Impedance
7. 150 Watt Minimum
8. Vertical Polarization

B. Omni Antenna shall be Maxrad/PCtel MFB9157(NF), Or Equal

2.06 TRANSMISSION LINES

A. COAXIAL JUMPER

1. Manufactured coaxial jumpers shall be installed between the radio and panel coaxial surge protector.
2. The jumper shall be factory assembled with the mating connectors attached and compatible with the radio and surge protector connection points.
3. The coaxial connection cable length shall be coordinated to provide a strain free connection between the radio and surge protector.
4. Mating connectors shall be stainless steel.
5. Jumper cable shall be 6.0 ft maximum.
6. Jumper cable shall be ½”, superflexible.

B. Transmission cable

1. Transmission cable shall be Low loss, super flexible non-kinking with a minimum bending radius of 3”. Cable length shall be continuous between the surge protector and antenna with out splicing or midpoint connection.
2. Cable construction shall be weathertight and shall be constructed as follows:
   a. Polyethylene Foam Dielectric
   b. Tinned Copper Outer Braid
   c. Aluminum Tape shield bonded to the dielectric
   d. Polyethylene Outer Jacket
   e. Cable shall be constructed with an inert flooding compound to provide a weather tight seal.
3. Transmission cable shall be Times Microwave
   a. LMR-900-DB for Distance > 100 ft < 150 ft
   b. LMR-600-DB for Distance > 50 ft < 100 ft
   c. LMR-400-DB for Distance < 50 ft

2.07 RF CONNECTORS
   A. RF mating connectors shall be selected to match the connection requirements of the Antenna, Surge Arrestor and Radio Equipment for the specified frequency range.
   B. Cable connectors shall be low loss Stainless Steel connectors compatible with the supplied RF transmission cable.
   C. Cable connectors shall match the equipment connection. Cable connection adapters shall not be utilized. Connectors shall be attached to the cable in accordance with the manufacturer's installation requirements.
   D. Connectors shall be crimp/solder style with the center pin soldered.
   E. Connectors shall be Times Microwave to match cable size and type.

2.08 ACCESSORIES
   A. Provide mounting hardware, grounding kits, cable hangers and other materials per this and applicable specifications required to make a complete and operable radio antenna feed system.
   B. Wall mount brackets shall be galvanized steel adjustable brackets. Wall mount brackets shall be Andrew Solutions MT-222L for hollow or solid wall installation, provide back plate for hollow wall installation.
   C. Tower mounting brackets shall be compatible with the antenna assembly.

PART 3 EXECUTION

3.00 GENERAL
   A. Coordinate and schedule work with Owner to minimize disruption and impact.

3.01 INSTALLATION AND START-UP
   A. Perform Site Work and install Communications equipment as shown on Drawings. Install associated equipment including antenna mounts, cable, cable jumpers, connectors and grounding systems.
   B. Replace all outdoor antenna feedlines and connectors at the existing radio sites.
C. Install antennas, associated transmission lines, conduit work and any ancillary antenna accessories per this and applicable specifications and as shown on the contract drawings.

1. Antennas shall be installed on a 2” pipe mast or tenon as indicated on the contract drawings.

2. Provide weather wrapping for all exposed cabling and connectors. Weather wrapping shall be Scotch 3M, cold shrink.

3. Antenna shall be firmly secured utilizing all necessary mounting brackets, clamps, bolts, screws and adapters. Mounting hardware shall be heavy duty rigid stainless steel.

4. Provide cable ground strap within 24” of antenna to pipe mast.

5. Antennas shall be aligned at each location to provide the maximum RSSI.

D. RF connectors shall be installed in accordance with the manufacturer’s installation requirements.

E. System Start-up and Site Acceptance:

1. Schedule start-up efforts with Owner.

3.02 CONTROL SYSTEM SUPPLIER FIELD SERVICES

A. Provide on-site supervision for installation efforts by a direct full-time employee of the CSS.

B. Path Verification

1. The preferred method of communications is 900 MHz licensed frequency for all remote sites. The CSS shall provide signal path and strength testing from the RTU to the 900 MHz repeater located at the elevated storage tank. If communications signal and path are not viable, the CSS shall test communications with the Thornton WTP 450 MHz Repeater and the 900 MHz Spread Spectrum master.

3.03 RADIO PROGRAMMING, CONFIGURATION AND ADJUSTMENT

A. Radio Adjustment:

1. Perform radio manufacturer’s maintenance and calibration tests as published in the O&M manuals.

2. Adjust radio parameters to meet the operational limits established by the Owner’s FCC license.

3. Reconfigure and tune the existing repeaters located at the Thornton Tower and Zone 5 Elevated Tank as required to communicate with the new radio equipment.
4. Align radio antenna for maximum RSSI and verify path signal at each site including verification of all existing antenna alignments.

B. Programming and Configuration

1. Program and configure the radio as required to interface with the existing communications network.

2. Program and configure the routing tables and repeater paths as required to establish communications with the defined SCADA master, repeater and hubs indicated on the drawings.

C. Radio System Diagnostics

1. Program the radio system diagnostics to provide for remote monitoring and tuning of all radio’s from the Wes Brown WTP. The CSS shall provide all set-up, programming and configuration necessary to provide remote system diagnostics. The diagnostics shall allow for the operator to select any radio for monitoring and diagnostics from a centralized location at the Wes Brown WTP.

3.04 RADIO SYSTEM TESTING

A. Perform the following feed system test for each antenna and feed system installation:

1. Perform a Time Domain Reflectometer (TDR) trace of the antenna and feed system in their installed configuration from the radio port to the antenna at the frequency of operation. For UHF and VHF antennas, use the frequency shown on the drawings. Setup the TDR to normalize the trace to the radio antenna port based on the type of cable used.

2. Correct components with VSWR greater than the specified maximum.

3. Correct transmission lines with discontinuities exceeding a VSWR of 1.2.

B. Perform the following transmitter tests (power output at antenna port) for the Licensed MAS Polling Remote, MAS Repeater and MAS Remote radio installation:

1. Measure and document transmitter power output.

2. Label radio with transmit power output.

3. Measure receive signal strength at repeater for each station.

C. Perform the following adjustments and tests for the MAS Remote radios:

1. Align remote site antennas for maximum receive signal level.

2. Record receive signal level for the radio and repeater location.

3. Notify Owner personnel if receive signal level is below -95 dBm.
D. Perform the following diagnostic tests for each radio installation:

1. Set the radio for diagnostic loopback mode.
2. Perform loopback diagnostics using the furnished diagnostic software provided.
3. Replace any radio that does not meet the manufacturer’s specifications.
4. Print final test record from diagnostic software.

E. Submit test records for each radio station installation including the following information:

1. Site name.
2. Test date.
3. Name of person performing test.
4. Test equipment model number, serial number, and calibration date.
5. TDR traces labeled with the antenna identifier as shown on the drawings.
6. Transmit power.
7. Reflected Power.
8. VSWR
9. Receive signal level at station and repeater location.
10. Final test record from diagnostic software.

F. Radio Configuration: Review radio configuration for agreement with manufacturer’s recommendations.

3.05 REPAIR/RESTORATION

A. Patch holes in walls that remain after equipment is removed. Texture surface to match existing conditions. Paint to match existing finish.

B. Paint or re-coat protective finishes on equipment and enclosures affected by work as necessary.

C. Patch concrete and asphalt cut during construction to match existing adjacent surfaces.

3.06 PREPARATION

A. Ensure spare parts and consumables are available to complete the Site Acceptance Test.

B. Provide Radio Commissioning Binder.

3.07 SITE ACCEPTANCE TEST
A. Perform Site Acceptance Test, witnessed by the Owner at each site upon completion of installation.

B. Review system installation to verify the following:
   1. Equipment is installed in accordance with manufacturer’s instructions as specified in the operations and maintenance manuals.
   2. Electrical terminations are complete.
   3. Power sources are verified.
   4. Equipment is calibrated in accordance with manufacturer’s instructions as specified in the operations and maintenance manuals.
   5. Radio feed systems have been tested and are within specification limits.

C. Test Radios as follows:
   1. Calibrate and test instruments per manufacturer’s recommendations. Document calibration and test data in Commissioning Binder.
   2. Test and verify Radio settings for frequency of operation, modulation, and power output to verify proper functioning of Radio subsystems. Record results.
   3. Diagnose and correct errors as they are discovered.
   4. Record test results.

D. Sign off each step of the test upon completion. Owner personnel will also sign off.

E. Identify the details of specific failures and performance degradation in writing and sign.

F. Correct deficiencies noted and retest with sign off.

G. Assign action items to specific design team members with required completion date. Submit report of completed action items on or before designated date.

H. Submit complete system test report for review. Correct system test report based on review comments. Include system test report with corrections in the operation and maintenance manuals.

3.08 GROUNDING

A. All antennas, masts, surge arrestors and communications equipment shall be grounded in conformance with Motorola R56 standards.
B. Where rock bottom is encountered, drive ground rod at an oblique angle not to exceed 45 degrees from the vertical or bury in a trench at least 2 ½ feet deep.

C. Ensure that any single ground rod having a resistance to ground of greater than 15 ohms is augmented with one additional rod. Where multiple ground rods are required, ensure they are at least 6 feet apart.

D. Attach main ground conductor to ground rod with exothermic welding. Exothermic welding shall be provided for all underground ground connections.

E. Exposed ground connections shall be Exothermic welded, listed pressure connectors, or listed clamps.

3.09 INSTALLATION

A. General:

1. Furnish necessary personnel, supervision, tools, equipment and transportation required to complete the installation and erection of items specified herein.

2. Verify location of the structure, including base orientation with Owner before construction begins.

B. Erection:

1. Align and adjust the members forming each tower/mast section before permanently fastening.

2. Maintain a check of structure plumbness throughout erection work.

3. Field welding is not permitted.

4. Field modifications including welding or burning of holes in members is not acceptable.

5. Touch up damaged galvanizing using zinc rich (95% in dried film) paint that meets Federal Specification: TT-P-6416 Galvanized Repair. Touch up may be done by either a spray or brush application.

END OF SECTION
Not Used
PART 1 GENERAL REQUIREMENTS

1.00 PURPOSE

A. This following programming methods and functions are the City of Thornton’s standard for programming applications for the PLC and SCADA software design, development and implementation for Supervisory Control and Data Acquisition (SCADA) and Programmable Logic Control (PLC) based systems employing treatment plants, pumping facilities and field mounted programmable logic controllers for process monitoring and control.

B. The standards document addresses the requirements for the design and development of applications programs pertaining to following areas:

1. General PLC Monitoring and Control Requirements
2. PLC Applications Program Definition
3. PLC Programming
4. SCADA Configuration
5. Wide and Local Area Network Configuration
6. Data Access and Report Generation
7. Historical Database Server and Data Logging

C. The standards document is based on an Intellution IFIX SCADA (Version 5.0) foundation for monitoring, control and information systems implementing Modicon based PLC controls for both new and existing processes. The SCADA system operation has complete monitoring and control capability of the PLC system via multiple communication topologies and protocols that include Modicon TCP Ethernet, Modbus RTU Serial Radio/Telco, and RIO communications networks.

1.01 REQUIREMENTS

A. The CSS shall adhere to the standard for all programming and development functions associated with the PLC and SCADA system applications.

B. Control System Supplier

1. The CSS shall provide a complete and comprehensive integrated control system hardware and software package.

2. Database system programming, wide and local Area WAN/LAN interface configuration, System Securities, PLC/SCADA programming and SCADA graphics configurations shall be provided complete, ready for use and operational by the CSS.

3. The CSS shall program and configure the SCADA and PLC system in accordance with the project plans and specification requirements and
in conformance with the standard methods and procedures covered in the Contract Documents.

4. Certain project applications may require that the CSS coordinate with the Owner to implement SCADA Wide Area Network functionality. The Role of the Owner is governed by several factors including integration of existing systems, modification of the WAN and overall consolidation of facility controls within the SCADA system.

   a. The CSS shall coordinate all Wide Area network configurations and modifications with the Owner.

1.02 TERMS AND ABBREVIATIONS

A. Abbreviations and acronyms are utilized throughout the document to reference standard technology terms and commonly utilized descriptors. The following is a brief list of most commonly used abbreviations:

1. CSS – Control System Supplier: The control system supplier is defined as an instrumentation and control system supplier or subcontractor to the contractor to provide instrumentation and control systems that are specific to the contract plans and specifications.

2. CTO – Control Time Out

3. HDS – Historical Data Server: The HDS is an Intellution, IHistorian Database configured as a Historical Database Server. The HDS acts as the central historical data repository for all process monitoring and control data.

4. IS – Information Systems: When referenced in the documents the IS is defined as the Agency’s Information Systems department.

5. I/O – Input/Output: The I/O represents the physical and virtual input and output requirements for process monitoring and control.

6. LAN – The LAN is defined as the Local Area Network and is normally confined to the Plant or Facility control systems.

7. LCP – Local Control Panel

8. MAS – Multiple Address System, referenced as the 900 MHz licensed multi-point radio communications for remote site communications.

9. MCC – Motor Control Center

10. MLO – Motor Lock Out

11. MOV – Motor Operated Valve

12. PSS – Packaged System Supplier.

13. SI – Systems Integrator: The Systems Integrator is defined as the Contractor’s Control System Supplier or Programmer providing system wide control system integrations services directly related to contract implementation.

14. SP – Systems Programmer: The System Programmer is defined as the Agencies System Programmer. The SP provides programming services directly to the Agency where indicated in the contract.
1.03 SYSTEM OVERVIEW

A. The City of Thornton system consists of one major operations center located at the Wes Brown Water Treatment Plants (WTP) with additional SCADA nodes operating at satellite Water Treatment Plants and IMC located within the area of operation. The operations center SCADA servers and workstation nodes are interconnected via a Wide Area Network (WAN) configured for view and control anywhere operation. System diagrams provides a general overview for the SCADA, PLC and communications system configuration.

B. A Historical Data Server (HDS) is located at the Water Treatment Plant for system wide historical data logging and reporting functions. SCADA servers and workstations update the HDS via the WAN system. Local SCADA servers and workstations provide for local database logging and reporting for a period of 90 days.

C. Local SCADA workstations provided at Water Treatment Plant and satellite locations are configured and programmed to monitor and control local plant functions independent of the status of the WAN and operation center SCADA servers. The local workstations are configured to access, control, monitor and perform alarm acknowledgement functions, typically referred to as view and control anywhere, over any SCADA node within the WAN infrastructure.

D. The SCADA system is configured and programmed to support a client/server architecture providing operations and engineering with view/control/configure operations anywhere within the WAN infrastructure. Access to remote SCADA nodes (server or workstation) from a local SCADA node shall utilize a client interface that is transparent to operations. System navigation shall be provided with securities to restrict and limit client access based on authorized levels of control for individual operators.
E. System communications is generally categorized as Information, Control and Device Networks for process monitoring and control.

1. Information Network
   a. The information network referred to as the SCADA WAN or SCADA Information Network is the SCADA workstation and server network for transferring SCADA related information.
   b. Data logging, client access, data transfer and global system operations are all conducted via the Information Network. All treatment plants and critical pumping facilities are provided with an Information network connected to the overall WAN via a wireless network bridge or T1 router.

2. Control Network
   a. All PLC based systems interact with a SCADA workstation or server via a dedicated control network. This control network operates independent of the information network and is utilized for all process monitoring and control at the PLC level.
   b. PLC systems are generally configured to support an Ethernet based Modbus TCP control network topology. However, other topologies such as Modbus are utilized.

3. Device Networks
   a. Device networks such as Devicenet, Modbus and Fieldbus are utilized to support direct instrument and equipment systems via dedicated PLC connections.

4. Remote Sites
   a. Communications with remote locations such as pressure reducing stations (PRS), tank/reservoir sites and smaller pump stations communicate with the Master Communication PLC via a MAS radio communications system operating at various licensed and unlicensed frequencies. All communications shall utilize Modbus or Modbus TCP.
   b. Fiber Optic based communications is also available to dedicated areas. A dedicated fiber-optic communications system owned and operated by the Owner is available for use to remote stations that can be connected to these systems as indicated on the contract drawings.
   c. Communications via these topologies is governed by site availability to radio, telco or dedicated communications systems available to the Owner.

1.04 GENERAL MONITORING AND CONTROL SYSTEM REQUIREMENTS

A. Implementation requirements for PLC, SCADA and networking will include the standard configurations and methodologies in addition to any project or plant specific requirements addressed by the Project Plans and Specifications.
B. Where existing controllers, packaged systems are utilized or providing systems incorporating PLC based controls other than those specified, the CSS shall be required to replace the PLC system. PLC programming and development shall be in conformance with the Owner standards.

C. In general, control and monitoring functionality shall be provided as follows:

1. Local Water Treatment Plant and Critical Pump Station SCADA Workstations and PLC’s shall be programmed and configured in conformance with the project plans, specifications and Owner standards.

2. The CSS shall configure and program all LAN switches, bridges and routers for implementation of the specified WAN/LAN topology. All network configurations are to utilize routable IP addressing. The CSS shall coordinate all network configurations with the Owner’s Information Systems (IS) group for system addressing, switching and routing requirements.

3. The CSS shall coordinate all specified configuration and development requirements with the Owner. Coordination shall be achieved with specified configuration meetings and submittals to establish an acceptable configuration format and operational methods that meet the intent of the contract documents.

4. The CSS shall obtain the latest revisions for graphic system configuration standards, system navigation methodology, alarm summaries, and general SCADA implementation requirements from the Owner prior to SCADA system development. The CSS will be given copies of the latest IFix applications to be utilized for development. The CSS shall configure the SCADA system utilizing the standard defined procedures and methods for SCADA system development.

5. The CSS shall program and configure the Remote SCADA Servers, Master Communications PLC’s and WAN equipment (routers and switches) as indicated in the Contract Documents. The CSS shall integrate the facility(s) SCADA Workstation configurations into the WAN infrastructure.

6. The CSS shall provide all local server SCADA tagging, PLC interface registers and configurations required to interface with the master communications PLC and SCADA WAN system. The tagging definition and register configuration shall be in conformance with the standards. All communications registers shall be provided in contiguous registers sets and grouped by type and function for read and write applications.

7. The CSS shall submit a complete Tagname Database for all physical, internal and virtual I/O points for review and discussion with the owner. The CSS shall coordinate the I/O functionality, Alarm Priority (Status, Alarm, and Shutdown), event log, log frequency, trending requirements, engineering units and operational function on a point by point basis. The Tagname Database shall be configured in the format provided in Appendix A.
8. The CSS shall configure and program the SCADA servers, workstations for both local and HDS data logging functions. The CSS shall coordinate the HDS logging requirements with the Owner and the Owner IS prior to system development.

9. The CSS shall provide all custom programming including but not necessarily limited to scripting, Visual Basic programming, SQL queries, High level C programming, configuration functions, data transfer algorithms and software product configurations necessary to implement the specified operation. The programming shall adhere to the same procedures and methodologies as that utilized in the existing applications.

1.05 SUBMITTALS

A. Configuration

1. The CSS shall prepare submittals for PLC Programming and SCADA configurations that are consistent with the requirements of the Owner standards. The CSS shall submit for review the following submittals:
   a. Detailed System Diagram
   b. Tagname Database
   c. Detailed Control Algorithm
   d. PLC Programming Documentation
   e. Graphics Displays (Screens, Trends, Pop-Ups, Navigation, etc)
   f. Data Logging and Archiving Format
   g. Report Generation
   h. Alarm Summary and Notification

B. Programming Software

1. The software shall be supplied on CD ROM media with a standard Windows Installation package. It shall be possible for personnel with basic computer skills to install the Server and Client components on a Windows based machine. Both components shall appear in the Add/Remove programs window of Windows operating systems and provide for the repair, or removal of the software components.

1.06 COMMUNICATIONS SYSTEM REQUIREMENTS

A. The CSS shall configure the local SCADA system networks to support separate information and control network topologies. Control networks shall be confined to the facility to provide for all local monitoring and control functions at the PLC level independent of the status of the information network.

B. The SCADA Information Network shall interface with the SCADA system via a High Speed Wireless Network or Fiber Optic WAN communications link. Fiber Optic communications is preferred over Wireless communications where an established fiber network is available.
C. The SCADA workstation communication drivers shall be the latest version of Modicon compatible with the Owner’s existing system configuration.

D. The CSS shall configure the Local PLC control systems to communicate with the Master PLC located at the WTP, via a digital communications network, fiber-optic or the 450/900 MHz Licensed/Unlicensed Multipoint Radio Communications network defined by the project requirements.

E. The CSS shall coordinate with the Owner the programming requirements for radio or digital service communications. The CSS shall program the radios and modems as required to interface with the SCADA system. Specific radio and modem configuration data will be made available by the Owner.

F. The CSS shall coordinate wireless WAN configuration requirements when information is directed to the WAN via a Wireless Network Access Point. The CSS shall provide for wireless network bridge configuration and secure access with the Owner’s network system provider. The CSS shall coordinate with the Owner IS all network configurations relevant to network bridge and router programming requirements.

1.07 CONTROL STRATEGY DEVELOPMENT

A. Control strategy development is a collaborative and consolidated effort between the Design Engineer, the Owner and the Control System Supplier to establish a detailed process control description for PLC programming and SCADA system development.

B. As a part of the design effort, a generalized control description is included as a part of project plans and specifications. The control description shall represent project specific vendor and process control requirements for the control systems to be implemented by the CSS as a part of the project. The control description shall address all project specific control systems and take into account the standard methodologies and functions outlined within the Owner standards document.

C. The project control description is not intended to be an all-inclusive operational procedure for step by step programming definition. Where provided generalized control strategies for existing PLC control programs and SCADA configurations are provided to establish a general understanding of existing operation. The CSS shall be responsible for reviewing existing program and configuration documentation and confirming existing systems prior to their modification for implementation within the overall system.

D. As a part of the construction contract, the CSS shall develop a detailed control system algorithm that identifies specific programming details associated with implementing the specified process control systems in conformance with the Owner programming standards and the specific project control system requirements. The control algorithm shall incorporate the standard methods and procedures addressed along with any site specific programming requirements as a result of coordination with the existing control systems and the project specific control descriptions into a comprehensive and complete document to be reviewed by the Owner prior to program development.

E. The detailed and comprehensive control algorithm shall be developed and submitted by the CSS. The CSS shall detail and delineate all control systems
and parameters on a process-by-process, equipment-by-equipment, loop-by-loop and point-by-point basis. The detailed control algorithm shall include the generalized control requirements, project specific control requirements, additional support system control requirements, existing control systems and any vendor supplied system controls that are necessary to fully understand the operational parameters and control functions to be provided as a part of the PLC and SCADA system control logic.

F. The comprehensive control algorithm shall be developed and finalized by the CSS through a series of programming coordination meetings with the Owner and their designated representatives. The CSS shall maintain and modify the control algorithm to include all comments and revisions made during the course of the programming development meetings. The final control algorithm document shall form the basis for providing an as-programmed document, including PLC programming logic, to be included as a part of the Operations and Maintenance Manual.

G. The Owner will provide standard programs for use by the CSS. These programs shall be modified by the CSS to incorporate project and site specific applications.

1.08 PROGRAMMING DEVELOPMENT MEETINGS

A. The CSS shall attend a series of programming development meetings prior to application program development. The programming meetings shall be established to address the various programming phases of the project. Meetings shall be held for the following:

1. General Programming and Standards Definitions Meeting
   a. Clarify standards and programming guidelines
   b. Address methods or procedures for new or complex systems not addressed in the standards.

2. SCADA Configuration Meeting
   a. SCADA Tagname
   b. Graphic Screen Navigation
   c. Graphic Screen Development
   d. Trending
   e. Data Archiving
   f. Alarming

3. PLC Applications Meeting
   a. Control Strategy Definition
   b. Communications Requirements
   c. WAN/LAN configurations

4. Graphics Screen Review and Demonstration Meeting
   a. The graphics screen review meeting shall be held after the first submittal for graphics displays has been reviewed. The CSS shall
present the graphic screens on a workstation such that the Owner can view the actual screen presentation, format, size and color. The CSS shall demonstrate the navigation and menu system.

1.09 SOFTWARE TESTING

A. GENERAL

1. The CSS shall conduct software testing for both the SCADA and PLC applications programs.

2. The CSS shall develop a series of test forms that address all aspects of operation in a cause and effect format. Test forms shall be provided to address the following:
   a. I/O Point Testing
   b. Control Strategy Testing
   c. SCADA configuration
   d. SCADA Alarm and Event Point Testing

B. FACTORY TESTING

1. Factory Demonstrations Test
   a. The CSS shall furnish its own hardware and software for development, demonstration and factory testing.
   b. The CSS shall conduct a factory demonstration test (FDT). The demonstration test is meant to demonstrate the overall functionality of the system and allow for the Owner operations to become familiar with the system and control program applications, prior to any comprehensive factory and field testing efforts.
   c. During the FDT, the Owner will provide comments with respect to the SCADA configuration and PLC applications program.

2. Factory Operational Test
   a. The CSS shall conduct a factory operational test (FOT). The operational is designed to test the complete system including all vendor supplied PLC systems as if they were operating in the field.
   b. The CSS shall coordinate all FOT requirements; provide all necessary testing hardware, simulation components and workstations necessary to simulate actual operating conditions.
   c. During the FOT, the Owner will provide comments with respect to the SCADA configuration and PLC applications program.

C. SYSTEM COMMISSIONING

1. Operational Readiness Test
   a. The CSS shall conduct an Operational Readiness Test (ORT). The ORT is designed to test the complete system including all vendor supplied PLC systems to verify system communications, I/O connection, system calibration and general operation prior to
field start-up and commissioning of the system. In general, an operational readiness test shall include:

1) I/O Point Testing
2) Analog Loop Testing
3) Communications Link Testing and Diagnostics
4) SCADA access and WAN connectivity
5) Functional Acceptance Test

b. The CSS shall conduct a Functional Acceptance Test (FAT). The FAT is designed to test the complete system including all vendor supplied PLC systems complete and operational. FAT testing shall be conducted on a fully operational system that is exercised to verify all modes of operation.
PART 2 COMMON SCADA AND PLC DEFINITIONS

2.00 GENERAL

A. Common functions and terms for basic monitoring and control operations are provided as a standard of implementation for the control system. These terms and functions address items that are typical for process control loops and most operator initiated actions.

B. These functions, methods and procedures shall be implemented for all process control functions and project specific site applications. The control descriptions presented are general control requirements of operation and are to be programmed utilizing the standard methods and functions indicated in the contract documents.

C. The following terms are used in the descriptions of SCADA/PLC functions:

1. Operator and User Defined Settings (Setpoints): Operator/user set or entered values that are adjustable or set from operator displays. Examples of operator set or entered values are controller setpoints, batch setpoints, timers, counters, mode selection, etc. Specific values that are normally required to be operator settable shall be noted in the process control strategy descriptions. The CSS shall provide a list of all operator settable parameters that are required for normal monitoring, control, alarming and process troubleshooting to be available at the SCADA workstation. Operator settable parameters shall be provided for:

   a. Process control setpoints (Flow, Level, Pressure, Analytical)
   b. Process mode selection, equipment sequencing and selection.
   c. Non-critical system control override and manual equipment operation.
   d. Manual control setpoints for equipment speed and stroke operations.
   e. High-High, High, Low and Low-Low alarm setpoints that will vary with process dynamics, time of use, energy conservation and seasonal modes of operation.
   f. Operational parameters required for providing normal operation of the control system from the SCADA system. The operator shall not be required to leave the control room to conduct any monitoring, control and alarm acknowledgement functions.
   g. Timer and counters associated with filter system and equipment sequencing.
   h. Alarm Enable/Disable Operations
   i. Control Time Out Delay
   j. Un-commanded Change Delay
   k. Tunable alarm setpoints and alarm delays,
2. Tunable Values (Setpoints): Tunable values are setpoints that are adjustable at SCADA password protected engineer level or maintenance displays without requiring any PLC or SCADA software reconfiguration. Tunable values are also identified and their preliminary values are shown when available. Examples of tunable values are:
   a. Tunable time settings, such as start, fail, or step delays, etc.
   b. PID tuning constants
   c. Deadband Percentages
   d. Filter Constants
   e. Timer and Counter Preset Values
   f. Calculation parameters, constants and ratio factors.

3. Fixed Values: Fixed values are constants that are contained within the PLC or SCADA control logic normally inaccessible by the SCADA system. Modification of fixed values requires a modification to the control logic via the PLC programming, configuration and diagnostics software package. The use of fixed values is limited to mathematical constants that will not change.

4. Displayed Values: The term displayed means that the value, or information referred to, is displayed in an easily read and understood format on the SCADA workstation. Values shall be identified by their device tag reference and associated equipment number. For analog variables the value is tagged (ISA Standard) and its associated engineering units are displayed.

5. Hardware Interlocks:
   a. Hardware interlocks refer to interlocks directly wired within the electrical control circuits of equipment that, when activated, will cause the equipment to shutdown or otherwise prevent operation of the equipment. Hardware interlocks do not pass through or depend on the PLC or SCADA logic to be operable. But will provide a status to the PLC for Alarm Shutdown Notification.
   b. Hardware interlocks may also be derived by local control panels or switches wired directly to the PLC to provide direct hardwired alarm status to the PLC for processing.

6. Software Interlocks: Software interlocks refer to interlocks that are generated by the PLC logic or otherwise pass through the PLC. Software interlocks are not operable when the PLC is not operable or if for some reason equipment is operated while bypassing the PLC logic such as manual control.

7. Hardware Generated Alarms: Hardware generated alarms are alarms that are generated external to the SCADA/PLC by equipment such as local control panels, analytical devices and process switches.
   a. Direct wired alarms that do not depend on the PLC or SCADA to be operable. An example would be a High-High Turbidity (NTU)
level signal from the Turbidity monitor and wired directly to an external shutdown logic and alarm light or horn.

b. Direct PLC wired alarms such as a High-High pressure switch that interfaces directly with the PLC inputs.

c. Hardware generated alarms are displayed on the SCADA workstation alarm screens and are available for archiving.

8. Software Generated Alarms: Alarms that are processed or generated by PLC logic are referred to as software generated. Software generated alarms are displayed on the SCADA alarm screens and are available for archiving.

9. Local Automatic Control Mode (Back-up)

a. Local automatic control refers to control logic performed in a local control panel independent of the PLC or SCADA. An example is a setpoint process controller that, when in the local automatic control mode, automatically modulates the valve or VFD to maintain the process independent of PLC operation.

b. Local automatic controls are provided for critical applications, where it would be difficult to operate the system or process in a manual mode. In general local automatic controls would be provided for:
   1) Back-up Control at Lift Stations
   2) Big Dry Lift Station

10. Local Manual Control Mode

a. Local manual control refers to the mode where operators can control equipment at their respective MCC, LCP or from the equipment location. Examples are an air compressor that may be stopped or started from the compressor’s local control panel (LCP), or a gate that may be opened or closed from the gate operator.

b. Local manual control overrides all PLC and SCADA interlock logic.

11. PLC Automatic Control Mode

a. In automatic mode equipment is controlled automatically per predetermined control schemes residing in the PLC usually without operator intervention. However, in some cases the operators may be required to initiate certain automatic functions. An example of this would be the operator initiation of the pump auto-start command. All setpoint registers shall be contained within PLC logic. PLC logic shall provide automatic control parameters (setpoints, modes of operation, equipment sequences, alarm interfacing, manual controls) and shall be accessible from the SCADA workstation. The SCADA workstation shall have access to all timers, counters, registers and control parameters.
b. When an equipment (HOA) switch is selected to auto the PLC will implement the last mode control state (PLC Auto or SCADA Manual) selected at the SCADA.

12. SCADA Manual Control Mode

a. SCADA manual control refers to the remote manual control of equipment from the SCADA workstation. In this mode, the operators override the PLC automatic control logic while all safety and PLC software interlock logic remains in effect. The SCADA shall set a control status at the PLC signifying that the SCADA has assumed control of the equipment. The PLC shall provide positive feedback that SCADA manual is selected and displayed at the workstation. The SCADA control status shall remain in effect until removed by the SCADA, an alarm override occurs or local manual control is invoked.

13. SCADA Automatic Control Mode:

a. SCADA automatic control refers to higher-level control logic that calculates flow and/or level set-points that are transmitted to the PLC’s for use in the PLC automatic logic routines. The SCADA shall set a control status at the PLC signifying that the SCADA has assumed control of the equipment. The SCADA control status shall remain in effect until removed by the SCADA or an override condition occurs.

14. SCADA Override Control:

a. SCADA override control refers to the ability to override specific software interlocks and initiate control actions. Software interlocks or permissives that can be overridden are identified within the individual control strategies. Override control is an abnormal control operation and a “SAFETY INTERLOCK OVERRIDE ALARM” shall be initiated for the specific override condition whenever an override command is in effect.

15. Setpoint Control

a. All process parameters, control parameters, limits, trips, timers, alarm delays, counters and other data associated with tuning shall be provided as a setpoint accessible by the SCADA system. At no time shall an operator be required to utilize programming software to adjust or tune any parameters.

b. Maximum value setpoints, initial setpoint values and other process data values referenced as user, operator or owner defined shall be coordinated during the programming phase of implementation. All unassigned or initial values shall be identified and implemented prior to the factory acceptance test.

c. All process parameters shall be setpoint assignable from SCADA. The SCADA system and PLC logic shall be configured to access all setpoints from the SCADA system without additional programming or configuration. Fixed or programmed values, with
exception of mathematical multipliers or ratios shall not be utilized in the PLC program.

PART 3  PLC AND SCADA SOFTWARE FUNCTIONS

3.00  PROGRAMMING FUNCTIONS

A. To provide for a standard of implementation various software control and monitoring functions are defined. The standard functions may not be fully delineated within each individual control strategy, however unless otherwise stated (excluded) the standard functions shall be provided for with the defined alarm, action, event, display, process variable or control action.

B. All automatic and semi-automatic controls are resident within the PLC. The PLC is configured as the primary control system for all alarm monitoring, pump start/stop sequencing, filter controls, backwash sequencing, shutdown interlocks and basic process control functions. The PLC control logic shall operate independent of the SCADA system status.

C. When delineated within individual control strategies as SCADA controlled or SCADA logic, the control program is resident within the SCADA system. Non-control related calculations, status indication, complex pump control matrix, energy management, optimization algorithms and historical data calculations are normally performed by the SCADA system. SCADA logic is noted within the individual control strategies and tables as SCADA Manual or SCADA Automatic Control.

D. All PLC programs shall be configured to support the use of a local operator interface panel (OIP). Programming shall be such that either the SCADA or the OIP can start/stop, reset, acknowledge and allow for setpoints to be changed in a last commanded format.

3.01  EQUIPMENT MODULES

A. General Equipment Monitoring

1. General equipment items are defined as but not necessarily limited to motors, pumps, mixers, feeders, drive systems and packaged equipment monitored and controlled by the PLC. All equipment status items monitored by the PLC and generated within the PLC control strategies are displayed at the SCADA.

2. Unless otherwise specified to be excluded, the following physical I/O shall be included at the PLC and monitored by SCADA:
   a. Equipment Control, Auto (Start/Stop)
   b. Equipment AUTO status (H-O-A in the Auto Position)
   c. Equipment RUNNING
   d. Equipment OFF status (Not in Auto)
   e. Equipment Failure (Overload)
   f. Equipment Thermal (Thermal Switch)
   g. Equipment Moisture Alarm
h. Equipment Amps (Sewage Lift Stations)
i. Equipment Shutdown Alarms as Indicated

3. Variable Speed Equipment
   a. Speed Feedback
   b. Speed Control Output
   c. VFD Drive Fault
   d. Local versus Auto Speed Select

4. Large HP and Complex Equipment Systems shall be provided with additional monitoring and control features to indicate the following:
   a. Power (kw)
   b. Equipment Amps
   c. Phase Failure
   d. Bearing Temperature
   e. Winding Temperature
   f. Equipment Vibration
   g. Individual Shutdown Alarms shall be created and represented for each shutdown component. A common shutdown alarm shall not be utilized where individual shutdown alarms are monitored and available to the PLC and SCADA system.

5. Equipment Status Virtual I/O
   a. Equipment Not In Auto (No Auto Status)
   b. Equipment Trouble
   c. Equipment Ready (In Auto, No Alarm Interlocks, In Service)
   d. Equipment Shutdown (MLO)
   e. Equipment Out of Service/In Service
   f. Equipment Starting/Stopping (utilized in step control or sequencing)

B. Equipment Control:
   1. For equipment that the PLC is allowed to control, the PLC shall provide a CONTROL TIME OUT (CTO) alarm if the equipment fails to comply with a PLC command signal (START, STOP, OPEN, CLOSE) that has been present for more than a tunable time period. In this event, the command shall be removed subsequent to the expiration of the tunable time period.
   2. Equipment that is operated that has not been commanded to operate by the PLC shall produce an UNCOMMANDED CHANGE (UNC) alarm. For example if a motor is running that has not been called to run by the PLC a UNC alarm is generated.
3. Equipment failures such as overload, phase failure or a direct equipment failure (VFD, RVSS etc.) from the device will initiate a Motor Lockout Condition (MLO). The MLO will remain active until the condition is cleared and/or the equipment reset. Individual MLO conditions shall be coordinated with the owner.

4. Equipment utilizing speed control shall be provided with a manual speed control capability. When operational equipment is selected to manual speed control from auto speed control or returns from manual to auto speed control, the control algorithm shall utilize bumpless transfer of the speed signal to avoid surging in the system.

5. When a device is switched from SCADA auto to manual or SCADA manual to auto the transitions shall be bumpless. A transition from SCADA manual to auto shall place the equipment into auto operation.

6. If an equipment item is taken out of auto at the Equipment HOA switch, and Equipment Not In Auto alarm shall be generated.

7. Equipment with extended start delays or start sequences shall be provided with SCADA feedback that the equipment is starting. In essence, the equipment has been called to run. Start sequences with multiple steps shall be provided with step feedback at the SCADA indicating the current step for motor operation.

C. Equipment Statistics:

1. Equipment Mode
   a. The status of the equipment HOA Switch shall be monitored to indicate the mode of control at the PLC. The HOA switch shall provide for equipment in AUTO status
   b. Equipment in hand indicates to the PLC that the equipment is in local control independent of the PLC.
   c. Equipment in AUTO indicates that the equipment is now under control of the PLC and available for both PLC Auto and SCADA manual operations.

2. Equipment statistics are provided for equipment monitoring and diagnostics to support operations and maintenance. This is information is logged to the HDS and utilized in the generation of maintenance reports. In general, equipment statistics are associated with runtimes, starts and performance data.

3. Equipment Runtime
   a. All equipment run times shall be totalized and recorded by the PLC and displayed at the SCADA workstation. Totalizers shall be resettable at the engineer level only.
   b. A daily equipment totalizer shall be provided that is reset at an operator selectable time frame. Daily equipment run time totalizers shall be initially configured to reset at midnight.

4. Equipment Starts
a. All equipment starts shall be totalized and recorded by the PLC and displayed at the SCADA workstation. Totalizers shall be resettable at the engineer level only.

b. A daily equipment starts totalizer shall be provided that is reset at an operator selectable time frame. Daily equipment starts totalizer shall be initially configured to reset at midnight.

5. Equipment Performance

a. For large motors equipment Kilowatt Hours (KWH) shall be totalized and recorded by the PLC and displayed at the SCADA. Totalizers shall be resettable at the engineer level only.

b. Daily KWH totalizers shall be provided that is reset at an operator selectable time frame. Daily KWH registers shall be initially configured to reset at midnight.

3.02 PROCESS MONITORING MODULE

A. General

1. All analog inputs shall have instrument failure alarms when the input is below 0 percent or above 100 percent for a tunable time initially set at 10 seconds.

2. User adjustable alarm trip points shall be provided for each analog input to establish High-High, High, Low, Low-Low, and Rate-Of-Change events. Each trip point shall be provided with a user tunable deadband for set and reset operations. Each individual signal trip point shall be provided with a unique tunable delay to alarm activation. Each trip point shall be provided with an enable/disable condition.

3. The Process Value shall be provided with a raw value, percent value and scaled to engineering units value. Each input shall be provided with the register raw value 0 – XXXX bits, 0 – 100 % and the engineering unit’s min and max setpoint values. The minimum and maximum engineering units setpoints shall be accessible from the maintenance screens.

4. High and Low Alarm setpoints shall be configured to provide general warning alarms. Analog values utilized for generating shutdowns shall be provided with an additional operator settable delay from the high/low event activation to shutdown. For example when a High Turbidity alarm is activated a shutdown timer is initiated if the high level does not clear before the timer expires a plant shutdown condition is initiated.

5. High-High and Low-Low Shutdown delay setpoints shall be initially set to zero seconds.

6. All process related analog inputs shall be trended based on a continuous 1, 12 and 24-hour trends additional trend times may be selected at the discretion of the operator utilizing historical trend configuration and evaluation tools.
7. The Rate of Change alarm shall be provided with value/time setpoint parameters.

B. Flow Monitoring
   1. In addition to the general requirements, the flow process module shall also provide for process variable totalization based on the variable type.
   2. All flow inputs shall be totalized and recorded by the PLC and displayed at the SCADA workstation. Totalizers shall be resettable at the engineer level only. When the flow value is less than a no totalization setpoint value, the flow shall be zeroed to disable totalization when equipment is not operational.
   3. A daily flow totalizer shall be provided that is reset at an operator selectable time frame. Daily flow totalizers shall be initially configured to reset at midnight.
   4. Where flow inputs are provided with an additional pulse input from the flow meter. The pulse input shall be utilized for process totalization functions. The pulse accumulator value shall be setpoint adjustable and the maintenance screen level.

C. Kilowatt Input (KW)
   1. In addition to the general requirements, the KW module shall also provide for process variable totalization based on the variable type.
   2. All KW inputs shall be totalized and recorded by the PLC and displayed at the SCADA workstation. Totalizers shall be resettable at the engineer level only.
   3. A daily KW totalizer shall be provided that is reset at an operator selectable time frame. Daily KW totalizers shall be initially configured to reset at midnight.
   4. Where KWH inputs are provided as a pulse input from the power meter. The pulse input shall be utilized for process totalization functions. The pulse accumulator value shall be setpoint adjustable and the maintenance screen level.

3.03 ALARM MODULE

A. All discrete alarm and failure inputs are alarmed by the PLC application software and displayed at the SCADA. Each discrete alarm input shall have a unique associated alarm delay setpoint that prevents nuisance tripping. A discrete alarm will be generated based on a tunable setpoint [10 seconds] time after the discrete event is initiated.

B. Where alarms are specified as shutdown or trip in the control strategy descriptions, those alarms are initiated by the PLC control logic based on the applicable discrete and analog input signals. Trip alarms are referenced as a trip alarm at the SCADA displays.
C. Each alarm shall be provided with an Enable/Disable status at the PLC. When disabled the alarm logic is disabled and the status of the alarm is indicated only for SCADA monitoring. When the alarm condition is disabled all associated shutdown interlocks are disabled. All critical alarms, trip alarms, and shutdown alarms shall be latching and require an operator reset.

D. For analog signals employing plant High-High and Low-Low shutdown conditions, associated High and Low alarms shall be configured with an additional time delay from alarm activation to initiate a shutdown based on time elapsed. The alarm time to shutdown delay shall be configured in minutes.

E. Process related alarms shall be disabled when the process is, paused, shutdown or operating in an abnormal mode. Example, filter turbidity, and related filter influent and effluent alarms are disabled during a backwash sequence or the plant is offline. The CSS shall coordinate these alarms with equipment operation, specific process dynamics and packaged system suppliers.

F. When associated flow producing equipment is off, the No Flow Alarm and Flow Totalization shall be disabled and the flow value set to zero.

3.04 WELL PUMP CONTROL

A. Individual wells and multiple wells controlled by a single PLC will operate in selected modes as follows:

1. Remote Auto - Where station Remote Auto is selected the well pump shall be controlled by the process conditions.

2. Manual Flow Mode – In manual flow mode control the well is manually started via the local OIP or SCADA and well run until a total accumulated flow is achieved for the well pump. Were VFD applications are utilized the PLC will maintain a desired flow based on a user adjustable setpoint.

3. Manual Flow Mode/Time of Day – In this mode of operation the pump is started by the PLC based on time and will continue to run until the desired flow total is achieved or the time of day window expired.

4. Time of Day – In this mode the well pump is started and stopped based on the time of day.

B. Regardless of the mode selected all associated pump interlocks, High Discharge PSI, Low Well Level and No Flow shall be in operation.

3.05 DIVERSION STRUCTURE MONITORING

A. Diversion structure monitoring consists of level and flow monitoring. The diversion structure consists of a level transmitter monitoring the stilling well level of a parshall flume or weir structure to calculate the flow passing through the gate.

B. The flow shall be calculated based on a weir calculation to be provided by the Owner for each of the sites listed.
C. The flow shall be calculated and totalized in gallons and acre feet for SCADA monitoring and control based on the standard flow totalization method defined.

D. Gate monitoring and control shall be provided for each site and provided as future functionality.

E. Provide flow alarm from the transmitter contact.

3.06 STILLING WELLS

A. Stilling well monitoring consists of level. The stilling well consists of a level transmitter monitoring the stilling well level of the lake/reservoir. The stilling well will be provided with analog level monitoring and site status as indicated on the drawings.

3.07 SOLAR POWER MONITORING

A. Where solar power is provided in lieu of utility power, system voltage (battery) and battery compartment temperature shall be monitored.

3.08 UPS MONITORING

A. All sites shall monitor the UPS for low battery, inverter on-line (power fail) and inverter failure.

3.09 ALARM MANAGEMENT

A. SCADA system alarm activation and annunciation shall adhere to a priority hierarchy that is established and maintained at the SCADA system. Each alarm shall have an associated priority level defined as:

1. Level 0 - Life Threatening or Danger Conditions
2. Level 1 – Critical process alarms that will create a plant shutdown condition cause a critical process failure or severely hinder plant operation.
3. Level 2 – Minor process alarms associated with warning conditions and minor equipment failures.
4. Level 3 – Informational alarms and status that will not hinder operation or cause equipment failure.
5. Level 4 – 10 Non-critical alarm and event levels shall be coordinated with the Owner.

3.10 PROCESS CONTROL LOGIC

A. Control logic that employs step sequencing of process control equipment such as Filter Backwash, CIP, Extended Start Sequences and Filter To Waste operations, shall be provided with user adjustable step durations for individual step sequences. Each process that utilizes a step sequence shall be displayed based on the status of the process step, setpoint time, time elapsed and the current status and description of the process step.

B. Discrete output control is processed by the PLC based on the PLC control algorithm or SCADA commands. All interlocks, permissives and start
sequences shall be provided at the PLC level. Unless otherwise stated or shown, all discrete outputs shall be provided as follows:

1. For equipment RUN/START PLC functions, the PLC shall issue a maintained START command until a RUNNING state is no longer detected, a fail condition is established or the START command is removed from the PLC, SCADA, OIP.

2. For equipment OPEN/CLOSE PLC functions, the PLC shall issue a maintained OPEN/CLOSE command until the command is removed. Valve control shall be configured to maintain position on loss of power, unless otherwise required by the process to establish failsafe conditions.

3. When a momentary command is required, the PLC shall issue the command for a minimum two (2) seconds, and then remove the signal.

4. Where pulsed outputs are utilized for valve positioning control, pulse width and rates shall be based on the valve control dynamics. Pulsed controls shall be provided with a user adjustable minimum and maximum On pulse width in seconds and a minimum off time in seconds.

5. Equipment operating in SCADA manual mode shall have the manual control action removed when an associated shutdown condition is in effect. All protective alarms and functions shall remain enabled during SCADA manual operation. On a shutdown condition the equipment shall be stopped and removed from SCADA manual mode. The operator shall be required to reset the alarm and restart the equipment manually in SCADA mode.

6. Filter trains, packaged control groups and sequentially controlled systems shall be configured to allow for SCADA and local manual operation of individual equipment items. When an equipment item of a train or system group is selected for manual control all equipment in the train or group shall revert to SCADA manual mode of operation.

7. In the event of a SCADA system failure the PLC will retain the last command from the SCADA system for all equipment that is in service. All PLC interlocks shall remain enabled during a SCADA communications or systems failure.

8. SCADA manual control shall be provided for all PLC controlled equipment. SCADA manual equipment control shall utilize two state (bit) control operation for equipment start-stop and valve open-close functions. When the control action is selected it shall be highlighted in accordance with the owner’s standard color code conventions.

3.11 PID CONTROL ALGORITHM

A. All PID control functions (P, PI, and PID) are provided with standard analog controller functions and SCADA operator interfaces including, but not limited to, the following:
1. AUTO/MANUAL mode selection: In AUTO, the output of controller shall be based on the PID control calculation resident in the PLC. In MANUAL, the output of the controller shall be operator adjustable. Transfer between operational modes shall be bumpless.

2. LOCAL/REMOTE set point selection: In LOCAL, the set point shall be operator adjustable from the equipment. In REMOTE, the set point shall be adjustable from a REMOTE set point input.

3. Set point, process variable, and controller output shall be displayed at the SCADA workstation. The display shall be represented as a dynamic bargraph with the associated value displayed in engineering units.

4. Deadband limits shall be placed on PID control algorithms to avoid hunting and continuous change actions. Deadband limits shall maintain a constant control until the process variable exceeds the deadband boundaries. A deadband value of zero will disable the deadband. Provisions shall be included to prevent reset windup.
   a. Gate controls shall be programmed to provide minimum and maximum change parameters with time delays between transitions to prevent over exercising the gate controllers.

5. PID controls shall be provided with a setpoint deviation alarm. The alarm condition shall be generated when the controller cannot sustain the desired setpoint within a user definable deadband for a tunable time delay.

6. Programming shall be provided to prevent wind-up when the PID is not actively controlling due to manual or override control functions.

7. Bumpless transition shall be provided when PID is invoked after a transition from manual to PID control or when pump start logic utilizes minimum speed controls for starting applications. The transition from current speed to calculated speed shall be provided as a user tunable setpoint percentage per second value.

B. PID Back-up Control

1. PID control systems employing external setpoint controllers as back-up or local automatic control equipment shall interface with the PLC control logic based on the following:
   a. Local/Remote mode control of the Setpoint Controller shall be capable of selecting “local automatic”, “local manual” and remote control of the setpoint controller. In the remote control mode the setpoint controller receives output control signals from the PLC to maintain the desired setpoint or position.
   b. Alternate mode select, in remote control the setpoint controller shall receive an alternate mode control condition from the PLC. This mode shall freeze the control output at its current state or drive the controller to produce a 0 output until the alternate mode condition is removed.
c. The setpoint controller shall provide a control mode status condition to the PLC indicating that it is in the local or remote HOST mode of operation.

3.12 OUT OF SERVICE (OOS)

A. When equipment is tagged OUT OF SERVICE (OOS), a SCADA function, all associated equipment and devices are automatically placed in OUT OF SERVICE status and their associated alarms inhibited until the tagged equipment is re-tagged IN SERVICE. The PLC shall receive an “Out of Service” status from the SCADA and remove all associated equipment from operation at the PLC control level. Exception, redundant systems shall remain in operation.

B. Instrument “OUT OF SERVICE” (OOS) tagging. When an instrument is failed or removed from service, the operator at the SCADA may block the instrument signal at the PLC to prevent nuisance alarm and abnormal control conditions. When an instrument signal is blocked at the PLC, associated alarms and controls are disabled. The operator shall be capable of entering substitute values for monitoring and control while in the blocked mode of operation.

3.13 CHEMICAL FEED SYSTEMS

A. Chemical Feed Controls shall be provided with SCADA manual Start/Stop control. Equipment provided with speed control and feedback shall be provided with three modes of control unless otherwise specified. The chemical feed controls shall be provided as follows:

1. On/Off Control – When selected for On/Off control the PLC shall start the associated chemical feed equipment based on equipment run and/or process flow interlock conditions.

2. Manual Speed Control – The operator shall select SCADA manual control and manually set the speed from the SCADA workstation. In this mode the equipment shall Start/Stop automatically and utilize the last speed setpoint value for equipment control.

3. Open Loop Control – The PLC shall control the chemical feed rate based on its associated flow pacing signal. The chemical feed output shall be provided with operator adjustable ratio and offset setpoints. The operator shall enter a dosage value that is utilized to calculate the appropriate pacing parameters. Dosage calculations shall be provided by the Owner at the time of implementation. The Dosage calculation shall be provided with enable/disable capability. When disabled the chemical feed pacing is based on the ratio and offset setpoints entered by the operator.

4. Closed Loop Control – The PLC shall control the chemical feed rate based on its associated flow pacing signal and feedback process variable for trimming the output to maintain a desired process parameter such as Chlorine Residual, PH etc. Unless otherwise specified the control shall be based on a PID control algorithm as described in item 12.
5. The operator shall select the desired mode of operation On-Off/manual/open loop/closed loop control from the SCADA workstation. The chemical feed controller shall display the operational status, speed and mode selected on the graphical screen.

B. Chemical System Monitoring

1. Large treatment plant and pumping facilities shall be provided with the means to monitor chemical storage capacity such as level or weight. These parameters shall be utilized to notify operations on low level, chemical required and initiate shutdown conditions on low-low levels to protect the chemical feed pumps. Additional storage data shall be logged to the HDS to allow for chemical usage reporting and analysis.

2. Chemical feed systems shall be coordinated with the chemical feed pump suppliers to provide for both local and PLC control of the chemical feed pumps. Critical system shall be provided with local automatic controls to all for local automatic control based on flow in the event of a PLC system failure. Under normal mode the PLC shall have complete control of the injection system.

3. Additional monitoring of the chemical feed systems shall be provided for alarming and notification of the following:
   a. Chemical Containment Leak
   b. Chemical Diaphragm Seal Failure
   c. Chemical Feed No Flow
   d. Chemical Feed Pressure Low

3.14 VALVE AND GATE CONTROL

A. Valve and gate controls provided with positive feed back for Opened and Closed (limit switch) states shall be provided with the following features:

1. When commanded to Open/Close and the valve is not fully Opened/Closed the SCADA shall display an equipment traveling status.

2. When both the equipment Opened/Closed states are present an equipment position conflict alarm shall be generated at the SCADA.

3. When an associated filter valve or equipment valve is put into local mode of operation the entire filter/equipment defaults to manual control.

B. Valve and gate controls provided with position feed back potentiometers or other position indication devices shall be provided with manual valve position capability. The operator shall be capable of positioning the valve/gate to a desired position with a user definable deadband. The operator shall enter the desired valve/gate position to the PLC for control. To prevent valve hunting the PLC shall position the valve to the user desired point within a user adjustable deadband.

C. When limit switches are utilized in conjunction with analog signals the PLC shall drive the valve/gate to the fully open or closed limit switches. Fail to
open/close conditions shall be based on the switch positions. Alarms shall be provided to signal a potential signal problem if the limit switch positions do not match the expected analog signal value within a user definable deadband.

D. When limit switches are not utilized for position feedback, the PLC shall position the valve based on the analog signal within a given deadband for both the full open and closed positions. Control shall provide for the following:

1. When the valve is commanded to open/close, the PLC shall position the valve to its desired position and then wait a user adjustable delay. If the valve is increasing/decreasing and its position is within deadband for a user adjustable delay stop the control action.

2. When the valve is commanded to open/close, the PLC shall position the valve to its desired position and then wait a user adjustable delay. If the valve is increasing/decreasing and its position is not within deadband for a user adjustable delay stop the control action and initiate a fail to open/close alarm condition.

E. Calculated valve/gate position controls shall be bound be values to prevent the valve from hunting and cycling to maintain a given process parameter such as flow. In general after the initial open cycle for gate control, gate operations shall be bound as follows:

1. If the gate position is within a deadband percentage (operator adjustable) that gate shall remain in position until the gate position is outside the desired value for a user adjustable time.

2. If the gate position control parameter such as flow is within a deadband percentage (operator adjustable) that gate shall remain in position until the flow is outside the desired value for a user adjustable time.

3. Regardless of a calculated parameter the valve position control for discreet operations shall be provided with a minimum and maximum pulse duration that is user adjustable in seconds. A new position control value shall be calculated based on a user adjustable sample time.

3.15 SYSTEM CONTROL HIERARCHY

A. The SCADA control system provides for all monitoring, alarming, interlocking and control functionality of the plant control systems. It provides the means in which the SCADA monitors and controls the system at the operator level. Equipment items throughout the plant are provided with numerous levels of control ranging from local manual to SCADA initiated controls. To establish a control hierarchy the following control precedence shall be in effect unless otherwise specified within individual control strategies:

1. Hardwired Interlock and Lock Out Stop (LOS)
2. Local Manual Control
3. Local Automatic Control (Setpoint Controller, Relay Logic)
4. PLC Automatic Control
5. SCADA Manual Control
6. SCADA Automatic Control

B. For equipment that is controllable from a PLC, a control mode status signal shall be present at the PLC to indicate when the PLC is allowed to control the equipment. The PLC monitors the switch position status (LOCAL/REMOTE, HAND-OFF-REMOTE) of each equipment item and is able to control only the equipment that is in the REMOTE or selected PLC mode.

C. SCADA control (Auto or Manual) can occur only when the PLC is in either the REMOTE or selected PLC mode for the equipment item and it is placed into the SCADA AUTO/MANUAL control mode. Under SCADA mode the SCADA system provides for all start/stop, open/close, speed and position control based on operator initiated actions or control algorithms resident within the SCADA system.

D. All interlocks, start sequences, stop sequences and permissives shall be retained in the PLC and remain active in the SCADA mode. Exceptions to this are those alarms listed as overrideable alarms by the SCADA.

E. There shall be three levels of PLC initiated control once the equipment is placed into the remote or PLC mode of operation. The control hierarchy for PLC operation is as follows:

1. Equipment placed into service and not under SCADA AUTO/MANUAL mode is directly controlled by the PLC without SCADA intervention.

2. Equipment placed into SCADA MANUAL is controlled at the SCADA workstation based on operator initiated control actions.

3. Equipment placed into SCADA AUTO is controlled by a control strategy resident within the SCADA. Control data is sent to the PLC based on SCADA calculated control requirements. Equipment placed into SCADA AUTO with various modes of control is controlled by a control strategy resident within the SCADA. Control data is sent to the PLC based on SCADA calculated control requirements for the control mode selected.

PART 4 ALARM PROCESSING AND MANAGEMENT

4.00 GENERAL

A. Alarm – An alarm represents a condition to which an operator’s attention must be drawn. This condition may be an out of limit process value, an equipment malfunction or other abnormal condition. The condition is represented by a block in the IFix database that has been configured for alarming.

B. Alarm Acknowledgement – A procedure by which an operator confirms the alarm condition. This acknowledgement is carried out through the IFix Workspace and the date, time and current operator are recorded when an alarm is acknowledged.

C. Alarm Area – Alarm areas are used to group and differentiate alarms so they can be presented to the operator. An area may correspond to a physical or process area or to a category of alarm. Alarm areas are implemented in IFix through an alarm area database that allows many areas to be defined. An alarm may belong to up to 15 areas.
D. Alarm Flood – An alarm flood (also called an alarm shower or alarm storm) is caused when a single event results in the generation of many alarms. For example, if an IFix I/O driver loses its connection to a PLC, all blocks for that PLC that are configured for alarming will go into a “Comm.” alarm state.

E. Alarm Level – As defined in the project specifications, an alarm level is a number from 1 to 10 describing the severity of an alarm, with 1 being highest severity and 10 being lowest.

F. Alarm Priority – An alarm’s priority is another, more general, measure of its severity. The various alarm levels are mapped to three alarm priorities (High, Medium, Low) available within IFix. These priorities are then used for coloring alarm summary display entries, filtering alarm lists and other functions.

G. Alarm Disable – A disabled alarm will not be generated even if the underlying condition is present. An operator must consciously act to disable an alarm through the IFix interface, resulting in the alarm being disabled in the programmable logic controller (PLC). Typically each alarm must be individually disabled. Any control logic or interlock associated with the alarm is also disabled. This should be differentiated from enabling or disabling alarm functions for a database block within the IFix SCADA system. These functions are part of the development process rather than operation and will not disable logic within the PLC.

H. Alarm Suppression – An alarm is suppressed if logic (which may be related to an operator’s selection) prevents the alarm from being generated without it being specifically disabled. For example, all alarms associated with a level transmitter (High-high, high, low, low-low, rate-of-change) will be suppressed if the instrument has been tagged as out of service. Another example would be suppression of turbidity alarms while a filter is undergoing backwash.

I. Interlock – An interlock is a logical relationship between an alarm and a process whereby the presence of an alarm condition will change or disable the normal control logic for a process. An example might be closing a fill valve when a high tank level alarm exists.

4.01 Alarm Levels

A. The level of an alarm is a measure of its severity with 1 high and 10 low. Alarm levels will be implemented through the use of common alarm areas as described in the alarm areas section below. The various levels are defined in the following table.

B. Assignment of alarm levels to specific alarms will require coordination with the Owner operations staff.

<table>
<thead>
<tr>
<th>ALARM LEVEL</th>
<th>Description/Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Danger to human life or environment</td>
</tr>
<tr>
<td>2</td>
<td>Water quality alarm, Plant Shutdown, Major Process Alarm</td>
</tr>
<tr>
<td>3</td>
<td>Minor process alarms associated with warning conditions and equipment</td>
</tr>
<tr>
<td>Alarm Level</td>
<td>Area Type</td>
</tr>
<tr>
<td>------------</td>
<td>----------------</td>
</tr>
<tr>
<td>01</td>
<td>Level 1 Alarms</td>
</tr>
<tr>
<td>02</td>
<td>Level 2 Alarms</td>
</tr>
<tr>
<td>03</td>
<td>Level 3 Alarms</td>
</tr>
<tr>
<td>04</td>
<td>Level 4 Alarms</td>
</tr>
<tr>
<td></td>
<td>Level</td>
</tr>
<tr>
<td>----</td>
<td>----------------</td>
</tr>
<tr>
<td>05</td>
<td>Level 5 Alarms</td>
</tr>
<tr>
<td>06</td>
<td>Level 6 Alarms</td>
</tr>
<tr>
<td>07</td>
<td>Level 7 Alarms</td>
</tr>
<tr>
<td>08</td>
<td>Level 8 Alarms</td>
</tr>
<tr>
<td>09</td>
<td>Level 9 Alarms</td>
</tr>
<tr>
<td>10</td>
<td>Level 10 Alarms</td>
</tr>
<tr>
<td>A - P</td>
<td>Unused</td>
</tr>
</tbody>
</table>

B. Each workstation shall be configured as a local alarm area or group.

C. An alarm summary may be filtered to display alarms from just a single area, several areas, or to exclude specific areas. Typical process alarms will belong to several alarm areas. For example, a high turbidity alarm from the water treatment plant will belong to the _Level02, Treatment alarm areas. Note the configuration shall be underscored in alarm areas “_Level01” through “_Level10.” This is inserted so that the alarm level is always the first alarm area listed for a database block. The selected areas are listed by an ASCII sort and it is desirable to have the alarm level be in a predictable location should it be used in scripting. Each block should have only one alarm level area associated with it.

D. Alarm area and group configuration shall be coordinated with the Owner based on the process and its location within the overall control system.

4.04 Alarm Summary Object

A. The alarm summary object is used on SCADA displays to present a list of active alarms in a spreadsheet-like table. Each row of the table represents a single alarm. The background color for each row is controlled by the priority of the alarm, so that an operator can quickly discern the severity of alarms in the table. The proposed colors can be distinguished by operators that suffer from any of the prevalent forms of red-green or green-yellow color blindness.

B. Background Color
   1. High Yellow
   2. Medium Light Cyan
   3. Low White

C. The alarm summary text is black to provide high contrast over these light background colors. Alarms that have not been acknowledged will blink to reverse video. The following columns are included in the alarm summary table.

4.05 Disabled Alarm Table

A. It is possible for an operator to disable alarms. To notify operation what alarms have been disabled, a table of disabled alarms is provided as an operations log book. The disabled alarm table is an alarm summary object.
that is configured to only show level 9 and level 10 alarms. Entries in this table are automatically acknowledged and do not blink. The background is white for all rows. This table will list alarm disable and instrument or equipment out of service selections made by an operator. Left-clicking on an alarm within the disabled alarm table will open a window from which the alarm may be configured and enabled.

4.06 Distributed and Local Alarming

A. Each IFix SCADA node in the wide area network (WAN) will generate alarms that will be received at all connected client and SCADA machines. This is provided for system-wide administration, but could be a distraction for operators at a particular plant. The solution to this problem is alarm filtering. Two alarm management screens will be available to the operator: local alarms and system-wide alarms. The alarm summary display and disabled list on the local display will be filtered to only display alarms from the local process. Other filters will be available to further limit the list of alarms displayed. This will prevent an alarm flood from a different location from saturating an operator’s alarm view. Without a filtered alarm display it would be easy for an important local alarm to be lost in an alarm flood caused by PLC or network maintenance at another location.

B. The system-wide alarm management screen will have the capability of displaying alarms from all IFix SCADA nodes in the WAN. Pre-configured filters will be available to look at ALARM HANDLING CONVENTIONS alarms from a particular area, priority or alarm level. In addition to the pre-configured filters, the operator will have the ability to create custom filters.

4.07 Alarm Horn

A. The PC speaker is used to provide an audible signal to operators that an unacknowledged alarm exists. Two alarm sounds are used; one is intended to signify an urgent alarm (high priority) while the other is for warning (medium priority) conditions. The alarm horn may be enabled or disabled from the local alarm management screen. It will sound for alarms defined as local (the same alarms that appear on the local alarm summary).

4.08 Alarm History

A. All alarm tags are to be recorded and at the central IHistorian database. From this database, alarm information can be compiled into on-demand and automatic reports. In addition, local alarms will be recorded in local alarm logs and the alarm history application. The alarm history application allows an operator to view alarm and event messages for the current day (beginning at midnight). Daily alarm log files are maintained on the local hard disk for 90 days. These files are text files that can be read and printed from applications like Notepad.
PART 5  NETWORKING

5.00  GENERAL

A. The SCADA Wide Area Network is configured as a fully meshed Ethernet based WAN system employing Cisco based routers and bridges.

B. Network management software and network components that are SNMP compliant. The network management software shall be deployed at the Historical Data Server for monitoring, diagnostics and control of the LAN/WAN system.

C. Ethernet routers shall be configured to provide secure routing of TCP/IP SCADA information. Router configuration shall utilize segmentation algorithms to consolidate information to specific areas or work groups. All configurations shall be based on the use of routable IP addressing.

D. Local Area Networks shall be isolated and configured to operate independent from the WAN. Resident LAN communications shall not be routed or broadcast through the WAN unless specific requests are made from SCADA nodes to access data outside the LAN environment. Prioritization shall be given to LAN communications for local monitoring and control.

E. Information and control network segmentation shall be provided at each WTP to separate the SCADA and SCADA WAN information systems communications from the PLC to SCADA control communications network. The segmentation of networks shall be as indicated on the drawings.

1. The control data network shall consist of the SCADA servers/workstations and PLC’s for process monitoring and control of plant functions. The control network shall be connected to the router via a second Ethernet channel for direct PLC access from remote locations.

2. The information network shall be configured to provide client/server functions for SCADA access via IClient nodes, Database client/server operations, Distributed Alarming, Historical Database Logging, WAN communications, and LAN communications.

END OF SECTION
SECTION 13371
SCADA AND PLC TAG NAMING CONVENTIONS

PART 1 GENERAL

1.00 PROCESS TAGGING GUIDELINES
A. SCADA and PLC tagging will generally follow the I/O tagging as follows:
   1. An analog input tag reference will contain the physical instrument tag displayed such as FIT, LIT, PIT for the scaled value to be represented on the SCADA screen. Intermediate variables and raw values are tagged as PIX, LIX, etc.
   2. An analog output value read from the PLC will be represented as a function control output such as SCT speed control output, ZCT valve position control, this is utilized in lieu of SIC or ZIC which may be field instrument devices to avoid a tag duplication. Intermediate control variables and parameters will carry SCX, ZCX, etc.
   3. A PLC discrete input will be represented as a YI or YA status with its associated modifier for equipment or its process description YIA Equipment Auto, YAF Equipment Fail, PAH Pressure Alarm High, FAL Flow Alarm Low. For discrete devices that are not utilized for alarming, the switch tag will be incorporated such as a flow enable switch FSH that enables a process.
   4. Discrete Outputs are represented as HC or OC at the SCADA level. The SCADA system will not control a discrete output directly and any SCADA initiated control action will always be filtered and processed by the PLC logic. If under certain operation requirements the physical output is monitored, such as the PLC Discrete output module, a YC function is utilized to represent the physical PLC discrete output state.

1.01 GENERAL
A. To maintain system development consistency a common instrumentation, PLC and SCADA tagging system shall be employed for system maintenance and SCADA/PLC system configuration. The tagging convention represented shall be included on all system drawings, PLC programming documentation and the SCADA system database. The PLC tagname shall be provided at the PLC programming level and carried out throughout the SCADA system configuration.
B. ALL existing tags associated with this project for distribution, water resources, raw water and sewage collection will be configured with new tags and logged to the HDS.
C. The SCADA process database requires that each input, output, or internally generated analog or discrete value be assigned a tag. Tags should have sufficient information and consistency not to require a comment field to
identify, and so two people are likely to develop the same tag for the same thing.

D. The PLC database consists of physical inputs and outputs, internally generated points, and tables of data that are read and written by the IFIX I/O device driver. Points are addressed according to Modicon conventions. Modicon supports alphanumeric "nicknames", otherwise known as symbolic addressing in the PLC. The "nickname", referred to hereinafter as the tag shall correlate to a PLC assigned address to a unique alphanumeric tag. In the latest version of the associated drivers, tag names can be up to twenty characters long. The latest version of the IFIX software allows tag names up to thirty characters long.

E. The PLC program logic shall incorporate the same tagging conventions as the SCADA system for all registers accessed by the SCADA system. A PLC point that is written to the PLC from the SCADA or read from the PLC to the SCADA shall carry the same alphanumeric tag as the associated point in the SCADA database. Since PLC library files are used extensively throughout this project, tag length is limited to 20 characters, which is the maximum number of characters required for the tagging scheme outlined herein.

F. The SCADA and PLC tag shall be derived with a 20 digit alphanumeric descriptor that will include the following groups:

1. Plant Location, system and/or Area ID
2. Instrument/Equipment Descriptor per ISA tagging requirements modified for specific digital loop functions
3. Process Loop Number
4. Register/Point Function Information Descriptor
5. Point Function Descriptor

   For example:
   a. WES01YIAH1001 DI 00HND
   b. WES01 is the Plant Location and Area ID for Wes Brown WTP Master PLC.
   c. YIAH per ISA standard and the City modifier table represent Equipment “In Auto” with X being a filler.
   d. 1001__00 represents the process loop/equipment number 1001 and a 00 modifier.
   e. DI represents the Point Type Information Character as Digital Input
   f. HND is the point function descriptor taken from the descriptor function identification table.

G. The tag begins with the Plant Location ID so that, in the SCADA or PLC software database, tags can be easily sorted or grouped by their location. It is difficult to find a loop’s tags if they begin with the instrument designator, although that is conventional. Groups are alternated alpha and numeric to further aid in system tag sorting.
H. There are two types of software tags: equipment tags, which are for equipment and instrument related points, and system status tags, which are for status points that are generated internally by the system software.

I. All letters in the software tag shall be upper-case. Lower-case letters are useful for demarcating information, but the PLC symbolic tag does not support lower-case letters. All 18 digits will be utilized shortened tag groups and unused characters shall be filled with a X.

1.02 PLANT LOCATION ID AND AREA NUMBER

A. WES01YIA01001DI00HND

1. The software tag begins with the location ID. This is the physical location of the Water Treatment Plant, Station or Monitoring Point. The IDs are a three letter representation of the water treatment plant. For example, WES is Wes Brown.

2. The Location Number is utilized to represent a specific location or control area for different systems and operations such as PRS01 and SLS02 which represent the different sites. The following site abbreviations shall be utilized:
   a. DRV – Pressure Reducing Station
   b. SLS – Sewage Lift Station
   c. RWG – West Gravel Lakes
   d. REG – East Gravel Lakes
   e. RTN – Tani
   f. RCL – Cooley
   g. RDH – Dalhia
   h. DPS – Distribution Pump Station
   i. DST – Distribution Storage Tank

3. This will help database development, sorting, querying and troubleshooting by establishing a sort and query based on location and process area.

1.03 INSTRUMENT/EQUIPMENT DESCRIPTOR

A. WES01YIA01001DI00HND

1. The Instrument/Equipment Descriptor shall be comprised of four upper case letters that describe the instrument or equipment, based on the ISA standard and the City designation modifiers represented in the tables. Descriptors shorter than four letters will utilize a fill letter of X, for example, hand switch HS is lengthened to HSXX. Descriptors longer than four letters are shortened to four.

2. Points whose instrument descriptor is not covered by the ISA standard are assigned a unique descriptor that represents the points’ function. Below are some typical representations for equipment/instrument.
3. General Designations Table

<table>
<thead>
<tr>
<th>Tag Reference</th>
<th>Tag Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSGX</td>
<td>Message Command Fail</td>
</tr>
<tr>
<td>JDAX</td>
<td>DC Power Alarm</td>
</tr>
<tr>
<td>JBAX</td>
<td>Battery Alarm</td>
</tr>
<tr>
<td>JAAX</td>
<td>AC Power Alarm</td>
</tr>
<tr>
<td>XJGX</td>
<td>Communications</td>
</tr>
<tr>
<td>BTWX</td>
<td>Block Transfer Write</td>
</tr>
<tr>
<td>BTRX</td>
<td>Block Transfer Read</td>
</tr>
<tr>
<td>BTFX</td>
<td>Block Transfer Fail</td>
</tr>
<tr>
<td>AIFX</td>
<td>Analog Input Module Fail</td>
</tr>
<tr>
<td>AITX</td>
<td>Analysis (pH, Chlorine…)</td>
</tr>
<tr>
<td>(*)ITX</td>
<td>Process Display Scaled</td>
</tr>
<tr>
<td>FQIX</td>
<td>Flow Totalization</td>
</tr>
<tr>
<td>JQIX</td>
<td>Power (KWH) Totalization</td>
</tr>
<tr>
<td>HC[*]X</td>
<td>Hand Control (SCADA)</td>
</tr>
<tr>
<td>KCXX</td>
<td>Time of Day Control/Timed Control</td>
</tr>
<tr>
<td>KYXX</td>
<td>Timer-Counter</td>
</tr>
<tr>
<td>(*)AHH</td>
<td>Process Alarm High High</td>
</tr>
<tr>
<td>KQIX</td>
<td>Equipment Elapsed Time</td>
</tr>
<tr>
<td>(*)AHX</td>
<td>Process Alarm High</td>
</tr>
<tr>
<td>(*)ALL</td>
<td>Process Alarm Low Low</td>
</tr>
<tr>
<td>(*)ALX</td>
<td>Process Alarm Low</td>
</tr>
<tr>
<td>YA[*]X</td>
<td>Status Alarm (SCADA)</td>
</tr>
<tr>
<td>YI[*]X</td>
<td>Status Indication (SCADA)</td>
</tr>
<tr>
<td>(*)CXX</td>
<td>Process Control (SCADA)</td>
</tr>
<tr>
<td>(*)AKX</td>
<td>Process Alarm Delay Setpoint</td>
</tr>
<tr>
<td>(*)ALK</td>
<td>Process Alarm Low Delay Setpoint</td>
</tr>
<tr>
<td>(*)AHK</td>
<td>Process Alarm High Delay Setpoint</td>
</tr>
<tr>
<td>(*)IKX</td>
<td>Instrument Variable Setpoint</td>
</tr>
<tr>
<td>(*)IKL</td>
<td>Instrument Variable Low Parameter Setpoint</td>
</tr>
<tr>
<td>(*)IKH</td>
<td>Instrument Variable High Parameter Setpoint</td>
</tr>
<tr>
<td>(*)CKX</td>
<td>Process Control Setpoint</td>
</tr>
<tr>
<td>KCSX</td>
<td>Equipment Start Delay</td>
</tr>
<tr>
<td>KQIX</td>
<td>Elapsed Time Meter</td>
</tr>
<tr>
<td>OI[*]X</td>
<td>Local OIP/HMI Operation (Status)</td>
</tr>
<tr>
<td>OC[*]X</td>
<td>Local OIP/HMI Operation (Control)</td>
</tr>
<tr>
<td>XJAX</td>
<td>Communications Alarm</td>
</tr>
<tr>
<td>XJIX</td>
<td>Communications Status</td>
</tr>
<tr>
<td>ZSOX</td>
<td>Position Switch Open</td>
</tr>
<tr>
<td>ZSCX</td>
<td>Position Switch Closed</td>
</tr>
</tbody>
</table>
B. ISA Designators represented in the table with the [\^] will contain an additional modifier to distinguish specific equipment discrete input and output types associated with equipment operation. The use of YI, YC, HC, HS, OS, OC, HS is employed with a third character modified to provide more detailed information of the status or operation function. These modifiers are represented in the Instrumentation legend. The following are some typical examples of their use:

<table>
<thead>
<tr>
<th>Designator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>YIA</td>
<td>Equipment in Auto</td>
</tr>
<tr>
<td>YIB</td>
<td>Equipment Bypass</td>
</tr>
<tr>
<td>YID</td>
<td>Equipment Disable</td>
</tr>
<tr>
<td>YIE</td>
<td>Equipment Enable or Energize</td>
</tr>
<tr>
<td>YIL</td>
<td>Equipment Stop or Lockout</td>
</tr>
<tr>
<td>YIM</td>
<td>Equipment Running</td>
</tr>
<tr>
<td>YIN</td>
<td>Equipment In Normal</td>
</tr>
<tr>
<td>YIR</td>
<td>Equipment Reset</td>
</tr>
<tr>
<td>HCO</td>
<td>SCADA Hand Operation Open</td>
</tr>
<tr>
<td>HCC</td>
<td>SCADA Hand Operation Close</td>
</tr>
<tr>
<td>HSO</td>
<td>Field or Panel Switch Open</td>
</tr>
<tr>
<td>HCZ</td>
<td>SCADA mode selection</td>
</tr>
<tr>
<td>YAA</td>
<td>Equipment Alarm</td>
</tr>
<tr>
<td>YAF</td>
<td>Equipment Failure</td>
</tr>
<tr>
<td>YAE</td>
<td>Equipment In Emergency Operation</td>
</tr>
<tr>
<td>HCA</td>
<td>CADA Auto Select</td>
</tr>
<tr>
<td>HCS</td>
<td>SCADA Equipment Manual Start</td>
</tr>
<tr>
<td>HCL</td>
<td>SCADA Equipment Manual Stop or Lockout</td>
</tr>
<tr>
<td>YCS</td>
<td>PLC Discrete Output Control Equipment Start/Stop</td>
</tr>
</tbody>
</table>
### C. Equipment Status Designations

<table>
<thead>
<tr>
<th>Tag Reference</th>
<th>Tag Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>YIA</td>
<td>Equipment In Auto</td>
</tr>
<tr>
<td>YIB</td>
<td>Equipment In Bypass</td>
</tr>
<tr>
<td>YIC</td>
<td>Equipment Closed</td>
</tr>
<tr>
<td>YID</td>
<td>Equipment Disabled</td>
</tr>
<tr>
<td>YIE</td>
<td>Equipment Enabled</td>
</tr>
<tr>
<td>YIF</td>
<td>Equipment Forward</td>
</tr>
<tr>
<td>YIG</td>
<td>User</td>
</tr>
<tr>
<td>YIH</td>
<td>Equipment In Hand</td>
</tr>
<tr>
<td>YII</td>
<td>User</td>
</tr>
<tr>
<td>YIJ</td>
<td>Equipment In Energy Management Mode</td>
</tr>
<tr>
<td>YIK</td>
<td>Equipment In Time Control Mode</td>
</tr>
<tr>
<td>YIL</td>
<td>Equipment Lock-Out or Stopped</td>
</tr>
<tr>
<td>YIM</td>
<td>Equipment Running</td>
</tr>
<tr>
<td>YIN</td>
<td>Equipment Normal Mode</td>
</tr>
<tr>
<td>YIO</td>
<td>Equipment Opened</td>
</tr>
<tr>
<td>YIP</td>
<td>User</td>
</tr>
<tr>
<td>YIQ</td>
<td>User</td>
</tr>
<tr>
<td>YIR</td>
<td>Equipment Reverse</td>
</tr>
<tr>
<td>YIS</td>
<td>Equipment Started/Stopped</td>
</tr>
<tr>
<td>YIT</td>
<td>Equipment Transfer</td>
</tr>
<tr>
<td>YIU</td>
<td>User</td>
</tr>
<tr>
<td>YIV</td>
<td>User</td>
</tr>
<tr>
<td>YIW</td>
<td>User</td>
</tr>
<tr>
<td>YIX</td>
<td>Equipment at X Position</td>
</tr>
<tr>
<td>YIY</td>
<td>Equipment at Y Position</td>
</tr>
<tr>
<td>YIZ</td>
<td>Equipment at Z Position</td>
</tr>
</tbody>
</table>
### D. Equipment Alarm Designations

<table>
<thead>
<tr>
<th>Tag Reference</th>
<th>Tag Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>YA or YAA</td>
<td>Equipment Common Alarm</td>
</tr>
<tr>
<td>YAB</td>
<td>Equipment In Bypass</td>
</tr>
<tr>
<td>YAC</td>
<td>User</td>
</tr>
<tr>
<td>YAD</td>
<td>Equipment Disabled</td>
</tr>
<tr>
<td>YAE</td>
<td>Equipment in Emergency</td>
</tr>
<tr>
<td>YAF</td>
<td>Equipment Failure</td>
</tr>
<tr>
<td>YAG</td>
<td>User</td>
</tr>
<tr>
<td>YAH</td>
<td>User</td>
</tr>
<tr>
<td>YAI</td>
<td>User</td>
</tr>
<tr>
<td>YAJ</td>
<td>User</td>
</tr>
<tr>
<td>YAK</td>
<td>Equipment Alarm Delay (Setpoint)</td>
</tr>
<tr>
<td>YAL</td>
<td>Equipment Lock-Out or Stopped Alarm</td>
</tr>
<tr>
<td>YAM</td>
<td>User</td>
</tr>
<tr>
<td>YAN</td>
<td>User</td>
</tr>
<tr>
<td>YAO (OOS)</td>
<td>Equipment Out of Service (OOS)</td>
</tr>
<tr>
<td>YAP</td>
<td>User</td>
</tr>
<tr>
<td>YAQ</td>
<td>User</td>
</tr>
<tr>
<td>YAR</td>
<td>Equipment Alarm Reset</td>
</tr>
<tr>
<td>YAS</td>
<td>Equipment Shutdown (Auxiliary)</td>
</tr>
<tr>
<td>YAT</td>
<td>Equipment Transfer</td>
</tr>
<tr>
<td>YAU</td>
<td>User</td>
</tr>
<tr>
<td>YAV</td>
<td>User</td>
</tr>
<tr>
<td>YAW</td>
<td>User</td>
</tr>
<tr>
<td>YAX</td>
<td>User</td>
</tr>
<tr>
<td>YAY</td>
<td>User</td>
</tr>
<tr>
<td>YAZ</td>
<td>User</td>
</tr>
</tbody>
</table>
### E. Equipment PLC Control Designations

<table>
<thead>
<tr>
<th>Tag Reference</th>
<th>Tag Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>YCA</td>
<td>Equipment Common Alarm</td>
</tr>
<tr>
<td>YCB</td>
<td>Equipment Bypass</td>
</tr>
<tr>
<td>YCC</td>
<td>User</td>
</tr>
<tr>
<td>YCD</td>
<td>Equipment Disable</td>
</tr>
<tr>
<td>YCE</td>
<td>Equipment Enable</td>
</tr>
<tr>
<td>YCF</td>
<td>Equipment Failure</td>
</tr>
<tr>
<td>YCG</td>
<td>User</td>
</tr>
<tr>
<td>YCH</td>
<td>User</td>
</tr>
<tr>
<td>YCI</td>
<td>User</td>
</tr>
<tr>
<td>YCJ</td>
<td>User</td>
</tr>
<tr>
<td>YCK</td>
<td>User</td>
</tr>
<tr>
<td>YCL</td>
<td>Equipment Lock-Out or Stopped</td>
</tr>
<tr>
<td>YCM</td>
<td>User</td>
</tr>
<tr>
<td>YCN</td>
<td>User</td>
</tr>
<tr>
<td>YCO</td>
<td>Equipment Out of Service (OOS)</td>
</tr>
<tr>
<td>YCP</td>
<td>User</td>
</tr>
<tr>
<td>YCQ</td>
<td>User</td>
</tr>
<tr>
<td>YCR</td>
<td>Equipment Reset</td>
</tr>
<tr>
<td>YCS</td>
<td>Equipment Start</td>
</tr>
<tr>
<td>YCT</td>
<td>User</td>
</tr>
<tr>
<td>YCU</td>
<td>User</td>
</tr>
<tr>
<td>YCV</td>
<td>User</td>
</tr>
<tr>
<td>YCW</td>
<td>User</td>
</tr>
<tr>
<td>YCX</td>
<td>Equipment Position X</td>
</tr>
<tr>
<td>YCY</td>
<td>Equipment Position Y</td>
</tr>
<tr>
<td>YCZ</td>
<td>Equipment Position Z</td>
</tr>
</tbody>
</table>
F. SCADA Hand Control Designations

<table>
<thead>
<tr>
<th>Tag Reference</th>
<th>Tag Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCA</td>
<td>Equipment Auto Select</td>
</tr>
<tr>
<td>HCB</td>
<td>Equipment Bypass</td>
</tr>
<tr>
<td>HCC</td>
<td>Equipment Close</td>
</tr>
<tr>
<td>HCD</td>
<td>Equipment Disable</td>
</tr>
<tr>
<td>HCE</td>
<td>Equipment Enable</td>
</tr>
<tr>
<td>HCF</td>
<td>Equipment Forward</td>
</tr>
<tr>
<td>HCG</td>
<td>User</td>
</tr>
<tr>
<td>HCH</td>
<td>Equipment Hand Select</td>
</tr>
<tr>
<td>HCI</td>
<td>User</td>
</tr>
<tr>
<td>HCJ</td>
<td>Power Management Mode</td>
</tr>
<tr>
<td>HCK</td>
<td>Time of Use Mode</td>
</tr>
<tr>
<td>HCL</td>
<td>Equipment Lock-Out or Stopped</td>
</tr>
<tr>
<td>HCM</td>
<td>User</td>
</tr>
<tr>
<td>HCN</td>
<td>User</td>
</tr>
<tr>
<td>HCO</td>
<td>Equipment Open</td>
</tr>
<tr>
<td>HCP</td>
<td>User</td>
</tr>
<tr>
<td>HCQ</td>
<td>User</td>
</tr>
<tr>
<td>HCR</td>
<td>Equipment Reset</td>
</tr>
<tr>
<td>HCS</td>
<td>Equipment Start</td>
</tr>
<tr>
<td>HCT</td>
<td>User</td>
</tr>
<tr>
<td>HCU</td>
<td>User</td>
</tr>
<tr>
<td>HCV</td>
<td>User</td>
</tr>
<tr>
<td>HCW</td>
<td>User</td>
</tr>
<tr>
<td>HCX</td>
<td>Equipment Position X</td>
</tr>
<tr>
<td>HCY</td>
<td>Equipment Position Y</td>
</tr>
<tr>
<td>HCZ</td>
<td>Equipment Position Z</td>
</tr>
</tbody>
</table>

G. The OC designation is utilized for Local OIP operations that are related to mode selection, lead-lag modification, scheduling and sequencing operations to be utilized by the PLC control logic, whereas the HC designation is utilized to signify a SCADA hand control action to operate equipment. In general, SCADA and local OIP operations shall be configured to provide the same operation, hence what is available to the SCADA is available to the OIP and vice versa.

H. Designators represented with (*) are replaced with the standard ISA process tag descriptor such a P-Pressure, L-Level, F-Flow.
I. Character utilizing a K designation as the third or fourth character signifies a setpoint variable that is accessible by the SCADA system. They are typically defined as follows:

1. (*)AK is an alarm delay setpoint parameter tunable from SCADA and utilized for a discrete input to alarm delay, setpoint trip alarm delay and any time out function that produces an alarm condition. Example:
   a. PALK is a low pressure alarm delay.
   b. YAK is an equipment alarm delay
   c. (*)CK is a control variable setpoint parameter for process operation such as desired pressure setpoint PCK or Desired Flow setpoint FCK.
   d. (*)IK is an analog input setpoint parameter for instrument process input alarming. Example PILK would represent a low pressure setpoint or LIHK a high level setpoint.

J. Process Designations

<table>
<thead>
<tr>
<th>Tag Reference</th>
<th>Tag Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Analysis</td>
</tr>
<tr>
<td>B</td>
<td>Burner</td>
</tr>
<tr>
<td>C</td>
<td>Chemical</td>
</tr>
<tr>
<td>D</td>
<td>User</td>
</tr>
<tr>
<td>E</td>
<td>Voltage</td>
</tr>
<tr>
<td>F</td>
<td>Flow</td>
</tr>
<tr>
<td>G</td>
<td>Graphic Display</td>
</tr>
<tr>
<td>H</td>
<td>Hand</td>
</tr>
<tr>
<td>I</td>
<td>Current</td>
</tr>
<tr>
<td>J</td>
<td>Power</td>
</tr>
<tr>
<td>K</td>
<td>Time</td>
</tr>
<tr>
<td>L</td>
<td>Level</td>
</tr>
<tr>
<td>M</td>
<td>Motion</td>
</tr>
<tr>
<td>N</td>
<td>User</td>
</tr>
<tr>
<td>O</td>
<td>Operator Display</td>
</tr>
<tr>
<td>P</td>
<td>Pressure</td>
</tr>
<tr>
<td>Q</td>
<td>Quantity</td>
</tr>
<tr>
<td>R</td>
<td>User</td>
</tr>
<tr>
<td>S</td>
<td>Speed</td>
</tr>
<tr>
<td>T</td>
<td>Temperature</td>
</tr>
<tr>
<td>U</td>
<td>Multi-Variable (PLC)</td>
</tr>
<tr>
<td>V</td>
<td>Velocity (Vibration)</td>
</tr>
<tr>
<td>W</td>
<td>Weight</td>
</tr>
<tr>
<td>X</td>
<td>Communications</td>
</tr>
<tr>
<td>Y</td>
<td>Event (Status)/PLC Input</td>
</tr>
<tr>
<td>Z</td>
<td>Position</td>
</tr>
</tbody>
</table>
1.04 PROCESS LOOP NUMBER

A. BOW02YIA$1001_D100HND

B. The six digit field of the loop number is divided into two groups. The longest loop number assigned in the P&ID’s is the 4 digit group 1 number represented as the P&ID loop number, excluding instrument identification. To maintain consistency in tag length, the complete tag loop number is always 6 digits long. If a loop number is 4 digits, use a trailing zero to retain a 6 digit loop number.

C. The first digit of the process loop number shall represent the process area and control system based on the City’s standard methods for identifying the process area and that number typically represented on the P&ID drawings as the 4 Digit Process loop number.

D. The loop numbering scheme shall be as follows:

<table>
<thead>
<tr>
<th>DIGIT 1 of LOOP NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Non-Process (Power Distribution, Common Systems)</td>
</tr>
<tr>
<td>1</td>
<td>Raw Water Monitoring</td>
</tr>
<tr>
<td>2</td>
<td>Raw Water Pumping</td>
</tr>
<tr>
<td>3</td>
<td>Treatment</td>
</tr>
<tr>
<td>4</td>
<td>Treatment</td>
</tr>
<tr>
<td>5</td>
<td>Treatment</td>
</tr>
<tr>
<td>6</td>
<td>Distribution Pumping</td>
</tr>
<tr>
<td>7</td>
<td>Distribution Monitoring</td>
</tr>
<tr>
<td>8</td>
<td>Non-Process Sites</td>
</tr>
<tr>
<td>9</td>
<td>Sewage Collection</td>
</tr>
</tbody>
</table>

E. The loop numbering scheme shall be as follows:

1. The second digit represents the Process Train or System #, for example
   a. 41XX is Filter #1 and 42XX is Filter #2
   b. The remaining digits of the four digit process loop number are unique identification codes for the process loop and control functions.
   c. For example
      1) PIT-6001 is System Pressure
      2) YIM-6011 is Distribution Pump #1 Running
      3) YIM-6012 is Distribution Pump #2 Running
   d. The loop number adjusts to match the P&ID representation of the instrumentation system.
2. Group 2 number (56) is reserved for custom tags which are more than 4 digits or reserved for the programmer to use the numbers from 01 to 99 to separate the probable duplication in the tags. Usually these two digits shall be 00.

a. For example:

1) If a device’s loop number on the P&IDs is specified as 2127, then the software tag loop number is 212700.

1.05 POINT FUNCTION INFORMATION DESIGNATOR

A. BOW02YIAX1001DI00HND

B. The Point Function Information Designator is comprised of two upper-case letters that designate the type of information.

C. AI, AO, DI, DO are used for hardwired and communicated I/O to the PLC. Device network such as Devicenet, Fieldbus or other local I/O networks will utilize the same I/O naming conventions for physical points. These items would be included for networked motor controllers, valve actuators, and power system monitors.

<table>
<thead>
<tr>
<th>Designator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Analog input to PLC; implies type analog</td>
</tr>
<tr>
<td>AO</td>
<td>Analog output from PLC; implies type analog</td>
</tr>
<tr>
<td>BT</td>
<td>Block transfer; implies type BT. PLC only.</td>
</tr>
<tr>
<td>CD</td>
<td>Counter down, used for counters that are internal to PLC or MMI only.</td>
</tr>
<tr>
<td>CU</td>
<td>Counter up, used for counters that is internal to PLC or MMI only.</td>
</tr>
<tr>
<td>DI</td>
<td>Digital input to PLC; implies type digital</td>
</tr>
<tr>
<td>DO</td>
<td>Digital output from PLC; implies type digital</td>
</tr>
<tr>
<td>DR</td>
<td>Digital read; implies type digital</td>
</tr>
<tr>
<td>DW</td>
<td>Discrete write; implies type digital</td>
</tr>
<tr>
<td>DX</td>
<td>General purpose digital, PLC; implies type digital</td>
</tr>
<tr>
<td>DY</td>
<td>General purpose digital, MMI; implies type digital</td>
</tr>
<tr>
<td>FR</td>
<td>Floating point read</td>
</tr>
<tr>
<td>FW</td>
<td>Floating point write (Setpoint Control)</td>
</tr>
<tr>
<td>FX</td>
<td>General purpose floating point, PLC; implies type floating point</td>
</tr>
<tr>
<td>FY</td>
<td>General purpose floating point, MMI; implies type floating point</td>
</tr>
<tr>
<td>IR</td>
<td>Integer read</td>
</tr>
<tr>
<td>IW</td>
<td>Integer write (Setpoint Control)</td>
</tr>
<tr>
<td>IX</td>
<td>General purpose integer, PLC; implies type integer</td>
</tr>
<tr>
<td>LG</td>
<td>Logging variable; implies type real/float</td>
</tr>
<tr>
<td>MG</td>
<td>Message instruction; implies type MG. PLC only.</td>
</tr>
</tbody>
</table>
**PU**  |  Pulsed signal; implies type digital
---|---
**SW**  |  Setpoint Write Variable settable from SCADA.
**SR**  |  Setpoint Read Variable Read from SCADA.
**TR**  |  Timer Read, used for timers that are internal to PLC or MMI only.
**TW**  |  Timer Write, used for timers that are internal to PLC or MMI only.
**TX**  |  Text

1.06 **LOOP # SUFFIX**

A. **BOW02YIAX1001DI00HND**

B. The loop number suffix is utilized internally to prevent duplication of tags where additional display, status and function parameters are required with the same loop designation. For Example:

1. **BOW02FQIX1002IR00GPM** – Flow in Gallons
2. **BOW02FQIX1002IR01GPM** – Flow in Kilogallons

1.07 **POINT FUNCTION DESCRIPTOR**

A. **BOW02YIAX1001DI00HND**

B. The Point Function Descriptor is a 3-digit alpha that distinguishes multiple functions or items in one instrument, such as an AFD’s buttons, or the cause of an alarm. Fill X’s are used to retain a 3-digit Point Function Descriptor.

C. Some examples would be for:

1. Individual Switch Functionality
   a. **HND** – Hand
   b. **REM** – Remote
   c. **BYP** – Bypass
   d. **OFF** – Off
   e. **STF** – Start Forward
   f. **STR** – Start Reverse
   g. **AUT** – Auto
   h. **POS** – Position
   i. **MOD** – Mode
   j. **RUN** – Running
   k. **SHD** – Shutdown
   l. **FLT** – Fault
   m. **ALM** – Alarm
   n. **HIX** – High Condition
   o. **LOX** – Low Condition
p. OPN – Open or Opened
q. CLS – Close or Closed
r. MID – Middle or Midpoint
s. OOS – Out of Service
t. ENX – Enable or Enabled
u. DIS – Disable or Disabled
v. RST – Reset
w. SEQ – Sequence or Step
x. STP – Stop
y. LOS – Lock-Out
z. CTO – Control Time Out
aa. EOT – End of Travel
bb. MTN – Motion
cc. INT - Intrusion

2. Additional Process Description Analog:
   a. PSI – Pressure
   b. GPM – Flow GPM
c. INS – Inches
d. CFS – Flow CFS
e. PCT – Percent
   f. PPM – Part Per Million
g. DGF – Degrees Fahrenheit
  h. FTX – Feet
   i. PHX – PH
   j. SEC – Seconds
   k. MIN – Minutes
   l. HRS – Hours
   m. MGD – Flow MGD
   n. DGC – Degrees Celsius
   o. SPD – Speed RPM
   p. CNT – Count
   q. TOT – Total
   r. ETM – Elapsed Time Meter
PART 2  PLC SYSTEM CONFIGURATION

2.00  GENERAL

A. This section details Conventions used with the PLC's naming, program files, and data files. A comparatively rigid and defined naming convention is required because there are significant number of PLC’s making up this system. Each PLC and PLC configuration has to be uniquely defined, so it is essential to have a convention that eliminates the possibility of choosing the same name for different things by mistake. Also, the convention can guide users as they maintain the system.

2.01  PLC NAMING

A. PLC names are related to the location in which the PLC resides. The name is eight characters in length and is divided into the following parts:

1. The first characters are always the station system type:
   a. S – Sewage Collection
   b. D – Distribution
   c. R – Raw Water
   d. T – Treatment
   e. P - Power

2. The second three characters designate the station number (RTU #) for that communications network or system.

3. The next two characters are for the station type:
   a. LS – Lift Station
   b. PS – Pump Station
   c. PR – Pressure Reducing Station
   d. MS – Metering Station
   e. ST – Storage Tank
   f. WS – Weather Station
   g. SW – Stilling Well
   h. DS – Diversion Structure
   i. IC – Interconnection Point
4. The dash and last three characters designate the PLC or RTU abbreviated name.
   a. **Examples:**

<table>
<thead>
<tr>
<th>PLC Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S001LS-HVN</td>
<td>Sewage Lift Station 01 - Haven</td>
</tr>
<tr>
<td>D001PR-112</td>
<td>Distribution Pressure Reducing Station 001 – at 112th</td>
</tr>
</tbody>
</table>

B. This PLC name is utilized in the following locations:

1. Processor Name in the PLC Configuration. The processor name takes the form of "<NAME>", where name is the name defined above. For example, the processor name for PLC No.1 at BOW IS "PLCBOW01".

2. Device Name in FIX I/O Configuration. The device name differs slightly from the PLC name convention. The first three characters that are PLC are omitted from the device name. This is done because the device name can only be 5 characters in length. An example of the device name is "BOW01" (note that "PLC" is omitted).

3. The reason the PLC Name is only eight characters in length is because the Processor Name in the PLC Configuration is limited by Modicon to eight characters. The PLC Configuration file name is also only eight characters in length because the PLC Name and PLC Configuration File Name will match.

**END OF SECTION**
PART 1  GENERAL

1.00  GENERAL

A. The following control functions are based on an Intellution IFIX SCADA foundation for monitoring, control and information systems implementing a Modicon based PLC radio communications network. The SCADA system shall have complete monitoring and control capability of the master radio(s) and communications PLC’s.

B. The existing master PLC (Quantum) located at the Wes Brown WTP shall be programmed to communicate via the defined radio communications networks. Radio communication programming shall be furnished to provide for optimized radio based communications.

C. A second master PLC (Momentum) shall be programmed to access those sites indicated.

1.01  SCADA PROGRAMMING

A. The SCADA graphics shall provide communications overview screens that depict the various communications topologies and subsystems by the communications medium to present the user with monitoring, diagnostic and control characteristics over the communications system.

B. The following graphic screens shall include:

1. SCADA system overview for Network and Fiber Optics
   a. SCADA Workstation symbol with Address and Description
   b. Workstation Status (Active, Disabled, Failed)
   c. Communications percentage (0 – 100 %)
   d. Terminal Services Status (Primary, Secondary, Failed)
   e. Hot-Standby Link Status
   f. Historical Data Server Status
   g. Control Network Status
   h. Information Network Status
2. Radio Communications Overview for 900MHz
   a. Radio communications overview graphic shall provide the following information.
      1) PLC symbol with Address and Description.
      2) Polling Status (Active, Disabled, Failed)
      3) Communications percentage (0 – 100 %)
      4) Polled attempts
      5) Failed Polls
      6) Poll XMT and RCV Status

3. Radio Communications Overview for 450MHz
   a. Radio communications overview graphic shall provide the following information.
      1) PLC symbol with Address and Description.
      2) Polling Status (Active, Disabled, Failed)
      3) Communications percentage (0 – 100 %)
      4) Polled attempts
      5) Failed Polls

4. Radio Communications Overview for Spread Spectrum (Two Systems)
   a. Radio communications overview graphic shall provide the following information.
      1) PLC symbol with Address and Description.
      2) Polling Status (Active, Disabled, Failed)
      3) Communications percentage (0 – 100 %)
      4) Polled attempts
      5) Failed Polls

5. Communications trend graphs fixed at 24 hours for each site. Trend graphs may represent up six sites on a single trend. Trend graphs shall be configured specific to each group of sites. Typical trends requiring the operator to assign pens and tags are not acceptable.
C. Radio System Diagnostics

1. The MDS radio system diagnostics shall be provided on a SCADA workstation with a connection link to the master radio. The workstation shall allow the operator to enable the MDS software and initiate diagnostics of the radio system with the MDS radio’s to view and control all radio parameters.

2. The MDS radio diagnostic software shall be fully configured and each individual site uniquely addressed and configured for diagnostic and monitoring from the SCADA workstation.

D. PLC Diagnostic Screens

1. Provide a rack layout graphics screen indicating the PLC system configuration and interconnection between systems. The screen shall be provided with all relative PLC diagnostics, module health and PLC operational status.

E. Communications Driver

1. Configure the communications driver to include those register sets developed for monitoring, control and diagnostics of the communications network.

2. Configure the communications driver to provide driver status to the SCADA software.

1.02 COMMUNICATION GROUPS

A. Register sets shall be optimized such that the communications messaging can be modified to support the polling of non-essential registers such as timer/counters and setpoints to be polled on user adjustable # of poll cycles or elapsed time.

B. Modbus registers at the Master PLC and the Remote Stations shall be grouped in contiguous register sets according to register type and function. Discrete, Process, Setpoint, Timers/Counters. In general messages shall be derived to communicate Discrete and Process data in one message and Setpoint Timer Counter in another message. If all registers can be accessed in a single message separate message blocks will not be required.

1.03 SYSTEM OVERVIEW

A. To enhance the SCADA system diagnostic capabilities the CSS shall provide PLC and SCADA programming services to address communications integrity, monitor communications status and allow for operator adjustable polling cycles and schedules to optimize radio based communications.
B. The CSS shall provide all associated technical services to establish the best methods for optimization based on the PLC software, radio interface and capabilities of the Modicon Quantum processor.

1.04 COMMUNICATIONS INTEGRITY

A. Program the PLC to provide for a communications integrity status that will display communications integrity from 0 – 100%. The CSS shall develop a weighted and filtered algorithm that views the last 100 communications attempts based on both successful and failed conditions to arrive at a percentage. On start-up (site enabled for polling) the algorithm shall be weighted to allow for initial communications functionality.

B. Program a communications fail counter that is based on poll cycles, polled attempts and number of polled failures. In essence, there will be a number of attempts within a poll cycle, when the number of attempts has been exceeded the communications will move onto the next site. This will continue for a user number of poll cycles. When the poll cycles have been exceeded the PLC will be removed from the polling cycle for a user adjustable time and a communications alarm posted. The PLC will reattempt communications at random time intervals. Upon successful transmission the PLC will be placed back into the poll cycle.

C. A communications alarm shall be generated if the communications percentage falls below a user specified value for a user adjustable time.

D. Upon start-up of the Master Communications PLC, the PLC logic shall disable communication write functions until all PLC’s have been polled and the system updated to be synchronized with the field units. Write controls shall be enabled upon completion of a remote system update. Upon start-up all registers including setpoints and timers shall be polled from all sites.

E. The operator shall be capable of enabling and disabling a site from the poll cycle.

1.05 COMMUNICATIONS CONTROL

A. The PLC shall be programmed to provide for a sequential polling cycle that steps through each PLC on a round robin basis. PLC’s that are disabled or failed shall be removed from the list and bypassed until they are enabled or reset by the operator.

B. Operator initiated writes (setpoint changes and equipment control) shall take priority and preempt the communications poll cycle to initiate immediate control actions. The writes shall be followed by a read of the PLC to verify that the control actions have been implemented.

C. The operator via setpoint pop-up screen shall be capable of tuning each PLC’s poll attempts, cycles, communications percentage trip and associated communication alarm delays.
D. The operator shall be capable of resetting a communications alarm which in turn will enable the PLC for radio communications.

E. The operator shall be capable of selecting a priority communications status of a given site. When a site is selected to have priority status it will be interleaved with the polling cycle to be polled after each site in the polling sequence i.e. it is polled every other time until its priority status is removed. A stations priority status polling alarm shall be generated to the SCADA system when enabled. This function shall be provided for each radio system or communications group.

F. Poll Immediate a poll immediate trigger shall be provided to initiate an immediate poll of selected sites information. Each site shall be provided with a poll immediate button on the communications monitoring and control screen. The poll immediate shall be a one shot trigger that moves the last selected site to front of the polling sequence and polls all data from the site. Once completed the polling cycle will resume where it left off prior to the poll immediate request. Poll immediate requests shall be queued to three requests only and shall interleave with the poll cycle. A poll immediate request shall be initiated whenever an operator selects or navigates to a new screen that incorporates a polling immediate trigger. The poll immediate shall be linked to the site data represented on the graphic screen.

G. Pending writes of control data shall be cleared on a Master PLC power-up or restart.

END OF SECTION
Not Used
SECTION 13373
CONTROL DESCRIPTIONS

PART 1 CONTROL SYSTEMS

1.00 GENERAL

A. The CSS shall provide all PLC, SCADA and communications device programming services utilizing the standard methods and procedures for applications programming to implement the individual sites process control and monitoring functions outlined in these control descriptions.

B. Local Operator Interface Panels (OIP) and PLC’s shall be programmed and configured in conformance with the project plans, specifications and Owner standards.

C. Each remote PLC shall be programmed and configured to communicate with the Master PLC located at the Wes Brown WTP and where indicated the Master at the Thornton communications tower.

D. The control strategies may not include all status inputs that are required for general monitoring and interlocking functions. Reference the drawing for additional and supplemental I/O requirements.

1.01 SEWAGE LIFT STATION

A. OVERVIEW

1. Sewage lift stations are located throughout the City's area of coverage and are to communicate with the SCADA system via the designated radio communications network to the Master PLC.

2. Each sewage lift station consists of two or three pumps configured as lead, lag and standby (third pump) that will operate based on an automatic pump down control algorithm to maintain the wetwell level.

3. The wetwell is monitored by a bubbler and associated level transmitter along with float controls to provide for back-up control in the event of a PLC or transducer failure.

4. Fault monitoring is provided for each pump by monitoring the motor current, motor protective relay and overload to monitor and protect the motor.

5. The City shall provide the CSS with a base PLC program that shall be adhered to for programming structure, methodology, tagging and development to maintain a standard PLC programming format. The CSS shall utilize this program and modify it as required to meet the individual site specific needs.
6. The programming shall adhere to all the standard blocks and functions specified in Sections 13370, 13371, 13372, 13373.

B. FUNCTION BLOCKS

1. Process Blocks
   a. LIT-9001 Wetwell Level
   b. IIT-9010 Pump #1 Motor Current
   c. IIT-9020 Pump #2 Motor Current
   d. IIT-9030 Pump #3 Motor Current (Three Pump Station)

2. Alarm Blocks
   a. LSHH-9001 High High Wetwell (Critical)
   b. LSH-9001 High Wetwell (warning)
   c. LSL-9001 Low Wetwell (warning)
   d. LSLL-9001 Low Low Wetwell (Shutdown)
   e. YAF-9010 Pump #1 Failure
   f. YAF-9020 Pump #2 Failure
   g. YAF-9020 Pump #3 Failure
   h. JAL-1001 Power/Phase Failure (Shutdown)
   i. YAF-1011 Generator Failure
   j. YAM-9000 Two or More Pumps Running Alarm
   k. LSHH-9002 High Float (Critical – Start Pumps) Enables Back-up
   l. LSLL-9002 Low Float (Disable Pumps)
   m. YIZ-0001 Site Intrusion
   n. XA-2000 Communications Failure

3. Equipment Blocks
   a. PMP-9010 Constant Speed Pump/Motor #1
   b. PMP-9020 Constant Speed Pump/Motor #2
c. PMP-9030 Constant Speed Pump/Motor #3 (Three Pump Station)

d. GEN-1010 Generator

e. UPS-1020 Uninterruptible Power Supply

C. LOOP-9001 WETWELL LEVEL

1. General

   a. The lift station pumps are controlled based on the level of the wetwell. As the level increases the pumps 9010 and 9020 are started and stopped (Lead/Lag) based on increasing and decreasing level.

   b. Pumps are provided with a fixed or auto alternation routine based on a 1, 2, or Auto selection at the SCADA or Local OIP. When either 1 or 2 is selected that pumps will always be the lead pump. In AUTO mode the pumps alternate automatically.

   c. Pump(s) are controlled automatically when the local HOA switches YIA-9010 and YIA-9020 are in auto.

2. Level Control

   a. When the level increases above the lead pump start setpoint LCHK-9001 and the pump start delay setpoint has expired, the lead pump is started.

   b. When the level increases above the lag pump start setpoint LCHH-9001 and the pump start delay setpoint has expired, the lag pump is started.

   c. When the level decreases below the lead pump stop setpoint LCLK-9001 and the pump start delay setpoint has expired, the lead pump is stopped.

   d. When the level decreases below the lag pump stop setpoint LCLL-9001 and the pump start delay setpoint has expired, the lag pump is stopped.

3. Software Interlocks

   a. IAHH-9010 and IALL-9010 pump #1 motor current alarms will shutdown the motor and prevent the motor from operation until manually reset.

   b. IAHH-9020 and IALL-9020 pump #2 motor current alarms will shutdown the motor and prevent the motor from operation until manually reset.
c. IAHH-9030 and IALL-9030 pump #3 motor current alarms will shutdown the motor and prevent the motor from operation until manually reset.

d. LSSL-9002 will disable and prevent the pumps from operating until the float condition is removed for a user adjustable time or reset by the operator.

e. JAL-1001 power/phase failures will shutdown the motor and prevent the motor from operation until the condition is removed for a user adjustable time or reset by the operator.

D. PUMP FAILURE

1. When a pump is failed based on a motor fault or a fail to operate (start) condition, the next available pump is started. Pump stations utilizing a standby pump will operate by shifting the lead-lag-sequence ie if the Lead pump fails the lag pump become the lead pump and the standby pump becomes the lag pump. If the lag pump fails the standby pump becomes the lag pump.

2. Motor Alarms shall be provided for each pump as follows:

   a. CTOX-9010 Motor #1 Control Time Out (Shutdown)
   b. CTOX-9020 Motor #2 Control Time Out (Shutdown)
   c. CTOX-9030 Motor #3 Control Time Out (Shutdown)
   d. YAF-9010 Motor #1 Fault (overload/thermal)
   e. YAF-9020 Motor #2 Fault (overload/thermal)
   f. YAF-9030 Motor #3 Fault (overload/thermal)
   g. LSH-9010 Motor #1 Moisture Alarm (Warning)
   h. LSH-9020 Motor #2 Moisture Alarm (Warning)
   i. LSH-9030 Motor #3 Moisture Alarm (Warning)
   j. Two or more motors running alarm

E. LOOPS IIT-9010, IIT-9020 and IIT-9030 MOTOR CURRENT

1. Individual motor currents are monitored to protect the motors and provide alarm indication for abnormal operation as follows:

   a. When the pump is running and motor current exceeds the high current alarm setpoint for a setpoint delay, a motor high current warning is provided.
b. When the pump is running and motor current exceeds the high-high current setpoint alarm for a setpoint delay, a motor high current warning is provided.

c. When the pump is running and motor current is below the low current alarm setpoint for a setpoint delay, a motor low current warning is provided.

d. When the pump is running and motor current is below the low low current ISLL-90X0 setpoint alarm for a setpoint delay, a motor high current alarm is provided.

F. LOOPS KCK-9100

1. To provide for odor control and recycling during low demand operation, a time control scheduler will allow for the lead pump to be controlled on a time interval. Time control is enabled/disabled at the SCADA and local OIP for operation.

2. When time control is enabled, a setpoint adjustable interval timer will cycle the lead pump on as follows:

   a. Interval timer KC-9100 has exceeded a setpoint KSH-9100 time value and the wetwell level is greater than the lead pump stop level, the lead pump is started and stopped when it is below the lead pump stop level setpoint.

1.02 BIG DRY SEWAGE LIFT STATION

A. OVERVIEW

1. The Big Dry Lift Station is the most critical lift station in terms of operation. Its control is similar to that of the standard lift station operation with the exception of VFD speed control to maintain the desired level.

2. The wetwell is monitored by a bubbler and associated level transmitter along with a back-up controller (existing level controller to be converted as a back-up control unit) to provide for back-up control in the event of a PLC or transducer failure.

3. Fault monitoring is provided for each pump by monitoring the motor current, motor protective relay and overload to monitor and protect the motor.

4. This station will operate in the same manner as the standard lift stations with the exception of speed control to maintain desired level, and additional I/O for monitoring and alarming functions.

B. FUNCTION BLOCKS
1. Process Blocks
   a. LIT-9001 Wetwell Level
   b. LIT-9301 Chemical Tank Level
   c. LIT-9302 Chemical Tank Level
   d. FIT-9002 Station Flow
   e. PIT-9003 Station Pressure
   f. SIT-9010 Pump #1 Motor Current
   g. SIIT-9020 Pump #2 Motor Current
   h. SIT-9030 Pump #3 Motor Current
   i. IIT-9010 Pump #1 Motor Current
   j. IIT-9020 Pump #2 Motor Current
   k. IIT-9030 Pump #3 Motor Current

2. Alarm Blocks
   a. PSHH-9003 High High Wetwell (Critical)
   b. PSH-9003 High Wetwell (warning)
   c. PSL-9003 Low Wetwell (warning)
   d. PSLL-9003 Low Low Wetwell (Shutdown)
   e. LSHH-9001 High High Wetwell (Critical)
   f. LSH-9001 High Wetwell (warning)
   g. LSL-9001 Low Wetwell (warning)
   h. LSLL-9001 Low Low Wetwell (Shutdown)
   i. YAF-9010 Pump #1 Failure
   j. YAF-9020 Pump #2 Failure
   k. YAF-9030 Pump #3 Failure
   l. JAL-9901 Power/Phase Failure
   m. YAF-9011 Generator Failure
n. YAM-9000 Two or More Pumps Running Alarm
o. LSHH-9002 High Float (Critical – Start Pumps)
p. LSSL-9002 Low Float (Disable Pumps)
q. YAB-9000 Station Control in Back-up Mode
r. YIZ-0001 Site Intrusion
s. XA-2000 Communications Failure

3. Equipment Blocks
   a. PMP-9010 Variable Speed Pump/Motor #1
   b. PMP-9020 Variable Speed Pump/Motor #2
   c. PMP-9030 Variable Speed Pump/Motor #3
d. GEN-1010 Generator
e. UPS-1020 Uninterruptible Power Supply

C. LOOP-9001 WETWELL LEVEL

1. General
   a. The lift station pumps are controlled based on the level of the wetwell. As the level increases the pumps 9010, 9020, and 9030 are started and stopped (Lead/Lag) based on increasing and decreasing level.
   
   b. Pumps are provided with a fixed or auto alternation routine based on a 1, 2, or Auto selection at the SCADA or Local OIP. When either 1 or 2 is selected that pumps will always be the lead pump. In AUTO mode the pumps alternate automatically.
   
   c. Pump(s) are controlled automatically when the local HOA switches YIA-9010 and YIA-9020 are in auto.

2. Level Control
   a. When the level increases above the lead pump start setpoint LCHK-9001 and the pump start delay setpoint has expired, the lead pump is started. And its VFD is modulated to maintain the desired level or is controlled proportional to level based on whether PID or Proportional control is selected.

   b. When the level increases above the lag pump start setpoint LCMH-9001, pump speed control is at maximum and the pump start delay
setpoint has expired, the lag pump is started. The lead and lag VFD pump speeds are controlled in tandem.

c. When the level increases above the lag-lag pump start setpoint LCHH-900, pump speed control is at maximum and the pump start delay setpoint has expired, the lag pump is started. The lead, lag and lag-lag VFD pump speeds are controlled in tandem.

d. When the level decreases below the lead pump stop setpoint LCLK-9001, pump speed control is at minimum and the pump stop delay setpoint has expired, the lead pump is stopped.

e. When the level decreases below the lag pump stop setpoint LCML-9001, pump speed control is at minimum and the pump start delay setpoint has expired, the lag pump is stopped.

f. When the level decreases below the lag pump stop setpoint LCLL-9001, pump speed control is at minimum and the pump start delay setpoint has expired, the lag-lag pump is stopped.

3. Software Interlocks

a. IAHH-9010 and IALL-9010 pump #1 motor current alarms will shutdown the motor and prevent the motor from operation until manually reset.

b. IAHH-9020 and IALL-9020 pump #2 motor current alarms will shutdown the motor and prevent the motor from operation until manually reset.

c. IAHH-9030 and IALL-9030 pump #3 motor current alarms will shutdown the motor and prevent the motor from operation until manually reset.

d. LSLL-9002 will disable and prevent the pumps from operating until the float condition is removed for a user adjustable time or reset by the operator.

e. JAL-1001 power/phase failures will shutdown the motor and prevent the motor from operation until the condition is removed for a user adjustable time or reset by the operator.

D. PUMP FAILURE

1. When a pump is failed based on a motor fault or a fail to operate (start) condition, the next available pump is started. Pump stations utilizing a standby pump will operate by shifting the lead-lag-sequence ie if the Lead pump fails the lag pump become the lead pump and the standby pump becomes the lag pump. If the lag pump fails the standby pump becomes the lag pump.
2. Motor Alarms shall be provided for each pump as follows:
   a. CTOX-9010 Motor #1 Control Time Out (Shutdown)
   b. CTOX-9020 Motor #2 Control Time Out (Shutdown)
   c. CTOX-9030 Motor #3 Control Time Out (Shutdown)
   d. YAF-9010 Motor #1 Fault (overload/thermal)
   e. YAF-9020 Motor #2 Fault (overload/thermal)
   f. YAF-9030 Motor #3 Fault (overload/thermal)
   g. YAS-9010 Motor #1 VFD Fault
   h. YAS-9020 Motor #2 VFD Fault
   i. LSH-9010 Motor #1 Moisture Alarm (Warning)
   j. LSH-9020 Motor #2 Moisture Alarm (Warning)
   k. LSH-9030 Motor #3 Moisture Alarm (Warning)
   l. Two or more motors running alarm

E. LOOPS IIT-9010, IIT-9020 and IIT-9030 MOTOR CURRENT

1. Individual motor currents are monitored to protect the motors and provide alarm indication for abnormal operation as follows:
   a. When the pump is running and motor current exceeds the high current alarm setpoint for a setpoint delay, a motor high current warning is provided.
   b. When the pump is running and motor current exceeds the high-high current setpoint alarm for a setpoint delay, a motor high current warning is provided.
   c. When the pump is running and motor current is below the low current alarm setpoint for a setpoint delay, a motor low current warning is provided.
   d. When the pump is running and motor current is below the low low current ISLL-90X0 setpoint alarm for a setpoint delay, a motor high current alarm is provided.

F. LOOPS KCK-9100

1. To provide for odor control and recycling during low demand operation, a time control scheduler will allow for the lead pump to be controlled on a
time interval. Time control is enabled/disabled at the SCADA and local OIP for operation.

2. When time control is enabled, a setpoint adjustable interval timer will cycle the lead pump on as follows:

   a. Interval timer KC-9100 has exceeded a setpoint KSH-9100 time value and the wetwell level is greater than the lead pump stop level, the lead pump is started and stopped when it is below the lead pump stop level setpoint.

G. VARIABLE SPEED DRIVE PROGRAMMING

1. The variable speed drives shall be configured to support a primary and a secondary speed control via two analog input channels located on the VFD.

2. The VFD shall be modified, furnish and install additional I/O cards as required to implement the following:

   a. Primary vs secondary speed select. The Primary control shall be based on the operation of the PLC system. The secondary control is defined the existing control system modified to be activated in the event of a High-High float condition. When the High-High float is activate for x time, a hardware timer will signal each VFD to switch to the secondary control signal which will also enable the existing level control to start and stop the motors utilizing the existing controls.

1.03 BRANNAN LAKES

A. OVERVIEW

1. The Brannan Lakes pumps are controlled by the PLC system based on time of day, desired flow and total accumulated flow control.

2. Pumps are provided with a fixed or auto alternation routine based on a 1, 2, 3 or Auto selection at the SCADA or Local OIP. When either 1, 2 or 3 is selected that pump will always be the lead pump. In AUTO mode the pumps alternate automatically.

3. Pump(s) are controlled automatically when the local HOA switches YIA-10X0 where X denotes the pump number are in auto.

B. FUNCTION BLOCKS

1. Process Blocks

   a. PIT-1001 Discharge Pressure

   b. FIT-1002 Discharge Flow
c. LIT-1003 Wetwell Level

d. LIT-1101 West Lake Level

e. LIT-1201 East Lake Level

f. TIT-1102 West Lake Temperature

g. TIT-1202 East Lake Temperature

2. Alarm Blocks

a. LSL-1003 Low Wetwell (warning)

b. LSLL-1003 Low Low Wetwell (Shutdown)

c. LSLL-1005 Vault Flooding

d. LSLL-1006 Low Low Wetwell Float (Shutdown)

e. PSH-1001 High Discharge PSI (warning)

f. PSHH-1001 High-High Discharge PSI (Shutdown)

g. FSL-1002 Low Flow (warning)

h. FSLL-1002 Low-Low Flow (Shutdown)

i. YAF-1010 Pump #1 Failure

j. YAF-1020 Pump #2 Failure

k. YAF-1030 Pump #3 Failure

l. YAF-1040 Pump #4 Failure

m. JAL-1901 Power/Phase Failure

n. XXX-1902 UPS Alarms

o. YIZ-1801 Site Intrusion

p. XA-2000 Communications Failure

q. TSL-1102/1202 Lake Temperature Low (Warning)

r. TSL-1102/1202 Lake Temperature Low-Low (Critical)

3. Equipment Blocks

a. PMP-1010 Constant Speed Pump/Motor #1
b. PMP-1020 Constant Speed Pump/Motor #2

c. PMP-1030 Constant Speed Pump/Motor #3

d. PMP-1040 Constant Speed Pump/Motor #3

e. VLV-1004 Discharge Flow Control Valve

f. UPS-1020 Uninterruptible Power Supply

C. LOOP-1002 STATION FLOW

1. General

a. The pump station pump(s) are controlled based on the desired discharge station flow. The pumps are enabled for operation based on the following modes of control:

1) SCADA manual – Pumps are started/stopped by the operator and operate to maintain the desired station flow by modulating the discharge gate position. Pumps continue to operate until stopped by the operator or a hardware/software interlock is activated.

2) Time of day – Pump(s) are started/stopped and operate to maintain a desired station flow by modulating the discharge gate position.

3) Time of Day Start/Flow Total Stop and operate to maintain a desired station flow by modulating the discharge gate position based on the time of day the flow produced.

4) SCADA Manual Start/Flow Total Stop and operate to maintain a desired station flow by modulating the discharge gate position.

b. Accumulated Flow Control

1) When the accumulated flow control is enabled, the flow will be accumulated and the pumps stopped when any of the modes of control are enabled, with exception to SCADA Manual in this mode an alarm message will be generated that will indicate that the desired total flow has been exceeded.

2) If the accumulated flow control is disabled, the flow will not accumulate for the pumps when they are operated in SCADA manual mode.

3) In accumulated flow control mode the Time of Day/Start/Flow Total Stop and SCADA Manual Flow Total Stop modes are enabled and selectable by the operator based on the desired mode of operation.
4) When the total desire flow has been achieved the pumps will be stopped, the Accumulated flow control disabled and an alarm/status message Pumps Stopped on Desired total flow will be generated. Once acknowledged by the operator, the accumulator can be reset and then enabled.

5) The graphic display shall indicate the following:

   a) Total Desired Flow

   b) Total Accumulated Flow – this accumulator is different than the station flow totalizers (Non-resettable and resettable). And is reset to zero when reset by the operator.

   c) Remaining Flow Total – Count down from the Total Desired Flow value.

2. Flow Control

   a. The operator shall select the desired flow setpoint. The value of the flow setpoint shall determine the number of pumps required to meet the desired flow and stage the pumps on with an adjustable sequential delay between pump starts.

   b. The pumps shall be automatically started and stopped based on the desired flow requirements for all modes with the exception of SCADA manual start/stop mode.

   c. In SCADA manual start/stop mode the operator shall manually start the pumps and adjust the flow setpoint accordingly. The control program shall provide indication as to the number of pumps required based on the flow rate to assist the operator in selecting the number of pumps.

   d. If the desired flow cannot be maintained by the selected number of pumps for a user adjustable delay. A setpoint deviation alarm shall be generated.

   e. Reverse flow monitoring, the PLC shall monitor reverse flow via the flow meter based on negative to positive transition of the flow signal or a separate reverse flow analog signal or status trigger. The reverse flow monitoring shall be coordinated with the flow meter requirements and provisions for provide a reverse flow status.

3. Software Interlocks

   a. LSSL-1003 and LSSL 1006 will disable and prevent the pumps from operating until the low-low wetwell condition is removed for a user adjustable time or reset by the operator.
b. FSLL-1002 will disable and prevent the pumps from operating until the low-low flow condition is removed and reset by the operator.

c. PSHH-1003 will disable and prevent the pumps from operating until the high-high pressure shutdown alarm is removed and reset by the operator.

d. JAL-1001 power/phase failures will shutdown the motor and prevent the motor from operation until the condition is removed for a user adjustable time or reset by the operator.

1.04 East Spratte Pump Station

A. OVERVIEW

1. The East Spratte pumps are controlled by the PLC system based on time of day, desired level and total accumulated flow control.

2. Pumps are provided with a fixed or auto alternation routine based on a 1, 2 or Auto selection at the SCADA or Local OIP. The VFD shall always be the Lead Pump.

3. Pump(s) are controlled automatically when the local HOA switches YIA-10X0 where X denotes the pump number are in auto. The lag pump will start based on pressure.

B. FUNCTION BLOCKS

1. Process Blocks
   a. PIT-1001 Discharge Pressure
   b. FIT-1002 Discharge Flow
   c. LIT-1003 Wetwell Level
   d. SIT-1010 VFD Speed

2. Alarm Blocks
   a. LSL-1003 Low Wetwell (warning)
   b. LSLL-1003 Low Low Wetwell (Shutdown)
   c. PSH-1001 High Discharge PSI (warning)
   d. PSHH-1001 High-High Discharge PSI (Shutdown)
   e. FSL-1002 Low Flow (warning)
   f. FSLL-1002 Low-Low Flow (Shutdown)
3. Equipment Blocks
   a. PMP-1010 Pump/Motor #1
   b. PMP-1020 Pump/Motor #2
   c. UPS-1020 Uninterruptible Power Supply

C. LOOP-1002 STATION FLOW

1. General
   a. The pump station pump(s) are controlled based on the desired discharge station flow or station pressure. The pumps are enabled for operation based on the following modes of control:

   1) SCADA manual – Pumps are started/stopped by the operator and operate to maintain the desired station flow by modulating the discharge gate position. Pumps continue to operate until stopped by the operator or a hardware/software interlock is activated.

   2) Time of day – Pump(s) are started/stopped and operate to maintain a desired station flow or pressure (user selectable from SCADA) by modulating the VFD Speed.

   3) Time of Day Start/Flow Total Stop and operate to maintain a desired station flow by modulating the discharge gate position.

   4) SCADA Manual Start/Flow Total Stop and operate to maintain a desired station flow by modulating the discharge gate position.

   5) Pressure control start and stop based on pressure and maintain either desired flow or desired pressure.

   b. Accumulated Flow Control

   1) When the accumulated flow control is enabled, the flow will be accumulated and the pumps stopped when any of the modes of control are enabled, with exception to SCADA Manual in this
mode an alarm message will be generated that will indicate that the desired total flow has been exceeded.

2) If the accumulated flow control is disabled, the flow will not accumulate for the pumps when they are operated in SCADA manual mode.

3) In accumulated flow control mode the Time of Day/Start/Flow Total Stop and SCADA Manual Flow Total Stop modes are enabled and selectable by the operator based on the desired mode of operation.

4) When the total desire flow has been achieved the pumps will be stopped, the Accumulated flow control disabled and an alarm/status message Pumps Stopped on Desired total flow will be generated. Once acknowledged by the operator, the accumulator can be reset and then enabled.

5) The graphic display shall indicate the following:
   a) Total Desired Flow
   b) Total Accumulated Flow – this accumulator is different than the station flow totalizers (Non-resettable and resettable). And is reset to zero when reset by the operator.
   c) Remaining Flow Total – Count down from the Total Desired Flow value.

2. Flow Control Mode
   a. The operator shall select the desired flow setpoint. The pumps shall be automatically started and stopped based on the pressure and then maintain desired flow requirements for all modes with the exception of SCADA manual start/stop mode.
   b. In SCADA manual start/stop mode the operator shall manually start the pumps and adjust the flow setpoint accordingly.
   c. If the desired flow cannot be maintained by the selected number of pumps for a user adjustable delay. A setpoint deviation alarm shall be generated.

3. Pressure Control
   a. When the pressure decreases below the lead pump VFD start setpoint PCLK-1X01 and the pump start delay setpoint has expired, the lead pump is started.
1) The VFD will ramp to a minimum speed for a user adjustable setpoint and then modulate to maintain the desired flow or pressure selected by the operator.

b. When the pressure decreases below the lag pump start setpoint PCML-1X01 and the pump start delay setpoint has expired, the lag pump is started.

1) When the lag pump is started the VFD speed shall be driven to the minimum speed setpoint for a user time and then begin to modulate after the lag pump is running to maintain the desired flow or pressure.

c. When the pressure increases above the lead pump stop setpoint PCHK-1X01 and the pump start delay setpoint has expired, the lead pump is stopped.

1) The VFD will hold its last speed for a user setpoint and then modulate to maintain the desired flow or pressure.

d. When the pressure increases above the lag pump stop setpoint PCMH-1X01 and the pump start delay setpoint has expired, the lag pump is stopped.

4. Level Control

a. When the increase above the lead pump VFD start setpoint LCHK-1X01 and the pump start delay setpoint has expired, the lead pump is started.

1) The VFD will ramp to a minimum speed for a user adjustable setpoint and then modulate to maintain the desired flow or pressure selected by the operator.

b. When the Level increase above the lag pump start setpoint PCMH-1X01 and the pump start delay setpoint has expired, the lag pump is started.

1) When the lag pump is started the VFD speed shall be driven to the minimum speed setpoint for a user time and then begin to modulate after the lag pump is running to maintain the desired flow or pressure.

c. When the level decrease below the lead pump stop setpoint PCLK-1X01 and the pump start delay setpoint has expired, the lead pump is stopped.

1) The VFD will hold its last speed for a user setpoint and then modulate to maintain the desired flow or pressure.
d. When the level decreases below the lag pump stop setpoint PCML-1X01 and the pump start delay setpoint has expired, the lag pump is stopped.

5. Software Interlocks

a. LSL-1003 will reduce the speed of the VFD by a user adjustable percentage to allow for the wetwell level to recover. This reduced speed control will remain in operation for a user adjustable setpoint time or until the wetwell level has recovered for a user adjustable setpoint.

b. LSLL-1003 will disable and prevent the pumps from operating until the low-low wetwell condition is removed for a user adjustable time or reset by the operator.

c. FSLL-1002 will disable and prevent the pumps from operating until the low-low flow condition is removed and reset by the operator.

d. PSHH-1003 will disable and prevent the pumps from operating until the high-high pressure shutdown alarm is removed and reset by the operator.

e. JAL-1001 power/phase failures will shutdown the motor and prevent the motor from operation until the condition is removed for a user adjustable time or reset by the operator.

1.05 ARVADA PUMP STATION (Phase 3 Future)

A. OVERVIEW

1. The Arvada Pump Station is comprised of both well pumps and discharge pumps that are controlled by the PLC system based on time of day, desired flow and total accumulated flow control.

2. Discharge Pumps are provided with a fixed or auto alternation routine based on a 1, 2, 3 or Auto selection at the SCADA or Local OIP. When either 1, 2 or 3 is selected that pump will always be the lead pump. In AUTO mode the pumps alternate automatically.

3. Well Pumps are started/stopped based on the flow requirements and grouped together based on a common flow header.

4. Pump(s) are controlled automatically when the local HOA switches YIA-10X0 where X denotes the pump number are in auto.

B. FUNCTION BLOCKS

1. Process Blocks

a. PIT-1001 Station Discharge Pressure
b. FIT-1002 Station Discharge Flow
c. FIT-1032 Well Flow 1
d. FIT-1052 Well Flow 2
e. LIT-1003 Station Wetwell Level
f. LIT-1011 Well #1 Level
g. SIT-1010 Well Pump #1 Speed
h. LIT-1021 Well #2 Level
i. SIT-1020 Well Pump #2 Speed
j. LIT-1031 Well #3 Level
k. SIT-1030 Well Pump #4 Speed
l. LIT-1041 Well #4 Level
m. SIT-1050 Well Pump #5 Speed
n. LIT-1051 Well #5 Level
o. SIT-1040 Well Pump #3 Speed
p. SIT-1110 Discharge Pump #1
q. SIT-1120 Discharge Pump #2
r. SIT-1130 Discharge Pump #3

2. Alarm Blocks
   a. LSL-1003 Low Wetwell (warning)
   b. LSLL-1003 Low Low Wetwell (Shutdown)
   c. LSLL-1005 Vault Flooding
d. LSLL-1006 Low Low Wetwell Float (Shutdown)
e. PSH-1001 High Discharge PSI (warning)
f. PSHH-1001 High-High Discharge PSI (Shutdown)
g. FSL-1002 Low Flow (warning)
h. FSL-1002 Low-Low Flow (Shutdown)
i. YAF-1010 Pump #1 Failure
j. YAF-1020 Pump #2 Failure
k. YAF-1030 Pump #3 Failure
l. YAF-1040 Pump #4 Failure
m. JAL-1901 Power/Phase Failure
n. XXX-1902 UPS Alarms
o. YIZ-1801 Site Intrusion
p. XA-2000 Communications Failure
q. TSL-1008 Lake Temperature Low (Warning)
r. TSH-1009 Lake Temperature High (Warning)

3. Equipment Blocks
   a. PMP-1010 Variable Speed Well Pump/Motor #1
   b. PMP-1020 Variable Speed Well Pump/Motor #2
c. PMP-1030 Variable Speed Well Pump/Motor #3
d. PMP-1040 Variable Speed Well Pump/Motor #4
e. PMP-1050 Variable Speed Well Pump/Motor #5
   f. PMP-1110 Variable Speed Pump/Motor #1
g. PMP-1120 Variable Speed Pump/Motor #2
   h. PMP-1130 Variable Speed Pump/Motor #3
   i. PMP-1210 MCC Screen Pump
   j. UPS-1020 Uninterruptible Power Supply
   k. JIT-1902 Power Meter

C. LOOP-1002 STATION FLOW
   1. General
      a. The pump station pump(s) are controlled based on the desired
discharge station flow. The pumps are enabled for operation based
on the following modes of control:
1) SCADA manual – Pumps are started/stopped by the operator and operate to maintain the desired station flow by modulating the discharge gate position. Pumps continue to operate until stopped by the operator or a hardware/software interlock is activated.

2) Time of day – Pump(s) are started/stopped and operate to maintain a desired station flow by modulating the discharge gate position.

3) Time of Day Start/Flow Total Stop and operate to maintain a desired station flow by modulating the discharge gate position.

4) SCADA Manual Start/Flow Total Stop and operate to maintain a desired station flow by modulating the discharge gate position.

b. Accumulated Flow Control

1) When the accumulated flow control is enabled, the flow will be accumulated and the pumps stopped when any of the modes of control are enabled, with exception to SCADA Manual in this mode an alarm message will be generated that will indicate that the desired total flow has been exceeded.

2) If the accumulated flow control is disabled, the flow will not accumulate for the pumps when they are operated in SCADA manual mode.

3) In accumulated flow control mode the Time of Day/Start/Flow Total Stop and SCADA Manual Flow Total Stop modes are enabled and selectable by the operator based on the desired mode of operation.

4) When the total desire flow has been achieved the pumps will be stopped, the Accumulated flow control disabled and an alarm/status message Pumps Stopped on Desired total flow will be generated. Once acknowledged by the operator, the accumulator can be reset and then enabled.

5) The graphic display shall indicate the following:

   a) Total Desired Flow

   b) Total Accumulated Flow – this accumulator is different than the station flow totalizers (Non-resettable and resettable). And is reset to zero when reset by the operator.

   c) Remaining Flow Total – Count down from the Total Desired Flow value.

2. Flow Control
a. The operator shall select the desired flow setpoint. The value of the flow setpoint shall determine the number of pumps required to meet the desired flow and stage the pumps on with an adjustable sequential delay between pump starts.

b. The pumps shall be automatically started and stopped based on the desired flow requirements for all modes with the exception of SCADA manual start/stop mode.

c. In SCADA manual start/stop mode the operator shall manually start the pumps and adjust the flow setpoint accordingly. The control program shall provide indication as to the number of pumps required based on the flow rate to assist the operator in selecting the number of pumps.

d. If the desired flow cannot be maintained by the selected number of pumps for a user adjustable delay. A setpoint deviation alarm shall be generated.

3. Software Interlocks

a. LSLL-1003 and LSLL 1006 will disable and prevent the pumps from operating until the low-low wetwell condition is removed for a user adjustable time or reset by the operator.

b. LSL-10X1 well level shall generate a warning alarm and reduce the speed of the pump by a user adjustable percentage until the alarm is removed for a user adjustable time.

c. LSLL-10X1 will disable and prevent the associated pump from operating until the low-low wetwell condition is reset by the operator.

d. FSLL-1002 will disable and prevent the discharge pumps from operating until the low-low flow condition is removed and reset by the operator.

e. FSLL-1032 will disable and prevent the associated well pumps from operating until the low-low flow condition is removed and reset by the operator.

f. FSLL-1052 will disable and prevent the associated well pumps from operating until the low-low flow condition is removed and reset by the operator.

g. PSHH-1003 will disable and prevent the pumps from operating until the high-high pressure shutdown alarm is removed and reset by the operator.
h. JAL-1001 power/phase failures will shutdown the motor and prevent
the motor from operation until the condition is removed for a user
adjustable time or reset by the operator.

1.06 BURLINGTON DITCH

A. OVERVIEW

1. General

a. The Burlington Ditch high and low flow gates are controlled by the
PLC system based on time of day and desired flow control.

B. FUNCTION BLOCKS

1. Process Blocks

a. PIT-1001 Discharge Pressure
b. FIT-1002 Station Flow
c. LIT-1010 Wetwell Level and FIT-1010 calculated flow
d. LIT-1020 Wetwell Level and FIT-1020 calculated flow
e. ZIT-1010 Low Flow Gate Position
f. ZIT-1020 High Flow Gate Position

2. Alarm Blocks

a. LSL-1010 Low Flow Wetwell Level Low (warning)
b. LSLL-1010 Low Low Wetwell Level Low-Low (Shutdown)
c. LSL-1020 High Flow Wetwell Level Low (warning)
d. LSLL-1020 High Wetwell Level Low-Low (Shutdown)
e. LSH-1010 Low Flow Wetwell Level High (warning), initiate rack cycle
f. LSHH-1010 Low Low Wetwell Level High-High (Shutdown)
g. LSH-1020 High Flow Wetwell Level High (warning), initiate rack cycle
h. LSHH-1020 High Wetwell Level High-High (Shutdown)
i. LSL-1005 Vault Flooding
j. LSLL-1012 Low Flow Wetwell High Float (Shutdown)
k. LSSL-1022 High Flow Wetwell High Float (Shutdown)
l. LSSL-1002 Inlet Chamber High Float (Shutdown)
m. LSSL-1003 Outlet Chamber High Float (Shutdown)
n. PSH-1001 High Discharge PSI (warning)
o. FSL-1001 Low Flow (warning)
p. FSLL-1001 Low-Low Flow (Shutdown)
q. YAF-1010 Low Flow Gate Failure
r. YAF-1020 High Flow Gate Failure
s. YAF-1101 Hydraulic Failure
t. YAF-1201 Check Gate Failure
u. YAF-1301 Screenings Failure
v. JAL-1901 Power/Phase Failure
w. XXX-1902 UPS Alarms
x. YIZ-1801 Site Intrusion
y. XA-2000 Communications Failure

3. Equipment Blocks
a. GTE-1010 Low Flow Gate
b. GTE-1020 High Flow Gate
c. GTE-1101 Hydraulic Gate
d. SCN-1301 System Screen
e. VLV-1201 Check Valve
f. UPS-1020 Uninterruptible Power Supply

C. LOOP-1002 STATION FLOW

1. General
a. The gates are controlled based on the desired discharge station flow. The gates are enabled for operation based on the following modes of control:
1) SCADA manual open/close and operate to maintain the desired station flow by modulating the discharge gate position.

2) SCADA manual position control gates are open/closed to a percentage output and remain at the position until closed or the position is changed by the operator. All interlocks are operational in SCADA manual position control.

3) Time of day start/stop and operate to maintain a desired station flow by modulating the discharge gate position.

4) Time of Day Start/Flow Total Stop and operate to maintain a desired station flow by modulating the discharge gate position until the total desired flow is reached.

5) SCADA Manual Open/Flow Total Close and operate to maintain a desired station flow by modulating the discharge gate position.

6) Gates(s) are controlled automatically when the local HOA switches YIA-1010, 1020, 1030 and YIA-1040 are in auto.

2. Flow Control

a. The operator shall select the desired flow setpoint. The value of the flow setpoint shall determine which gate(s) are required to meet the desired flow and open the associated gate(s) to meet the desired flow or position value.

b. The gates shall be modulated based on the desired flow requirements for all modes with the exception of SCADA manual position control mode.

c. In SCADA manual open/close mode the operator shall manually open and adjust the flow setpoint accordingly. The control program shall provide indication as to the gate(s) required based on the flow rate to assist the operator in selecting appropriate control actions.

d. If the desired flow cannot be maintained by the selected gate(s) for a user adjustable delay. A setpoint deviation alarm shall be generated

D. Software Interlocks

1. LSHH-1010, 1012 and 1020, 1022 will close the associated gate, disable control and prevent the gates from operating until the wetwell condition is reset by the operator.

2. FSLL-1002 will disable and prevent the pumps from operating until the low-low flow condition is removed and reset by the operator.
3. JAL-1001 power/phase failures will shutdown the motor and prevent the motor from operation until the condition is removed for a user adjustable time or reset by the operator.

E. Screening control

1. System screenings will operate based on the existing control requirements with the addition of the following:
   a. On a High Wetwell Level Warning for either gate a screenings cycle will be initiated.
   b. On a Low Flow Condition a screenings cycle will be initiated.
   c. On a system start-up all gates closed a screenings cycle will be initiated prior with the gate controls.
   d. Screenings cycle shall be initiated based on a user adjustable cycle delay.

F. Hydraulic Unit and Check Gate Controls

1. Prior to operation of the Check Gate the hydraulic unit is started and confirmed to be operational before the check gate is raised or lowered either in the SCADA manual or PLC automatic modes.

1.07 ZONE 3/4 PUMP STATION

A. OVERVIEW

1. The Zone 3 and Zone 4 pumps are controlled by the PLC system based on System Pressure and/or time of day. Each zone is controlled independent of each other based on their own control setpoints.

2. Pumps are provided with a fixed or auto alternation routine based on a 1, 2, 3 or Auto selection at the SCADA or Local OIP. When 1, 2 or 3 is selected that pump will always be the lead pump. In AUTO mode the pumps alternate automatically.

3. Pump(s) are controlled automatically when the local HOA switches YIA-10X0 where X denotes the pump number are in auto.

B. FUNCTION BLOCKS

1. Process Blocks
   a. PIT-1301 Zone 3 Discharge Pressure
   b. FIT-1302 Zone 3 Discharge Flow
   c. PIT-1401 Zone 4 Discharge Pressure
2. Alarm Blocks

a. PSLL-1001 Low Suction PSI (Station Shutdown)
b. TSLL-1002 Station Temperature Low-Low
c. PSH-1301 Zone 3 High Discharge PSI (warning)
d. PSHH-1301 Zone 3 High-High Discharge PSI (Shutdown)
e. PSH-1401 Zone 4 High Discharge PSI (warning)
f. PSHH-1401 Zone 4 High-High Discharge PSI (Shutdown)
g. FSL-1302 Zone 3 Low Flow (warning)
h. FSLL-1302 Zone 3 Low-Low Flow (Shutdown)
i. FSL-1402 Zone 4 Low Flow (warning)
j. FSLL-1402 Zone 4 Low-Low Flow (Shutdown)
k. YAF-1310 Zone 3 Pump #1 Failure
l. YAF-1320 Zone 3 Pump #2 Failure
m. YAF-1330 Zone 3 Pump #3 Failure
n. YAF-1340 Zone 3 Pump #4 Failure
o. YAF-1410 Zone 4 Pump #1 Failure
p. YAF-1420 Zone 4 Pump #1 VFD Failure
q. YAF-1420 Zone 4 Pump #2 Failure
r. YAF-1420 Zone 4 Pump #2 Failure
s. YAF-1430 Zone 4 Pump #3 Failure
t. YAF-1440 Zone 4 Pump #4 Failure
u. YAF-1440 Zone 4 Pump #4 VFD Failure
v. YAF-1940 Zone 4 Generator Failure
w. JAL-1901 Power/Phase Failure
x. XXX-1902 UPS Alarms
y. YIZ-1801 Site Intrusion
z. XA-2000 Communications Failure

3. Equipment Blocks
   a. PMP-1310 Zone 3 Constant Speed Pump/Motor #1
   b. PMP-1320 Zone 3 Constant Speed Pump/Motor #2
   c. PMP-1330 Zone 3 Constant Speed Pump/Motor #3
   d. PMP-1340 Zone 3 Constant Speed Pump/Motor #3
   e. PMP-1410 Zone 4 Variable Speed Pump/Motor #1
   f. PMP-1420 Zone 4 Constant Speed Pump/Motor #2
   g. PMP-1430 Zone 4 Constant Speed Pump/Motor #3
   h. PMP-1440 Zone 4 Constant Speed Pump/Motor #3
   i. UPS-1020 Uninterruptible Power Supply
   j. GEN-1930 Zone 3 Generator
   k. GEN-1940 Zone 4 Generator

C. LOOP-1301/1401 STATION PRESSURE

1. General
   a. The pump station pump(s) are controlled based on the desired zone pressure band. The pumps are enabled for operation based on the following modes of control:

      1) SCADA manual – Pumps are started/stopped by the operator. Pumps continue to operate until stopped by the operator or a hardware/software interlock is activated.

      2) VFD Control – Pumps shall be manually started/stopped by the operator. The operator shall select the speed via a slide bar and/or speed entry command to operate the VFD at a desired speed. The operator shall select VFD or Normal mode control via the SCADA where a bypass starter is used in conjunction with the VFD.

      3) Time of day – When the time of day window(s) are enabled the pump station is enabled for operation and the lead pump is started immediately provided that the pressure is less than the lead pump stop value. This allows for a pump to start in anticipation of
demand. When the pump is started it will run for a minimum time that is user adjustable. The high pressure and no flow interlocks will override this timer and stop the pumps.

4) Automatic Control – When selected for PLC auto the pump station pumps are controlled by the zone pressure.

2. Pressure Control

   a. When the pressure decreases below the lead pump start setpoint PCLK-1X01 and the pump start delay setpoint has expired, the lead pump is started.

   b. When the pressure decreases below the lag pump start setpoint PCML-1X01 and the pump start delay setpoint has expired, the lag pump is started.

   c. When the pressure decreases below the lag-lag pump start setpoint PCLL-1X01 and the pump start delay setpoint has expired, the lag pump is started.

   d. When the pressure increases above the lead pump stop setpoint PCHK-1X01 and the pump start delay setpoint has expired, the lead pump is stopped.

   e. When the pressure increases above the lag pump stop setpoint PCMH-1X01 and the pump start delay setpoint has expired, the lag pump is stopped.

   f. When the pressure increases above the lag pump stop setpoint PCHH-1X01 and the pump start delay setpoint has expired, the lag-lag pump is stopped.

3. Software Interlocks

   a. PSLL-1001 low-low suction pressure will disable and prevent the pumps from operating until the low-low suction pressure condition is removed for a user adjustable time or reset by the operator.

   b. FSLL-1302 will disable and prevent the Zone 3 pumps from operating until the low-low flow condition is removed and reset by the operator.

   c. FSLL-1402 will disable and prevent the Zone 4 pumps from operating until the low-low flow condition is removed and reset by the operator.

   d. PSHH-1301 will disable and prevent the Zone 3 pumps from operating until the high-high pressure shutdown alarm is removed and reset by the operator.
e. PSHH-1401 will disable and prevent the Zone 4 pumps from operating until the high-high pressure shutdown alarm is removed and reset by the operator.

f. JAL-9001 power/phase failures will shutdown the motor(s) and prevent the motor(s) from operation until the condition is removed for a user adjustable time or reset by the operator.

1.08 PRESSURE REDUCING STATION (Typical)

A. OVERVIEW

1. General

   a. The pressure reducing stations are monitored by SCADA

2. FUNCTION BLOCKS

   a. Process Blocks

   b. PIT-2001 Downstream Pressure

   c. PIT-2002 Upstream Pressure

3. Alarm Blocks

   a. LSH-2003 Vault Flooding

   b. YIZ-0001 Vault Intrusion

   c. JAL-1001 Power/Phase Failure

   d. XA-9000 Communications Failure

1.09 DIVERSION STRUCTURE (Typical)

A. OVERVIEW

1. General

   a. The diversion structures flow is monitored by SCADA and totalized to provide for SCADA monitoring and reporting functionality.

   b. The flow is established based on a level signal provided by an ultrasonic level transmitter. The PLC shall convert the level signal to a flow signal based on formulas provided by the Owner.

   c. Provisions for manual gate control are provided to allow for SCADA operations to manually open and close the gate.
2. FUNCTION BLOCKS
   a. Process Blocks
   b. FIT-5001 - Station Flow
   c. FQIT-5001 – Station Flow Total (Gallons and Acre Feet)
   d. ZIT-5010 - Gate Position 0 – 100 %

3. Alarm Blocks
   a. FA-5001 Flow Transmitter Alarm
   b. YIZ-0001 Intrusion
   c. JAL-1001 Power/Phase Failure
   d. XA-9000 Communications Failure
   e. ZSC-5010 Gate Not Ready

4. Equipment Blocks
   a. SG-5010 Motorized Gate

1.10 RAW WATER SITES (typical)

A. OVERVIEW

1. General
   a. Raw Water Sites consist of stilling wells and intertie gates that are monitored and controlled by SCADA to monitor lake level and transfer water between lakes and the river.
   b. Each site may consist of a single well, intertie gate or a combination of gates and wells as indicated on the drawings.
   c. Gates are manually controlled by SCADA to open and close to a desired position.
   d. Stilling well level is monitoring by the PLC and provides level information to the SCADA system for monitoring and reporting functions.

B. FUNCTION BLOCKS

1. Process Blocks
a. LIT-5001 – Stilling Well Level

b. FIT-XXX – Intertie Flow

2. Alarm Blocks

a. LA-5001 Level Transmitter Alarm

b. FA-5001 Flow Transmitter Alarm

c. YIZ-0001 Intrusion

d. JAL-1001 Power/Phase Failure

e. XA-9000 Communications Failure

f. ZSC-5010 Gate Failure

3. Equipment Blocks

a. SG-XXXX Motorized Gate

b. UPS

C. South Tani

1. The South Tani site consists of several interties and the south tani lake level. This site acts as a repeater site for the east/west gravel lakes area and provides for monitoring and control of the gates.

2. The gates shall be manually controlled locally and from SCADA. The operator shall be able to open/close the gates and set them at a desired position.

D. South Tani Return

1. The South Tani Return site consists of two motorized gates and associated flow meters that allow for water flow between the South Tani Lake and the river.

2. The gates shall be manually controlled locally and from SCADA. The operator shall be able to open/close the gates and set them at a desired position.

3. The operator may also establish a desired flow and the gates operated to maintain the desired flow.

END OF SECTION
PART 1 GENERAL

1.00 SCOPE OF WORK

A. The Contractor shall install, ready for use, the electrical systems as specified herein and shown on the Contract Drawings. This document describes the function and operation of the system and particular components, but does not necessarily describe all necessary devices.

B. All components and devices shall be furnished and installed as necessary to provide a complete operable and reliable system for accomplishing the functions and meeting the performance set forth hereinafter.

C. Furnish all required labor, materials, project equipment, tools, construction equipment, safety equipment, transportation, test equipment, incidentals and services to provide a complete and operational electrical system as shown on the Contract Drawings, included in these specifications, and necessary for a fully operating facility.

D. The major areas in the scope of work shown on Contract drawings which includes but is not necessarily limited to the furnishing, installation and commissioning are:

1. Phase 2A – Moscad RTU Replacement
   a. Furnish and Install replacement RTU panels
   b. Modify existing control panels
   c. Furnish and Install Instruments

2. Phase 2B - Pressure Reducing Station’s RTU Panel and Antenna Mast
   a. Furnish and Install RTU Panel
   b. Furnish and Install Antenna Mast
   c. Furnish and Install Photovoltaic System
   d. Furnish and Install Pressure Transmitter and Associated Instrumentation

3. Phase 2C- Diversion Structures
   a. Furnish and Install RTU Panel
   b. Furnish and Install Antenna Mast
   c. Furnish and Install Photovoltaic System
   d. Furnish and Install Flow Instrumentation

4. Phase 2D - Raw Water Stilling Well Monitoring Stations and Antenna Mast
   a. Furnish and Install RTU Panel
   b. Furnish and Install Antenna Mast
   c. Furnish and Install Photovoltaic System
   d. Furnish and Install Flow and Level Instrumentation

5. All Phases of work shall include the following:
a. Modify Existing Radio and Antenna system
b. Furnish and install conduits, grounding system and the field interconnection wiring between the field devices, and electrical equipment enclosures.
c. Trenching, backfilling, compaction and resurfacing for all new underground conduit routes.
d. Furnish and install all mounting frames, brackets and assemblies for the installation of control equipment, antenna masts, field devices and field instruments.
e. Cutting, coring and welding at facilities to route conduits and install equipment.
f. Furnish and install all conduit raceways complete.
g. Modification of Existing Control Systems.
h. PLC and SCADA System Programming.
i. Site Grounding.

E. The following specifications incorporate specific equipment and devices that are preferred by the Owner because of their serviceability, because of the local availability of labor, parts and materials, or because of the ability of the Owner to umbrella the equipment under existing maintenance contracts.

F. All electrical equipment and materials, including installation and testing, shall conform to the applicable codes and standards listed in this and other sections. All electrical work shall conform to the latest National Electric Code (NEC) issue. Nothing on the drawings or in the specifications shall be construed to permit work or materials not conforming to these codes and standards.

1.01 RELATED WORK IN OTHER SECTIONS

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

B. The Contractor is required to furnish and install all equipment covered in other sections and divisions of the contract. The Contractor shall also install all equipment supplied by the Control System Supplier (CSS). The following are covered in other sections of related Divisions and Sub-Sections in the Contract Documents and are part of Division 16.

1. Division 01
2. Section 13300 Instrumentation and Control.
3. Section 13320 Quality Control
4. Section 13330 Field Instrumentation
5. Section 13340 Control Panels.
6. Section 13350 PLC Systems.
7. Section 13360 Wireless Communications
8. Section 1337X – Applications Programming Sections
9. Section 16600 Photovoltaic System
10. Division 17

C. The contents of this section apply to all "electrical and instrumentation" equipment suppliers and manufacturers providing materials and doing work listed in other sections as required.

1.02 QUALIFICATIONS

A. It is the intent of this Division that the complete responsibility for management and installation of the electrical and instrumentation required for this project be by the Electrical Contractor. This responsibility includes, but not limited to, supervision and coordination of work performed by all suppliers of Division 16.

B. It is the intent that a qualified Electrical Contractor/Control System Supplier be qualified in providing the systems and installations specified. The Contractor shall submit the qualification(s) for the Electrical Contractor and Control System Supplier with the bid indicating that the minimum qualifications are met.

C. It is the intent of the Owner to have the CSS act as the prime Contractor and as such must have an Electrical Contractors License in the State of Colorado. The City will consider an Electrical Contractor as prime that utilizes the CSS as a Subcontractor provided that the following conditions are met:

1. Joint Venture or Partnership with established history prior to bid date and all associated documents for verification submitted with the bid. In this case the CSS shall act has the Project Manager.

2. Electrical Contractor has a project manager with at least 10 years of experience directly related to the management of SCADA system installations for water and wastewater municipalities and a history of working with the Control System Supplier. Resume with at least three references and working history with CSS shall be submitted with the bid.

D. Electrical Contractor

1. The Electrical Subcontractor shall meet the following minimum qualifications:
   a. Has regularly engaged in similar electrical contracting for the Municipal Water and Wastewater Industry.
   b. Has successfully performed work of similar or greater complexity on at least two previous projects under one company name and under the present company name.
   c. Has been actively engaged in the type of electrical and instrumentation work specified in this Division for a minimum of two years.
   d. Has a current Electrical Contractor's License.

E. Control System Supplier (CSS)

1. The CSS shall meet the following minimum qualifications:
   a. Has regularly engaged in similar systems for the Municipal Water and Wastewater Industry for a period of 5 years.
   b. Has successfully performed work of similar or greater complexity on at least five previous projects under one company name and under the present company name.
c. Has certified or 10 years plus experience, Modicon Momentum and Quantum PLC Programming Staff.

d. Has certified or 10 years plus experience, Intellution Ifix Programming Staff.

e. Has a Registered Electrical Engineer licensed in the State of Colorado on Staff, Out of state registration shall be considered with application for local state registration submitted with the Bid.

f. Has a current Electrical Contractor’s License in State or meets the requirements of C above.

g. Has ISA certified technicians on staff, Level 2 minimum.

1.03 CONTRACT DOCUMENTS

A. The Contract drawings and specifications are intended to be descriptive of the type of electrical system to be provided; any error or omissions of detail in either shall not relieve the Contractor from the obligations there under to install in correct detail any and all materials necessary for a complete operational system, at no additional cost.

B. The Contract drawings are generally diagrammatic; exact locations of electrical products shall be verified in the field with the Engineer. Except where special details on drawings are used to illustrate the method of installation of a particular piece or type of equipment or materials, the requirements or descriptions in this section shall take precedence in the event of conflict.

C. Location at facilities of new equipment, inserts, anchors, panels, pull boxes, conduits, stub-ups, and fittings for the electrical system are to be determined by the Contractor and Engineer at time of installation. Contractor shall make minor adjustments to locations of electrical equipment required by existing conditions and coordination with other trades at no additional cost.

D. The Contractor shall examine the architectural, mechanical, structural, and electrical and telecommunications equipment provided under other Sections of this Contract in order to determine the exact routing and final terminations for all conduits and cables. The exact locations and routing of cables and conduits shall be governed by structural conditions, physical interferences, and the physical location of wire terminations on equipment. Conduits shall be stubbed up as near as possible to equipment terminals.

E. All equipment shall be installed and located so that it can be readily accessed for operation and maintenance. The Engineer reserves the right to require minor changes in location of equipment, without incurring any additional costs.

F. The Contractor shall maintain a neatly and accurately marked full size set of Contract Drawings recording the as built locations and layout of all electrical and instrumentation equipment, routing of raceways, junction and pull boxes, and other diagram or drawing changes.

1.04 COORDINATION

A. The Contractor shall coordinate the electrical work with the other trades, code authorities, utilities, and the Engineer; with due regard to their work, towards promotion of a rapid completion of the project. If any cooperative work must be altered due to lack of proper supervision of such, or failure to make proper provisions, then the Contractor shall bear expense of such changes as necessary to be made in work of others.
B. Manufacturer’s directions and instructions shall be followed in all cases where such is not shown on the Contract Drawings or herein specified.

C. The Contractor shall cease work at any particular point, temporarily, and transfer his operations to such portions of work as directed, when in the judgment of the Agency it is necessary to do so.

D. The Contractor shall schedule a minimum of one (1) mandatory Coordination Meeting(s) during the initial and submittal phase of the project. The meetings shall be held at the jobsite and include, as a minimum, attendance by the Contractor, and Engineer.

1. The meeting shall be held after the review of the first comprehensive submittal has been completed by the Owner. The purpose of the meeting is to discuss comments made on the submittal package, to update the project schedule, and coordinate the testing, training, and installation phases of the project.

1.05 UTILITY SERVICES COORDINATION

A. Service Power

1. Sites require utility service connection shall be installed in accordance with the serving utility’s requirements. Installation shall be in conformance with the Xcel Energy Standard for Electrical Installation and Use. The standards document is considered a part of the specifications requirements and shall be adhered to for all utility services construction.

2. Sites indicated on the Contract Drawing that will require service connection shall be coordinated by the Contractor. The Contractor shall submit all required documents for approval by the utility. The Contractor shall notify the Owner all schedules associated with applying for and obtaining power at the indicated locations.

3. Coordinate all work with the serving Power Utility, for the work shown on Contract Drawings. The Contractor shall obtain the required inspections and provide the following:

   a. Submit to the Power Utility the proposed metering details and utility service applications. Provide a written statement from the Utility that shows approval of the proposed metering.

   b. Coordination of utility service access. The Contractor shall coordinate service location, conduit routing and installation requirements for utility service connection.

   c. All work associated with material and installation for utility power service not paid by the Utility shall be borne by the Contractor. The Contractor shall provide and install all material, conduits, wiring, pull ropes, pole risers, transformer pads, bollards, etc. as shown on utility engineered drawings for a new power service.

   d. All fees and charges of the Power Utility for service hook-up will be paid by the Owner. The Contractor shall coordinate the submission of the utility service application and the applicable service requirements for the Utility Metering Panel.

B. Telephone Service
1. Coordinate all work with the serving Telephone Utility for the work shown on Contract Drawings. The Contractor shall obtain the required inspections and provide the following:
   a. Coordination of utility service access. The Contractor shall coordinate service location, conduit routing and installation requirements for telephone utility service connection.
   b. All work associated with material and installation for the telephone Utilities not paid by the Utility shall be borne by the Contractor. The Contractor shall provide and install all material, conduits, wiring, pull ropes, pole risers, from the equipment to the point of demarcation.
   c. All fees and charges of the Telephone Utility service hook-up will be paid by the Owner.

C. Scheduling

   1. Schedule within 30 days after award of Contract all service installations and connections with utilities. Delays due to lack of effort by the Contractor which delay the project completion for lack of utility services will not be considered valid and Contract liquidated damages will be assessed.

1.06 SEISMIC/WIND LOADING CALCULATIONS

   A. Submit seismic installation and anchoring calculations for all equipment. Anchoring shall have the capability of withstanding seismic forces per the UBC 1997, Seismic, with applicable area design factors.
   B. Submit equipment-anchoring methods. Include anchoring locations; anchor types, sizes and materials; and minimum anchor embedment depths. All anchors shall be stainless steel.
   C. Seismic anchoring calculations and equipment anchoring requirements are required for all towers, poles, freestanding enclosures, MCC’s, Switchgear, cable tray supports, conduit racking and wall mount enclosures.
   D. Furnish and install all anchoring and support materials required to meet the seismic installation requirements determined by the approved seismic calculations.
   E. A licensed Civil or Structural Engineer registered in the State of Colorado shall perform and stamp all calculations.

1.07 SUPERVISION

   A. The Contractor shall schedule all activities, manage all technical aspects of the project, coordinate submittals and drawings, and attend all project meetings associated with this Section.
   B. The Contractor shall supervise all work in this Section, including the electrical system general construction work, from the beginning to completion and final acceptance.
   C. The Contractor shall supervise and coordinate all work in this Section to insure each phase of the project, submittal, delivery, installation, and acceptance testing, etc. is completed within the allowable scheduled time frames.
D. The Contractor shall be responsible for obtaining, preparing, completing, and furnishing all paper work for this Section; which shall include transmittals, submittals, forms, documents, manuals, instructions, and procedures.

1.08 INSPECTIONS

A. All work or materials covered by the Contract Documents shall be subject to inspection at any and all times by the Owner. If any material does not conform to the Contract Documents, or does not have a favorably reviewed submittal status; then the Contractor shall, within three days after being notified by the Owner, remove said material from the premises; and if said material has been installed, the entire expense of removing and replacing same, including any cutting and patching that may be necessary, shall be borne by the Contractor.

B. Work shall not be closed in or covered over before inspection and approval by the Engineer. All costs associated with uncovering and making repairs where non-inspected work has been performed shall be borne by the Contractor.

C. The Contractor shall cooperate with the Engineer and provide assistance at all times for the inspection of the electrical system under this Contract. The Contractor shall remove covers, provide access, operate equipment, and perform other reasonable work which, in the opinion of the Engineer, will be necessary to determine the quality and adequacy of the work.

1.09 JOB CONDITIONS

A. The Contractor shall make all arrangements and pay the costs thereof for temporary services required during construction of the project, such as temporary electrical power and telephone service. Upon completion of the project, remove all temporary services, equipment, material and wiring from the site as the property of the Contractor.

B. The Contractor shall provide adequate protection for all equipment and materials during shipment, storage and construction. Equipment and materials shall be completely covered with two layers of plastic and set on cribbing six inches above grade so that they are protected from weather, wind, dust, water, or construction operations. Equipment shall not be stored outdoors without the approval of the Engineer. Where equipment is stored or installed in moist areas, such as unheated buildings, etc., provide an acceptable means to prevent moisture damage, such as a uniformly distributed heat source to prevent condensation.

1.10 SUBMITTAL AND DRAWING REQUIREMENTS

A. GENERAL

1. The Contractor shall provide submittals and shall ensure all equipment suppliers provide the submittal documentation required in this section. The major equipment suppliers are the Control System Supplier. Submittals shall be complete, neat, orderly, and indexed. The Contractor shall check all submittals required under this Division for the correct number of copies, adequate identification, correctness, and compliance with the Contract Documents, and initial all copies certifying compliance.
2. The Contractor shall coordinate submittals with the work so that project will not be delayed. This coordination shall include scheduling the different categories of submittals, so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals.

3. No material or equipment shall be allowed at the job site until the submittal for such items has been reviewed by the Engineer and marked "no exceptions taken" or "make corrections noted".

4. Exceptions to the Specifications or Drawings shall be clearly defined by the equipment suppliers. Submittal data shall contain sufficient details so a proper evaluation may be made by the Engineer.

5. The Contractor shall coordinate submittal with the work so that project will not be delayed. This coordination shall include scheduling the different categories of submittal, so that one will not be delayed for lack of coordination with another.

B. The equipment specifications have been prepared on the basis of the equipment first named in the Specifications. The Contractor shall note that the second named equipment, if given, is considered acceptable and equal equipment, but in some cases additional design, options, or modifications may be required to meet Specifications all at no additional cost to the Owner.

1. The decision of the Engineer governs what is acceptable as a substitution. If the Engineer considers it necessary, tests to determine equality of the proposed substitution shall be made, at the Contractor's expense, by an unbiased laboratory that is satisfactory to the Engineer.

2. The Contractor shall submit for approval the proposed drawing format for each type of drawing or diagram specified. The Contractor shall not go into production with the drawings or diagrams for this project until the Engineer has given written approval of the submitted proposed drawing format submittal.

C. SUBMITTAL FORMAT

1. Each submittal shall be bound in a three ring binder, which is sized such that when all material is inserted the binder is not over 3/4 full. Binder construction shall allow easy removal of any page without complete manual disassembly; spiral ring type binders are not acceptable.

2. Each binder shall be appropriately labeled on the outside spine & front cover with the project name, contract number, equipment supplier's name, specification section(s), and major material contained therein.

3. Submittal cover sheet list the project name, contract number and equipment supplier's name, address, phone number, and contact person on the index page.

4. A Table of Contents shall be provided at the inside of the front cover. This index shall itemize the contents of each tab and subtab section. With the exception of general installation materials, all equipment, instruments and major electrical components shall be tabbed.

5. Field equipment shop documents, panel equipment shop documents, drawings, and bill of materials shall be grouped under separate tabs. Shop documents shall be ordered in the same sequence as their corresponding Contract Specification subsection.
6. Bill of Material
   a. Complete Materials list shall be provided at the inside of the front cover. The Contractor shall provide Material list providing name of project, location of equipment, specification section, quantity, description, manufacturer, full part number and tag number.
   b. All spare parts shall be listed separately at the end of the Bill of Materials list. Generic names or part numbers used by a distributor or Systems House are not acceptable; originating manufacturer’s name and part number shall be listed.
   c. Material lists shall be grouped by panels, areas and structures.

7. Data summary sheets shall be provided. Provide a subtab for all shop documents for each individual piece of equipment. Data summary sheets shall be bright yellow or blue for easy identification.

8. The data summary sheets shall have the following information preceding their corresponding shop documents:
   a. Product identification; name used herein and on the Contract Drawings.
   b. The manufacturer's model number, part number or other designation. This shall include the specific numbers of all proposed options.
   c. Tag name/number per the drawings or schedules.
   d. Location of assembly at which it is installed.
   e. Range, span, engineering units, input and output characteristics.
   f. Contract specification subsection number.

9. Drawings that are "C" or "D" size shall be folded with the title block visible and placed in reinforced clear plastic pockets.

10. The submittal documents shall be clearly copied from originals. No FAX copies of documents are allowed. Color copies shall be provided when black and white copies do not show adequate clarity. Shop documents shall include the following:
    a. Complete catalog cuts with full description of equipment. General sales literature will not be acceptable. The part or model number with options to be provided shall be clearly identified. Where more than one item or catalog number appears on a catalog cut, the specific item(s) or catalog numbers(s) proposed shall be clearly identified. Each catalog cut sheet shall be identified with the applicable Section & subsection numbers.
    b. Equipment technical specifications, ratings and listings.
    c. Physical size with dimensions and mounting details.
    d. Quantity and quality requirements for electric power, air, and/or water supply.
    e. Materials of components in contact with or otherwise exposed to the process.
    f. Calibration, performance or accuracy curves.

D. SHOP DRAWINGS
1. All drawings shall be generated with a computer utilizing the AutoCAD 2000 or later drafting package. Standard preprinted drawings simply marked to indicate applicability to the Contract will not be acceptable. Drawings shall be prepared in a professional manner and shall have borders and a title block identifying the project, system, drawing number, AutoCAD file name, project engineer, date, revisions, and type of drawing. Drawings shall be no smaller than 11” x 17” and printed with a laser jet printer or plotted in ink on vellum. The lettering shall be legible and no smaller than 0.075 inch in height.

2. Shop drawings shall be provided with minimum drafting details as illustrated on the Contract drawings. Diagrams shall carry a uniform and coordinated set of wire colors, wire numbers, and terminal block numbers. The shop drawings shall include:

   a. Electrical one line diagrams detailing all devices associated with the power distribution system. The following applicable information or data shall be shown on the one-line diagram: location, size and amperage rating of bus; size and amperage rating of wire or cable; breaker ratings, number of poles, and frame sizes; utility metering, voltage, amperage, number of wires and phases; ground size and connections; neutral size and connections; voltage, amperage and wattage monitoring instruments; power fail and other protective devices; fuse size and type; distribution transformers; panelboards; starters; contactor size and overload range; motor full load amperage of submitted motor and horsepower; rating for miscellaneous loads; etc. Submit of all equipment motor voltage, phase and full load amps provided for this project for verification of accuracy of submitted one line drawings.

   b. Enclosure layout diagrams; show all front panel and backpan devices drawn to scale. Show fabrication methods and details; including material of construction, paint color, support & latching mechanisms, fans & ventilation system, and conduit entrance areas.

   c. Enclosure Wiring Diagrams

3. Interconnection Wiring Diagrams – A point-to-point interconnection wiring diagram shall be furnished for each electrical and instrumentation system, even if one was not shown explicitly on the Contract Drawings. Interconnection drawings shall be prepared for all new and existing conduits indicated on the Contract Drawings or Conduit Schedule. Each interconnection wiring diagram shall include the following as a minimum:

   a. Conduit, raceways and junction boxes.

   b. Labeling to include raceway numbers, raceway size, cable number, wire size, color code, and wire numbers.

   c. Wire routing and termination.

   d. All termination points on the diagram shall be shown with the actual equipment identification terminal number or letter. This identification of terminations includes terminal blocks, junction boxes, all devices, computer I/O points, etc.

   e. Wire and cable routing through conduits, wireways, manholes, handholes, junction boxes, terminal boxes and other electrical enclosures shall be shown with the appropriate equipment labels. All spare wires, cable, and termination points shall be shown. Cable shields shall be shown.

   f. Labeling codes for terminal blocks, terminals, wires, cables, panels, cabinets, instruments, devices, and equipment shall be shown.
g. Schematic symbols ISA and IEEE shall be used for field devices and instruments, showing electrical contacts.

h. Signal and DC circuit polarities shall be shown.

i. Interconnection diagrams shall be submitted and approved by the Engineer for each electrical and instrumentation system. The Contractor shall not pull in any wires into conduits that does not have approved interconnects. If the Contractor pulls in wire without Engineer approval of associated interconnect drawings, the Contractor will not be reimbursed for labor for re-pulling in wires even if there was an error in wire fill or sizing. Also, if the Contractor pulls in wire without Engineer approval of associated interconnect drawings, then all progress payments for that particular area of work will be withheld until approved interconnect drawings are in use.

E. NAMEPLATE SCHEDULES

1. Submit full size drawing of all nameplates and tags, as specified herein, to be used on project. The Engineer has the right to adjust nameplate engraving titles during submittals at no additional cost to the Owner. Submittal to include the following:

   a. Dimensions of nameplate.
   b. Exact lettering and font for each nameplate.
   c. Color of nameplate.
   d. Color of lettering.
   e. Materials of construction.
   f. Method and materials for attachment.
   g. Drawing showing location of nameplate on each panel.

F. PROGRAMMING AND CONFIGURATION SUBMITTALS

1. Provide PLC programming and configuration submittals in conformance with Section 13300, 13340 and Section 13350.

G. SHOP DOCUMENTS

1. Shop documents and drawings shall be submitted for all devices and components in the electrical and instrumentation system. The following items shall have shop documents and drawings submitted for approval:

   a. Utility metering pedestal
   b. Control Panels
   c. General Electrical Installation and Materials
   d. Instrumentation and Control Systems
   e. Motor Control Centers
   f. Electrical Equipment and Materials
   g. Packaged Systems
1.11 OPERATIONS AND MAINTENANCE MANUALS

A. Provide six (6) Operation and maintenance manuals bound in a three ring binder and shall provide at least the following as a minimum:

1. A comprehensive index.
2. A complete "Record" set of favorably reviewed electrical submittals as provided under subsection 1-9 Submittal and Drawing Requirements illustrating all components, piping, and electrical connections.
3. A complete list of the equipment supplied, including serial numbers, ranges, catalog cuts, and pertinent data.
4. Full specifications on each item.
5. Detailed service, maintenance and operation instructions for each item supplied. Schematic diagrams of all electronic devices shall be included. A complete parts list with stock numbers shall be provided on the components that make up the assembly. All of these shall be originals, no copies.
6. No photo copies are allowed of standard published manuals available from manufacturers. All of the hardware and software manuals shall be originals.
7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

B. At the end of the project these manuals shall be updated to show "as-built" conditions.

C. Provide two (2) sets of compact disk (CD) containing all drawings prepared for this project in Autocad format, updated to reflect as-built conditions.

PART 2 PRODUCTS

2.00 QUALITY

A. It is the intent of the Contract Documents to secure the highest quality in all materials and equipment in order to facilitate operation and maintenance of the facility. All equipment and materials shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product.

B. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed and 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. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble free service. Light duty, fragile and competitive grade devices of doubtful durability shall not be used.
C. Products that are specified by manufacturer, trade name or catalog number established a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed by the Engineer prior to installation.

D. Underwriters Laboratories (UL) listing is required for all substituted equipment when such a listing is available for the first named equipment.

E. When required by the Contract Documents or requested by the Engineer, the Contractor shall submit equipment or material samples for test or evaluation. The samples shall be furnished with information as to their source and prepared in such quantities and sizes as may be required for proper examination and tests, with all freight and charges prepaid. All samples shall be submitted before shipment of the equipment or material to the job site and in ample time to permit the making of proper tests, analyses, examinations, rejections, and resubmissions before incorporated into the work.

2.01 NAMEPLATES & TAGS

A. Equipment exterior nameplates - Nameplate material shall be rigid laminated black phenolic with beveled edges and white lettering; except for caution, warning, and danger nameplates the color shall be red with white lettering. The size of the nameplate shall be as shown on the drawings. No letters are allowed smaller than 3/16". All phenolic nameplates located outdoors shall be UV resistant. Securely fasten nameplates in place using two stainless steel screws if the nameplate is not an integral part of the device. Epoxy cement or glued on nameplates will not be acceptable. Engrave the nameplates with the inscriptions as approved by the Engineer in the submittal.

1. For each major piece of electrical equipment provide a manufacturer's nameplate showing the Contract specified name and number designation, the manufacturer's name, model designation, part number, serial number, and pertinent ratings such as voltage, amperage, # of phases, range, calibration, etc.

2. For each device with a specific identity (pushbutton, indicator, instrument, etc.) mounted on the exterior or deadfront of a piece of equipment provide a nameplate with the inscription as shown in the Contract documents. Where no inscription is indicated in the Contract documents, furnish nameplates with an appropriate inscription providing the name and number of device.

B. Equipment Tags - When there is no space or it is impractical to attach an engraved phenolic nameplate with screws, as is the case with most field devices and instruments, the Contractor shall attach a tag to the equipment with the same inscriptions as specified above in paragraph A. The tag shall be made from stainless steel material and the size of the nameplate shall be no smaller than 3/8"h x 2"w with 3/16" machine printed or engraved lettering unless otherwise approved by the Engineer. The tag shall be attached to the equipment with stainless steel wire of the type normally used for this purpose.

2.02 WIRING AND TERMINATION

A. General

1. The Contractor shall furnish and install wiring and devices as specified in this Division. The Contractor shall provide all wire and terminations to all equipment requiring electrical connections.

B. Low Voltage Power (to 600 VAC):
1. General:
   a. Low voltage conductors shall be used for power, control, lighting and miscellaneous circuits. This Section applies to all wires or conductors used internally for all electrical equipment or externally for field wiring. Wire shall be new, plainly marked with UL label, gauge, voltage, type of insulation, and Manufacturer's name.

2. Low voltage wire shall conform with the following:
   a. NEMA standards WC3 and WC5 and UL requirements. Class B stranding. Conductors shall be copper with a minimum of 98% conductivity.
   b. Insulation type for conductors smaller than #6 AWG shall be moisture and heat resistant thermoplastic NEC Type THHN/THWN, rated 90 °C in dry locations and 75 °C in wet locations, or approved equal.
   c. Conductors #6 AWG and larger shall be XHHW insulation rated 90 °C in dry locations and 75 °C in wet locations, or approved equal.
   d. Conductors #6 AWG and larger routed in underground ductbanks shall be XHHW-2 insulation.
   e. Insulation of all conductors shall be rated 600 volt or higher.
   f. Field wire minimum AWG sizes:
      1) #12 for wires used for individual conductor circuits 120 volt and above.
      2) #14 for wires used for individual conductor circuits below 120 volt.

3. Control Conductors
   a. NEMA standards WC3 and WC5 and UL requirements. Class B stranding. Conductors shall be copper with a minimum of 98% conductivity.
   b. Insulation type for conductors smaller than #6 AWG shall be moisture and heat resistant thermoplastic NEC Type THHN/THWN, rated 90 °C in dry locations and 75 °C in wet locations, or approved equal.
   c. Insulation of all conductors shall be rated 600 volt or higher.
   d. Field Wire, Control panel, field panel or equipment wire minimum AWG sizes:
      1) #14 for wires used for individual conductor circuits 100 volt and above.
      2) #16 for Signal and low voltage DC wires used for individual control conductor circuits below 100 volt.

4. Instrument Cable
   a. All 4-20 mA and 1-5VDC instrument and control panel cables shall conform with the following:
      1) Signal wiring shall be shielded twisted pair with #18 AWG tinned copper stranded conductors and shield drain conductor.
      2) Conductor insulation shall be polyethylene rated 300 VAC 90° C and outer jacket shall be PVC.
      3) A metal foil shield shall completely surround the signal conductors.
4) Conductor insulation colors shall be white/clear and black.

5) Multiple pair cables with individually shielded pairs may be used only with prior approval of the Engineer.

b. All field 4-20mA instrument cables shall conform with the following:
   1) Signal wiring shall be shielded twisted pair with a minimum #18 AWG, tinned copper stranded conductors and shield drain conductor. #16 AWG shall be utilized where circuit distance exceeds 500 ft.
   2) Conductor insulation shall be polyethylene rated 600 VAC, 90° C and outer jacket shall be PVC.
   3) A metal foil shield shall completely surround the signal conductors.
   4) Conductor insulation colors shall be white/clear and black.
   5) Multiple pair cables with individually shielded pairs may be used only with prior approval of the Engineer.
   6) Instrument Cables shall be Belden 9342, or approved equal.

5. Manufacturer Supplied Cables:
   a. Cables and wiring for special systems shall be provided by the Manufacturer or system supplier with the equipment and installed per the Manufacturer's recommendations.

6. Communications Cable:
   a. Communications wiring and cabling shall be provided as specified in applicable specification sections for PLC, Network, Computer and instrumentation communications networks.
   b. RS-485 Communications Cable: Paired, 2 pairs, twisted, 24 AWG, stranded (7x32) TC - Tinned Copper conductors, PE - Polyethylene insulation, overall Aluminum Foil-Polyester Tape (Beldfoil) shield with 100% shield coverage plus copper Braid shield with a 24 AWG tinned copper drain wire and 90% shield coverage, PVC - Polyvinyl Chloride jacket. Applicable Specifications: UL NEC Type CM, AWM 2919, CEC C(UL) CM. Low Capacitance for EIA RS-485 Applications. Cable shall be Belden #9842.
   c. Remote Input/Output (RIO) and Data Highway Plus DH+ Communications Cable: Multi-Conductor, 1 twinax (2 conductors), 20 AWG, stranded (7x28) TC - Tinned Copper conductors, PE - Polyethylene insulation, Aluminum Foil-Polyester Tape (Beldfoil) shield with a 20 AWG stranded (7x28) tinned copper drain wire and 100% shield coverage plus tinned copper Braid shield with 55% shield coverage, PVC - Polyvinyl Chloride jacket. Applicable Specifications: UL Type CM, CL2, AWM 2464, CEC C(UL) CM. Flame Resistance: UL 1581 Vertical Tray. Blue Hose Cable for DH and DH+ Systems. 78 Ohm Twinax. Coaxial. Industrial Automation & Process Control Cables. Industrial Twinax Cables. Cable shall be Belden #9463, Allen Bradley 1770-CD.
   d. Cat 5e cables installed by Contractor shall meet the following specifications:
      1) TIA/EIA-568-A Category 5e specifications.
2) #24 AWG copper conductors, 4 pair shielded twisted pair.
3) Thermoplastic Dielectric type overall foil shield with drain wire.
4) PVC jacket.
5) NEC rating: CM, MP.
6) UL listed for NEC compliance.
7) Non-plenum usage.
8) Color Code:
   a) Information Network (YELLOW)
   b) Control Network (BLUE)
   c) Telco Communications (RED)

C. Pulling Compound

1. Use only cable pulling compound which is approved by the manufacturer of the cable as being compatible with cable insulation and jacket materials.

D. Terminal Blocks:

1. General:
   a. Each terminal block shall have a unique identifying alphanumeric code.
   b. Numbers shall be assigned to all blocks except grounding blocks. Fuse blocks shall be assigned unique tag numbers such as FU1, FU2. No two fuses in a common enclosure shall be assigned the same tag number. Fuse blocks shall also be provided with markers identifying the current rating of the fuse.
   c. A plastic marking tab shall be provided to label each individual terminal block. Each tab shall have a unique number/letter for each terminal which is identical to the "elementary" and "loop" diagram wire designation. Numbers on tabs shall be machine printed and 1/8-inch high.
   d. Terminal blocks shall be physically separated into groups by the level of signal and voltage served. Power and control wiring above 100 volts shall have a separate group of terminal blocks from terminal blocks for wiring below 100 volts, intermixing of these two types of wiring on the same group of terminal blocks is not allowed.
   e. Provide a separate common or neutral terminal for every two (maximum) inputs and/or outputs or as coordinated with the interconnect diagrams.
   f. Terminal blocks shall be, DIN rail, and 600V rated.
   g. Provide terminal blocks with "follower" plates, which compress the wires and have wire guide tangs for ease of maintenance. Terminal blocks, which compress the wires with direct screw compression, are unacceptable.

2. Miscellaneous - Terminal Blocks, for locations other than MCC cubicles and Control/Signal Panels:
   a. Provide terminal blocks rated a minimum of 20 amps at 600VAC.
b. Terminal blocks shall be Buchanan 500 series, or approved equal.

   a. Power Distribution, 120 VAC
   b. Terminal Blocks: Compression -clamp, black bodies, 600 volt rating, Entrelec M4/6 or approved equal.

4. Fuse Blocks and Fuse Size:
   a. Fuseblocks shall be Compression Clamp, 600 volt rating, reference Section 13340 for fuseblock requirements.
   b. Fuse Sizes:
      1) Fuses used in circuits 200 VAC and above shall be time-delay type FNQ, or approved equal, and have an interrupting rating of 10,000 AIC at 500 VAC. Fuse holders shall be of the barrier type and rated 600 VAC.
      2) Fuses used in 120 VAC/VDC shall be time-delay type MDL or approved equal, 1/4" x 1 1/4", and have a rating of 250 Volts. Fuse-holders shall be of the terminal block type, and shall be rail-mounted. Fuses shall have neon or LED blown fuse indicators.
      3) Fuses used in signal and 24 VDC circuits shall be fast acting type, or approved equal, 5mm x 20mm, and have a rating of 250 Volts. Fuse holders shall be of the terminal block type, and shall be rail mounted. Signal and control fuses shall be provided with a removable fuseholder with integral blown fuse indication.
      4) Provide a separate fuse and neutral terminal block for each analog input and output.
      5) Analog input and output terminal blocks, in addition to terminal block numbering, shall have "+", "-" and ground prefabricated symbol plastic terminal label inserts.
      6) Fuses shall be sized in conformance with the NEC or the manufacturers recommended size. The most stringent value shall apply.

5. Power Termination Blocks
   a. Power termination blocks shall be provided as indicated or required for power conductor termination, tapping and distribution of power.
   b. Termination blocks shall be 600 VAC rated, tin plated copper with compression lug.
   c. Terminal block housing shall be phenolic.
   d. Manufacturer: Marathon series 145, “Or Equal”.

6. Splices:
   a. No splices are allowed.
7. Wiring Connectors
   a. Solderless Pressure Connectors:
      1) Burndy Model: Universal Terminal.
      2) Thomas & Betts Model: Locktite.
      3) O-Z/Gedney Model: Socket Set-Screw.
   b. Spring Wire Connectors:
      1) 3 M Model: Scotchlok.
      2) Ideal Model: Wire-Nut.
      3) Buchanan Model: B-Cap.
   c. Compression Connectors:
      1) Burndy Model: Hydent.
      2) Thomas & Betts Model: Color-Keyed & Sta-Kon.
      3) Teledyne Penn-Union Model: Penn-Crimps.

2.03 ELECTRICAL EQUIPMENT

A. Disconnect Switches
   1. All switches shall have switch blades which are visible when the switch is OFF and the
      cover is open.
   2. Lugs shall be UL Listed for 75° C conductors, aluminum or copper.
   3. All current carrying parts shall be plated to resist corrosion.
   4. The switch operating mechanism shall be quick-make, quick-break such that, during
      normal operation of the switch, the operation of the contacts shall not be capable of
      being restrained by the operating handle after the closing or opening action of the
      contacts has started.
   5. The operating handle shall be an integral part of the box, not the cover.
   6. Provisions shall be provided for padlocking the switch in the OFF position.
   7. The enclosure shall be finished with gray baked enamel paint which is electrodeposited
      on cleaned, phosphate pre-treated steel (Type 1).
   8. NEMA 12/3R gray baked enamel paint which is electrodeposited on cleaned, phosphate pre-treated galvannealed steel. Tangential knockouts shall be provided to facilitate ease of conduit entry on switches through 200 ampere.
   9. Enclosures for Type 3R switches through 200 ampere shall have provisions for
      interchangeable bolt-on hubs in the top endwall.
   10. Switches shall be horsepower rated for 240Vac and above as indicated on the plans.
   11. The UL Listed short circuit rating shall be 100,000 rms symmetrical amperes when
      used with or protected by Class R fuses (30-600 ampere switches employing
      appropriate fuse rejection scheme).
12. Disconnect switches shall be as manufactured by:
   a. Square D
   b. Cutler-Hammer
   c. “Or Equal”

B. UTILITY METER AND DISTRIBUTION PANELS

1. Utility Meter Main Panels
   a. 1-phase, 3-wire, 120/240V AC, 10,000 AIC.
   b. Lay-in lugs and 3-inch knockouts for ease of installation.
   c. Box-type main lugs included.
   d. Factory-installed neutral.
   e. Hub provisions on top endwall.
   f. Padlockable device covers provide additional measure of safety and help prevent tampering.
   g. NEMA 3R rainproof construction.
   h. Euserc approved and for installation in accordance with local utility requirements
   i. Provide 60 Amp 240 Main
   j. Provide 2 -20 Amp CB
   k. Provide 2-15 Amp CB
   l. Meter and Socket per utility requirements.
   m. Meter Main Panel shall be Eaton, Square “D” or equal

C. Receptacles

1. Provide weather tight, GFCI receptacles.

2.04 CONDUIT, RACEWAYS, AND WIREWAYS

A. GENERAL

1. Conduit, raceways, and wireways, wiring methods, materials, installation shall meet all requirements of the NEC, be UL labeled for the application, and meet the minimum following specifications:
   a. All wiring shall be installed in conduits, raceways, or wireways when interconnecting equipment and devices.
b. The Contractor shall use special conduit, raceways, wireways, construction methods, and materials as shown on the Contract Drawings.

c. The minimum size conduit shall be 3/4-inch unless indicated otherwise on the Drawings or for special connections to equipment.

d. Conduit stubs for future use shall be capped with coupling, nipple, and plug.

e. Conduits to be abandoned that protrude above graded shall be cut flush and filled with grout.

2. Conduit installation shall be as follows:

   a. RMC – Outdoors

   b. PVC-40 and PVC-80 Underground

   c. PCS – All transitions from below grade to a minimum of 12” above grade.

B. CONDUIT MARKING

1. All conduits (except receptacle and lighting wiring) shall have conduit tags at both terminations of each conduit.

2. Tag material shall be rigid laminated red phenolic with white lettering. The size of the tag shall be 2” diameter. No letters are allowed smaller than 7/16”. Tags shall be heat and UV resistant, stain proof, electrically non-conductive and non-corroding. Securely fasten tags in place using plastic tie-wraps. Engrave the tags, on both sides, with the conduit number as listed in the conduit schedule or on the Contract Drawings. Labeling shall be neatly installed for visibility and shall be clearly legible. Conduit tags shall be Brady Custom B-1 or approved equal.

C. RIGID METALLIC CONDUIT - (RMC)

1. Standard weight, zinc coated on outside by hot-dipping or sherardizing process, with either zinc coated or other approved corrosion resistant coating on inside. Fabrication shall be hot-dip galvanized after fabrication, conforming to NEMA RN 1.

2. Provide galvanized rigid steel factory elbows for 90 degree transitions.

3. Fittings shall be hot dipped galvanized steel or galvanized cast ferrous metal. Provide threaded-type fittings, couplings, and connectors; set-screw type and compression-type are not acceptable.

4. All joints shall be treated with T & B "Kopr-Shield".

5. Conduits entering enclosures shall be fitted with insulated grounding bushing; O-Z "HBLG", Appleton "GIB", or approved equal. All grounding bushings shall be tied to the grounding system with properly sized bonding conductors per the NEC code.

D. RIGID METALLIC CONDUIT - PVC COATED STEEL (PCS)
1. Standard weight, galvanized conduit with a 40-mil thick polyvinylchloride coating bonded to both the outside and urethane interior coating. Conduit shall be hot-dip galvanized conforming to NEMA RN 1. PCS conduit to be Robroy Plasti-bond RED or approved equal.

2. Provide PVC coated galvanized rigid steel factory elbows for 90 degree transitions.

3. Fittings shall be hot dipped galvanized steel or galvanized cast ferrous metal with a PVC 40 mils thick coating. Provide threaded-type fittings, couplings, and connectors; set-screw type and compression-type are not acceptable.

4. All joints shall be treated with T & B type CP "Kopr-Shield", LPS No. 3 rust inhibitor or approved equal.

5. All junction and metal pull boxes shall be galvanized with exterior surfaces PVC coated to 40 mils thickness.

6. Conduits entering enclosures shall be fitted with insulated grounding bushing; O-Z "HBLG", Appleton "GIB", or approved equal. All grounding bushings shall be tied to the grounding system with properly sized bonding conductors per the NEC code.

E. PVC CONDUIT (PVC)

1. Shall be high impact schedule 40 or 80, polyvinylchloride suitable for use underground, direct burial and for use with 90 C wires, and shall conform to UL 651. Shall be UL listed and labeled for "direct" burial.

2. A copper bonding conductor shall be pulled in each raceway and bonded to equipment at each end with approved lugs.

3. Each underground run shall be placed in a trench with a minimum of two (2) inch sand bed evenly compacted on all sides, top and bottom.

4. Bends, elbows, and risers shall be made with galvanized rigid steel (GRS) conduit using threaded adapters. Bond each metallic portion to each other and to equipment connected at each end of conduit run.

5. PVC fittings shall have solvent-weld-type conduit connections.

6. PVC conduit shall be stored on a flat surface and shielded from the sun.

F. SEALED LIQUID TIGHT FLEXIBLE METAL CONDUIT (SLT)

1. Minimum trade size one-half inch (1/2").

2. Connectors: Appleton "STB" or approved equal through two inches (2") trade size. Appleton "ST", O-Z "4Q", or equal with insulated bushings for over two inches (2") trade size.

3. Suitable for connection of indoor or outdoor motors, controls, and mechanical equipment.
4. Shall be used for conduit coupling to all vibrating and shifting equipment.

5. Flexible conduit lengths shall not be greater than 36 inches.

6. Flexible metallic conduit shall not be considered as a ground conductor, install a separate wire for equipment bonding.

7. Flexible conduit shall only be installed in exposed or accessible locations.

8. Final connections to vibrating equipment such as field devices, motors and fans shall be made with flexible conduits.

G. SEALING FITTINGS

1. Sealing fittings shall be installed in conformance with NEC requirements for hazardous locations and as indicated on the Contract Drawings. Sealing fittings and compounds shall be certified and UL listed for the Hazardous location class, division and group.

2. Sealing fittings shall be Crouse Hinds EYS, Appleton EYS, or Equal.

H. PULL BOXES

1. JIC BOXES
   a. Each JIC box shall have JIC type construction and shall be manufactured of stainless steel. Cover shall be attached with stainless steel screws. No devices, screws, rivets, or bolts shall protrude through the exterior surface unless specifically shown on the drawings.
   
   b. Boxes shall be NEMA 4X Stainless Steel with hinged covers.
   
   c. Boxes shall be Hoffman, Circle AW, or approved equal.

2. UNDERGROUND BOXES
   a. Underground pull boxes, where shown or required by length of conduit runs, shall be prefabricated concrete type with the size shown on the Drawings or larger to allow for adequate pull area. Extension sections shall be provided as necessary to reach the depth of underground conduits. All boxes shall have galvanized steel hold down bolts and hardware. Boxes located in paved areas or other areas which vehicles may travel shall be H/20 loading rated and have traffic covers. Steel covers or lids shall be galvanized. Pull box covers shall be labeled power, signal, utility, and telephone, whichever applies. Pull boxes shall be Christy Concrete Products, Brooks or approved equal.

I. GROUNDING SYSTEM

1. The utility service entrance ground bus shall be tied to a ground grid consisting of a ground rod type grounding system.

2. The ground rod shall consist of not less than 10 continuous feet of 3/4 inch copper coated electroplated high grade carbon steel. The ground rod shall be a NEHRING
type NCC, Weather 348 or approved equal. The ground rod shall extend up for visible connection of a UL approved "ground clamp" to the ground bus.

3. The main ground bonding wire from the ground shall extend up into the utility service entrance switchboard for the visible connection with a UL approved "ground clamp" attached to the ground bus. The main ground bonding wires shall be a 2/0 copper.

4. Network ground bond wires shall be connected from the switchboard ground bus and other points shown on the Contract drawings. The network ground bonding wires shall be 1/0 copper minimum.

5. Ground clamps shall be bolt-on type as manufactured by ILSCO type AGC, O-Z Gedney type GRC, or approved equal.

6. Grounding conductors shall be sized as shown on the Plans or in accordance with NEC table 250-95, whichever is larger.

7. Grounding and bonding wires shall be installed in all PVC conduits and nonmetallic raceways and connected to the ground bus and all equipment.

8. Each ground bus shall be copper. Screw type fasteners shall be provided on all ground busses for connection of grounding conductors. Ground bus shall be a Challenger GB series, ILSCO CAN series or approved equal.

9. One side of the secondary on all transformers shall be grounded to the ground bus.

10. All raceway systems, supports, enclosures, panels, motor frames, and equipment housings shall be permanently and effectively grounded.

11. All receptacles shall have their grounding contact connected to a grounding conductor.

12. Attachment of the grounding conductor to equipment or enclosures shall be by connectors specifically provided for grounding. Mounting, support, or bracing bolts shall not be used as an attachment point for ground conductors.

13. Antenna shall be grounded directly to the site ground rod via a #3 awg ground conductor routed directly from the mast to the ground rod.

PART 3 EXECUTION

3.00 WORKMANSHIP

A. All work in this Section shall conform to the codes and standards outlined herein.

B. The Contractor shall employ personnel that are skilled and experienced in the installation and connection of all elements, equipment, devices, instruments, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide first class workmanship for all installations.

C. Ensure that all equipment and materials fit properly in their installations.

D. Perform any required work to correct improper installations at no additional expense to the Owner.
E. The Engineer reserves the right to halt any work that is found to be substandard or being installed by unqualified personnel.

F. Keep the premises free from accumulation of waste material or rubbish on a daily basis. Upon completion of work, remove materials, scraps, and debris from the premises and from the interior and exterior of all devices and equipment. Refinish damaged surfaces to new condition using skilled craftsmen of the trades involved at no additional cost to the Owner.

G. All equipment installed by the Contractor shall be in accordance with the Drawings and the manufacturer's recommendations & instructions and shall operate to the Engineer's satisfaction. Follow all manufacturers' instructions for handling, receiving, installation, and pre-check requirements prior to energization. After energization, follow manufacturer's instructions for programming, set-up and calibration of equipment. The Contractor shall be responsible for, and shall correct by repair or replacement, at his own expense, equipment that, in the opinion of the Engineer has been caused by faulty mechanical or electrical assembly by the Contractor. Necessary tests to demonstrate that the electrical and mechanical operation of the equipment is satisfactory and meets the requirements of these Specifications shall be made by the Contractor at no additional cost to the Owner.

3.01 CONSTRUCTION METHODS, GENERAL

A. All field wires and panel wires shall have wire markers as specified in the “WIRE” Section.

B. No wires shall be spliced without prior approval by the Engineer.

C. Where splices are approved by the Engineer they shall conform with the following:
   1. Wire splicing devices shall be sized according to manufacturer's recommendations.
   2. Splices of #10 and smaller, including fixture taps, shall be made with see-thru nylon self-insulated twist on wire joints; T & B "Piggys", Ideal "Wing-Nut" or approved equal.
   3. Splices of #8 and larger shall be hex key screw two way connectors, with built in lock washers; T & B "Locktite", O-Z type XW or approved equal, insulated with 3M Scotch Super #88, Plymouth or approved equal.
   4. Splices in underground pullboxes shall be insulated and moisture sealed with 3M "Scotchcast" cast resin splice kits, Plymouth splice kits, or approved equal and shall have a date marking for shelf life.

D. Equipment shall be wired and piped by the manufacturer or supplier. Major field modifications or changes are not allowed without the written "change order" authority by the Engineer. When field changes are made, the components, materials, wiring, labeling, and construction methods shall be identical to that of the original supplied equipment. Contractor's cost to replace or rework the equipment to match original manufacturer or supplier methods shall be done at no additional cost to the Owner.

E. Mating fittings, bulkhead fittings, plugs, connectors, etc. required to field interface to the equipment and panels shall be provided by the supplier when the equipment is delivered.

F. All electrical and instrumentation drawings associated with the equipment shall be provided with the equipment when it is delivered to the job site. Drawings for each piece of equipment shall be placed in clear plastic packets of sufficient strength that will not tear or stretch from drawing removal and insertion.

3.02 DAMAGED PRODUCTS
A. Damage products will not be accepted. All damaged products shall be replaced with new products at no additional cost to the Owner.

3.03 FASTENERS

A. Fasteners for securing equipment to walls, floors, and the like shall be stainless steel. The minimum size fastener shall be 3/8 inch diameter.

B. Concrete pad with stainless steel anchor bolts shall be provided for all free standing enclosures and metering/control panel pedestals.

3.04 INSTALLATION METHODS

A. Install all products per manufacturer’s recommendations and the Drawings.
   1. Contract Drawings are intended to show the basic functional requirements of the electrical and instrumentation system and do not relieve the Contractor from the responsibility to provide a complete and functioning system.
   2. Provide all necessary hardware, conduit, wiring, fittings, and devices to connect the electrical equipment provided under other Sections. The following shall be done by the Contractor at no additional cost to the Owner:
      a. Provide additional devices, wiring, conduits, relays, signal converters, isolators to complete interfaces of the electrical and instrumentation system.
      b. Changing normally open contacts to normally closed contacts or visa versa.
      c. Adding additional relays to provide more contacts as necessary.

B. Panels and Enclosures
   1. Install all panels in accordance with the approved Seismic and Wind Load anchoring requirements.
   2. Install panels and enclosures at the location shown on the Plans or approved by the Engineer.
   3. Install level and plumb.
   4. Seal all enclosure openings to prevent entrance of insects and rodents.

C. CONDUITS AND DUCTS
   1. Control conductors, DC signal conductors, communications conductors and power conductors shall be routed in separate conduits. Consolidation of signal, power and control into a single conduit is not allowed.
   2. Except as expressly indicated or approved, all conduits shall be concealed in walls and located below floor slabs. Care shall be exercised to avoid interference with the work of other trades. This work shall be planned and coordinated with the other trades to prevent such interference. Pipes shall have precedence over conduits for space requirements.
   3. Exposed conduits shall be neatly arranged with runs perpendicular or level and parallel to walls. Bends shall be concentric. Exposed conduits shall be originating from below grade shall be PCS.
   4. All conduits shall be secured by means of proper fittings.
5. Outlet boxes, fittings and junction boxes shall be used for all outlets, pull boxes and junction points. (Lighting fixtures shall not be supported or hung from PVC junction boxes but be supported in position by other means.)

6. PVC conduit, except where embedded in concrete or direct buried shall be supported to permit adequate lineal movement to allow for expansion and contraction of conduit due to temperature change.

7. For above ground installations where temperature change in excess of 14°C (25°F) is anticipated, expansion joints shall be installed. See Table 347-9(A) NEC for expansion characteristics.

8. Proper care shall be taken when field bending is employed to maintain the internal diameter and wall thickness of the conduit.

9. All spare conduits shall have 3/8" nylon pull ropes installed.

D. WIRING METHODS

1. GENERAL
   a. Provide grounding and shielding in conformance with ISA. The shield of shielded cables shall be terminated to ground at one end only, the origination end. The shield at the other end shall be encased in an insulated material to isolate it from ground.
   b. Route all conductors in accordance with the contract drawings and/or conduit schedules.
   c. Provide 20 percent spare conductors for all instrumentation, control and signal wiring above that indicated in the Contract Documents.
   d. All wiring shall be neatly bundled and laced with plastic tie-wraps, anchored in place by screw attached retainer. Where space is available, all wiring shall be run in slotted plastic wire ways or channels with dust covers. Wire ways or channels shall be sized such that the wire fill does not exceed 60% of the NEC allowable fill. Tie-wraps shall be T&B TY-RAP, or approved equal.
   e. Wiring inside of conduit, plastic wire duct, duct bank sections or corrugated loom tubing is not to be wire tied or taped together.
   f. Where wiring crosses hinged surfaces, provide a "U" shaped hinge loop protected by black head stabilized corrugated loom tubing as manufactured by Panduit # CLT100N-C630, or approved equal. The hinge loop shall be of sufficient length to permit opening and closing of the door without stressing any of the terminations or connections. Corrugated flexible wire duct shall be Graybar T25N, or approved equal.
   g. Wireway retainers and other devices shall be screw-mounted with round-head 316 stainless steel screws or mechanically mounted by push-in or snap-in attachments. Glue or sticky back attachment of any type or style shall not be used. Retainers shall be T&B TC series, or approved equal.

2. Wire Routing
   a. Wires within panels shall be routed in slotted plastic wire-ways with snap covers. Wires carrying 120 VAC shall be separated as much as possible from other wires and signal cables, and shall be routed only in wireways for 120
VAC. If the power wiring has to cross the signal wiring, the crossing shall be as close to a right angle as possible. Wireways for 24 VDC wiring shall be used for all other wires and cables. Routing of 120 VAC in combined ducts shall not be allowed.

b. Wires and cable shall be routed along the shortest route between termination points, excepting routes which would result in routing 120 VAC and other wires and cables in the same duct. Wires and cables shall have sufficient length to allow slack and to avoid any strain or tension in the wire or cable. Wires and cables shall be placed in the wireways in a straight, neat and organized fashion and shall not be kinked, tangled, or twisted together. Additional wire ducting shall be provided for use by the Electrical Subcontractor for routing field wires to their landing points in the each electrical and instrumentation panel.

c. Wiring that cannot be routed in wireways, shall be neatly bundled and laced with plastic ties. Wiring across door hinges shall be carefully made up and supported to avoid straining and chafing of the conductors or from putting any strain on their terminals.

d. Wires carrying 100 volts and above shall be physically separated from lower voltage wiring by using separate bundles or wireways with sufficient distance to minimize the introduction of noise, crossing only at 90 degree angles.

e. Exposed Tie-Wraps: Plastic tie-wraps used in all outdoor or exposed applications shall be sun resistant UV rated for outdoor usage.

3. Wire Terminations

a. Single wire and cable conductors shall be terminated according to the requirements of the terminal device.

b. As a minimum, provide a ground terminal or connection point for the power system grounding conductor for each terminal block group.

c. Terminate field wiring on the "field side" of the terminal blocks. Do not connect internal panel wiring to the "field side" of the terminal blocks. Do not connect field wiring to the "panel side" of the terminal block.

d. Provide a minimum of 20% spare terminals in all MCC cubicles, electrical and instrumentation enclosures, and instrumentation/control panels.

e. Terminate all conductors including spares. All power, control and instrument wires entering and leaving a compartment shall terminate on terminal blocks.

f. No more than two field wires are to be inserted in any single terminal block.

g. For screw terminals, appropriately sized locking forked spade lugs shall be used. Lugs shall be crimp type that forms gas tight connections. All crimping shall be done using a calibrated crimping tool made specifically for the lug type and size being crimped.

h. On shielded cables, the drain wire shall be covered with heat shrunk insulating tubing along its full bare length between the cable jacket and the terminal lug or terminal pressure plate. To insulate the foil or braid shielding use heat shrink tubing sized for the wire and shrunk into place with the properly sized heat gun.

i. Minimum distance between terminal blocks and relays or other terminations shall be 2".
j. The wire label codes for each end of the same wire shall be identical.

E. Device Mounting Heights:

1. Mounting heights of fixtures and devices shall be as follows unless otherwise indicated or when height has to be adjusted to be over or under counter tops.

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall switches</td>
<td>48 inches</td>
</tr>
<tr>
<td>Convenience outlets</td>
<td>18 inches</td>
</tr>
<tr>
<td>Telephone outlets</td>
<td>54 inches</td>
</tr>
<tr>
<td>Bracket fixtures</td>
<td>7 feet 6 inches</td>
</tr>
</tbody>
</table>

F. Excavation and Back Filling

1. Trenches for all lines below floor slabs and all underground electrical lines shall be excavated to the required depths. Conduits under floor slabs shall have trenches no deeper than is required to properly contain bends within walls.

2. Underground conduits outside of structures, excluding utility conduits, shall have a minimum cover of 18 inches except under roadways where minimum cover shall be 24 inches or when concrete encased. Back filling shall be done only after conduits have been inspected. Material for back filling shall be sand covered by compacted earth back fill. Excavation and back fill of lines and conduits shall conform to the requirements of the Earthwork Section of these Specifications, unless modified on plans, and to other entities as required.

3. At all times during the installation of the electrical distribution system, the Contractor shall provide barricades, fences, guard rails, etc., to safeguard all personnel, including small children, from excavated trenches.

G. Cutting and Patching

1. The Contractor shall do all cutting and patching required to install his work. Any cutting which may impair the structure shall require prior approval by the Engineer. Cutting and patching shall be done only by skilled labor of the respective trades. All surfaces shall be restored to their original condition after cutting and patching.

H. Conduit Sealing

1. Seal each conduit entrance from below grade into the panel and other electrical enclosures with plugging compound sealant to prevent the entrance of insects and rodents. Conduits between the Power & Control Connection Boxes and the panel shall be sealed with plugging compound sealant on each end. Plugging compound sealant shall be Courtaulds Aerospace, Semco PR-868 or approved equal.

2. Seal all metallic conduit threads utilizing an approved sealing compound such as T&B, KopR-Shield.

3.05 Cleaning and Touch up
1. At the completion of the work, all parts of the installation, including all equipment, exposed conduit, and fittings, shall be thoroughly cleaned of grease and metal cuttings. Any discoloration or other damage to parts of the building, the finish, or the furnishings, due to the Contractor's failure to properly clean the system, shall be repaired by the Contractor without cost to the Owner.

2. The Contractor shall thoroughly clean any of his exposed work requiring same.

3. Vacuum and clean the inside of all enclosures prior to applying power.

4. The Contractor shall paint scratched or blemished surfaces with the necessary coats of quick drying paint to match existing color, texture and thickness. This shall include all prime painted electrical equipment including but not limited to enclosures, poles, boxes, devices etc.

3.06 TESTING

A. GENERAL REQUIREMENTS

1. It is the intent of these tests to assure that all equipment is operational within industry and manufacturer's tolerances and is installed in accordance with design plans and specifications.

2. The first set of tests to be performed shall determine the suitability for energization and shall be completed with all power turned off.

3. Prior to any field testing, Interconnection Drawings and Operation & Maintenance Manuals shall have been submitted by the Contractor and approved by the Engineer.

4. The test forms shall be completed by the testing person for field checkout, testing and calibration of all equipment. All tests shall be witnessed by the Engineer and/or Owner personnel. All filled in test forms shall be given to the Engineer and/or Owner the day of the test. Fill in two sets of test forms if Contractor wants to keep a copy.

5. The Contractor shall give the Engineer 10 days notice of the dates and time for inspections and testing using the “Scheduled Test Request Form.”


7. Prepare and submit formal test procedures and start-up forms to the Owner at least two weeks prior to the start of testing. Testing shall not commence until the test procedures have been reviewed and approved by the Owner. Submit separate test procedure submittals for factory and field tests. The factory test procedure shall be in a separate binder from the field test procedure.

8. If the results of any of tests are unacceptable to the Engineer, the Contractor shall make corrections and perform the tests again until they are acceptable to the Engineering; these additional tests shall be done at no additional cost to the Owner.

B. SAFETY

1. Testing shall conform to the respective manufacturer's recommendations. All manufacturers’ safety precautions shall be followed.

2. The procedures stated herein are guidelines for the intended tests, the Contractor shall be responsible to modify these tests to fit the particular application and ensure personnel safety. Absolutely no tests shall be performed that endanger personal safety.
3. Occupational Safety and Health Act (OSHA): The Contractor is cautioned that testing and equipment shall comply with OSHA as to safety, clearances, padlocks and barriers around electrical equipment energized during testing.

C. ELECTRICAL FIELD TESTS

1. Visual Inspection
   a. Verify installation is in compliance with manufacturers requirements.
   b. Verify installations are in conformance with specifications.
   c. Verify all device ratings.
   d. Verify all wiring is terminated and labeled in accordance with the contract documents and interconnection diagrams.
   e. Verify protective device settings for equipment and motors per field operational data.
   f. Verify motor nameplate data.

2. Mechanical Operation
   a. Operate all handles and mechanism to insure smooth operation.
   b. Open and close doors to verify proper alignment.

3. Torque Connections
   a. All electrical, mechanical and structural threaded connections inside equipment shall be tightened in the field after all wiring connections have been completed. Every worker tightening screwed or bolted connections shall be required to have and utilize a torque screwdriver/wrench at all times. Torque connections to the value recommended by the equipment manufacturer. If they are not available, use NEC 2002 110-14 as guidelines.

4. Wire Insulation and Continuity
   a. All devices that are not rated to withstand the 500V megger potential shall be disconnected prior to the megger tests.
   b. Megger insulation resistances of all 600 volt insulated conductors using a 500 volt megger for ten seconds. Make tests with circuits installed in conduit and isolated from source and load. Each conductor shall be meggered conductor to conductor and conductor to ground. These tests shall be made on cable after installation with all splices made up and terminators installed but not connected to the equipment.
   c. Megger insulation resistances of all motor leads using a 500 volt megger for thirty seconds. Make these tests with motors installed in place and not connected to any other wiring. Each motor lead shall be tested conductor to ground.
   d. Each megger reading shall not be less than 10 Meg-ohms resistive. Corrective action shall be taken if values are recorded less than 10 Meg-ohms.
   e. Continuity Tests:
1) Each instrumentation conductor twisted shielded pair shall have the conductor and shield continuity measured with an ohmmeter. Conductors with high ohm values, that do not match similar lengths of conductors the same size, shall be replaced at no additional cost to the Owner.

2) Values of different phases of conductors in the same conduit run showing substantially different Meg-ohm values, even if showing above 10 Meg-ohms shall be replaced

5. Instrument Cable Tests

a. General: The following tests shall be performed on each instrumentation and control system cable. All tests shall be end-to-end tests of installed cables with the ends supported in free air, not adjacent to any grounded object. All test data shall be recorded on forms, which are available from the Engineer. Complete records of all tests shall be made and delivered to the Engineer. The Owners Representative who witnessed the testing shall sign each form.

b. Continuity tests shall be performed by measuring wire/shield loop resistance of each signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall vary by more than plus or minus 2 ohms from the calculated average loop resistance value.

c. Insulation resistance tests shall be performed by using a 500 volt megometer to measure the insulation resistance between each channel wire, between each channel wire and the channel shield, between individual channel shields in a multi-channel cable, between each individual channel shield and the overall cable shield in a multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 1 megohms shall be unacceptable.

6. Ground System Testing

a. Visual and Mechanical Inspection.

1) Verify ground system is in compliance with drawings and specifications.

2) Before making connections to the ground electrodes, and before placement of sidewalks, landscape and paving, measure the resistance of each electrode to ground using a ground resistance tester. Perform the test not less than two days after the most recent rainfall and in the afternoon after any ground condensation (dew) has evaporated.

3) After all individual ground electrode readings have been made, interconnect as required and measure the system's ground resistance.

4) The grounding test shall be in conformance with IEEE Standard 81.

7. Electrical Testing

a. Manually Start/Stop, Open/Close and position all equipment.

b. Verify control operators and indicators operate as indicated on the Contract Drawings.

c. Measure and record individual motor load currents (measure and record each...
d. Measure and record output voltage for all power sources contained in the panel.

e. Test GFCI receptacles.

f. Operate all switches and circuit breakers.

g. Verify operation of light switches, temperature switches, intrusion switches and all other switching devices.

8. Control System Testing

a. Test control systems in conformance with Section 16300.

b. Verify Instrument Loops.

c. Verify PLC Controls.

d. Verify Communications.

D. Operational Testing:

1. After all the previous tests in this subsection are complete, the Contractor shall conduct operational testing.

2. For the operational testing the new equipment shall be activated to automatically run for 5 days, Monday through Friday. During this five day period the Owner will run the different combinations of the control options. If equipment failure occurs during the 5 days of operational testing, the Contractor shall repair or replace the defective equipment and shall begin another 5 day operational test, Monday through Friday. This shall be continued until the new equipment functions acceptably for 5 consecutive days.

E. Final Acceptance Trial Period:

1. The system shall not be "final" accepted unless the system functions without hardware failures or software problems during a 30 day trial period, to the satisfaction of the Owner. The Owner reserves the right to restart the 30 day trial period, at their discretion, when a major hardware failure has occurred or a software problem has been identified. The Owner will notify the Contractor when the 30 day trial period has been satisfactory completed.

2. The completion of the above tests does not relieve the Contractor from warranties specified herein.

3.07 SPARE PARTS

A. The Contractor shall supply all spare parts prior to start of field tests. All parts shall be sealed in plastic bags and delivered to the site in a heavy duty plastic storage bag. Bag shall be clearly labeled with part name & number and the corresponding equipment tagname.
B. The Contractor shall make available any replacement parts that are not manufacturer's normal stock items for immediate service and repair of all the instrumentation equipment throughout the warranty period.

3.08 WARRANTY

A. The Contractor shall have a staff of experienced personnel available to provide service on 2 working days notice during the warranty period. Such personnel shall be capable of fully testing and diagnosing the hardware & software and implementing corrective measures. If the Contractor "fails to respond" in 2 working days, the Owner at its option will proceed to have the warranty work completed by other resources; the total cost for these other resources shall be reimbursed in full by the Contractor. "Fail to respond" shall be defined as: The Contractor has not shown a good faith effort and has not expended adequate resources to correct the problem. The use of other resources, as stated above, shall not change or relieve the Contractor from fulfilling the remainder of the warranty requirements.

B. The Contractor shall warrant all electrical and instrumentation equipment & software for a period of one (1) year from date of final acceptance. Standard published warranties of equipment which exceed the preceding specified length of time shall be honored by the manufacturer or supplier.

C. Prior to "final acceptance", the Contractor shall furnish to the Engineer a listing of warranty information for all manufacturers of materials and equipment used on the project. The listing shall include the following:

1. Manufacturer's name, material and equipment description, equipment number, part number, serial number, and model number.
2. Manufacturers service contact person, phone number, and address.
3. Warranty expiration date.

3.09 FINAL ACCEPTANCE

A. Final acceptance will be given by the Owner after the equipment has passed the "final acceptance trial period", each deficiency has been corrected, final documentation has been provided, and all the requirements of design documents have been fulfilled.

B. At the end of the project, following the completion of the field tests, and prior to final acceptance, the Supplier shall provide the following to the Owner:

1. Each "operation and maintenance" manual shall be modified or supplemented by the Supplier to reflect all field changes and as-built conditions.
2. Two (2) disk copies of all final documentation to reflect as-built conditions.

-END OF SECTION-
Not Used
SECTION 16600
PHOTOVOLTAIC POWER SYSTEM

PART 1 GENERAL

1.00 SCOPE OF WORK

A. This Specification Section covers the furnishing, installing, and testing of a photovoltaic power array, DC power distribution, battery charging systems, wiring devices, poles, conduit, wiring, and other material for the complete photovoltaic power systems as shown on the Drawings.

B. The provisions of Electrical Section 16010 of these Specifications shall apply, unless otherwise specified in this Section.

C. The photovoltaic system shall operate on 24/48 volts DC and shall supply power to the PLC, communications module, instrumentation, local display and radio equipment specified in divisions 13 and 16.

D. The DC power distribution system shall provide for 12 and 24 VDC sourcing to provide power for electronic system components. Power conditioners and regulators shall be supplied to provide power at the required equipment voltage inputs.

E. The photovoltaic system shall be sized to provide uninterrupted continuous power. The battery system shall be designed for five days of autonomy without active recharging of the solar array. The battery system shall be designed to provide a battery recharge rate from fully discharged to full capacity in 8 hours. The charging system shall be sized for 200 percent of maximum load capacity.

F. DC disconnection and protection means shall be supplied in accordance NEC Article 690 for photovoltaic source, batteries and load applications. The disconnecting means shall be rated for a maximum 125 VDC and shall be UL listed for DC applications.

G. Earthwork required for materials and equipment installed under this Section shall be done in accordance with other sections of this specification.

1.01 SUBMITTALS

A. Provide data and Drawings for all materials furnished under this Section with the content and format as specified in Section 13300.

B. In addition, the following information shall be included in the Submittal:

1. Submit pole dimensions, anchor bolt details, wind loading data, materials, and finish.

2. Installation instructions.

3. Manufacturer's catalog information, including complete catalog number, photovoltaic array data, cooling calculations, wiring diagrams, and descriptive literature. Catalog
cuts for each component shall be clearly identified with the designated fixture type letter indicated on the drawings.

4. Submit manufacturer's catalog data for photovoltaic modules, charge controller, batteries and mounting hardware.

C. Submit for approval, calculations and concrete base size requirements to meet pole wind loading of 100 MPH and seismic criteria specified in Section 16010 - Seismic Restraint For Electrical Equipment. The concrete base shall not be poured prior to approval of the concrete base Submittal.

D. Battery sizing, charging and photovoltaic load calculations shall be provided to verify that the load conditions meet the specified load requirements. Calculations shall be based on 200 percent of load with a recharge rate of 24 hours. Battery back-up of all equipment shall be provided for 100 hrs of operation based on 200 percent load.

E. Provide O&M manual data and Drawings for all materials furnished under this Section with the content and format as specified in Section 13300 and 16010.

1.02 CODES AND STANDARDS

A. Photovoltaic systems shall be installed, tested and adhere to the following codes and standards.

1. ASTM E44.09
   a. E 1462-95 Test Methods for Insulation Integrity and Ground Path Continuity of PV Modules
   c. E 1799-96 Practice for Visual Inspection of PV Modules
   d. E 1802-96 Test Methods for Wet Insulation Integrity Testing of PV Modules

2. IEEE
   a. 937 IEEE Recommended Practice for Installation and Maintenance of Sealed Lead-Acid Batteries for PV Systems
   b. 1013 IEEE Recommended Practice for Sizing Lead-Acid Batteries for PV Systems
   c. P1262 Recommended Practice for Qualification of PV Modules
   d. P1361 Recommended Practice for Determining Performance Characteristics and Suitability of Batteries in PV Systems
   e. P1373 Recommended Practice for Field Test Methods and Procedures for Grid-Connected PV Systems
3. UL-1703 Flat-Plate PV Modules and Panels

4. NEC ANSI/NFPA, Article 690

PART 2 PRODUCTS

2.00 GENERAL

A. Contractor shall furnish and install photovoltaic modules and supporting power equipment complete and ready for service in accordance with the contract, drawings and applicable sections together with radio antenna system mounting as required for radio based communications.

B. Power and control cabinets shall be provided as specified in section 13300 and 13340 to mount the photovoltaic power distribution components and batteries.

C. Radio, communication, RTU’s and control equipment shall be provided as specified in Section 13350 and 13360.

2.01 PHOTOVOLTAIC MODULES

A. The photovoltaic module shall be designed for heavy-duty use, with multicrystalline silicon solar cells and installation-speeding polarized connectors. The photovoltaic arrays shall be configured (series and parallel) to provide the voltage and amps required to power the load and recharge the discharged battery system in 10 hours plus an additional 100 percent capacity. The photovoltaic module shall be configurable for both 12 and 24 VDC applications and shall have a minimum 150 watt capacity per module. The module shall be provided as follows:

1. Fabrication:

   a. 72 multicrystalline silicon solar cells in series, and efficiency enhanced by an improved cell coating.


   c. Cells shall be laminated between sheets of ethylene vinyl acetate (EVA) and high-transmissivity low-iron 3mm tempered glass.

   d. Manufactured in accordance with ISO 9001-certification.

   e. Shall be listed by Underwriter’s Laboratories for electrical and fire safety (Class C fire rating).

   f. Shall be tested in accordance with IEC 61215, including: repetitive cycling between -40°C and 85°C at 85% relative humidity; simulated impact of 25mm (one-inch) hail at terminal velocity.

   g. 2200 VDC frame/cell string isolation test; ° static loading, front and back, of 2400 pascals (50 psf); front loading (e.g. snow) of 5400 pascals (113 psf).

2. Electrical Characteristics
a. Maximum power (Pmax) 150W
b. Voltage at Pmax (Vmp) 34.5V
c. Current at Pmax (Imp) 4.35A
d. Warranted minimum Pmax 140W
e. Short-circuit current (Isc) 4.75A
f. Open-circuit voltage (Voc) 43.5V
g. Maximum system voltage 600V
h. Temperature coefficient of Isc (0.065±0.015)%/°C
i. Temperature coefficient of Voc (160±20)mV/°C
j. Temperature coefficient of power (0.5±0.05)%/°C

B. PV modules shall be provided with diode block modules for parallel string connection.

C. The photovoltaic array shall be BP solar, or equal.

2.02 Photovoltaic Charger/Regulator

A. LOW CURRENT

1. The photovoltaic system shall be provided with a 12-48 VDC solid-state charge controller and power regulator for regulating DC Voltage to the control equipment load and provide charger regulation for the battery system. The charge/controller shall be sized to power the load and recharge the batteries from a discharged state to full capacity in 24 hours plus 100 percent headroom for future battery and photovoltaic equipment. The charger shall be provided with a 4 stage charging algorithm to optimize battery performance and extend battery life. The charge controller shall be provided with the following:

a. Standard Features:
   1) Voltage 12 VDC
   2) Adjustable Voltage
   3) Temperature compensation
   4) 100% solid state
   5) Current compensated low voltage disconnect (LVD)
   6) LED’s indication of battery status and fault conditions
   7) Operate continuously at 125% of rated load
8) Remote battery voltage sense terminals

b. Electronic Protections:
1) Short-circuit — solar and load
2) Overload — solar and load
3) Reverse polarity
4) Reverse current at night
5) High voltage disconnect
6) High temperature disconnect
7) Lightning and transient surge protection
8) Loads protected from voltage spikes
9) Automatic recovery with all protections

2. The charge/controller shall be Specialty Concepts, Inc ASC, Morningstar Sunsaver, or equal.

B. High Current 15 Amp and Greater

1. The photovoltaic system shall be provided with a 12-48 VDC solid-state charge controller and power regulator for regulating DC Voltage to the control equipment load and provide charger regulation for the battery system. The charge/controller shall be sized to power the load and recharge the batteries from a discharged state to full capacity in 24 hours plus 100 percent headroom for future battery and photovoltaic equipment. The charger shall be provided with a 4 stage charging algorithm to optimize battery performance and extend battery life. The charge controller shall be provided with the following:

a. Standard Features:
1) Voltage 12-48 selectable negative or positive ground
2) PWM series battery charging (not shunt)
3) 3-position battery select: gel, sealed or flooded
4) Temperature compensation
5) Tropicalization: conformal coating, stainless steel fasteners & anodized aluminum heat sink
6) No switching or measurement in the grounded leg
7) 100% solid state
8) Current compensated low voltage disconnect (LVD)
9) LED’s indication of battery status and fault conditions
10) Operate continuously at 125% of rated load
11) Remote battery voltage sense terminals
12) Remote digital meter to display voltage, current and temperature
13) Shall include manual disconnect button
14) Shall display protection functions and disconnect conditions
15) Shall be supplied with Self-Diagnostics (self-test)
16) Battery Temperature Sensor

b. Electronic Protections:
   1) Short-circuit — solar and load
   2) Overload — solar and load
   3) Reverse polarity
   4) Reverse current at night
   5) High voltage disconnect
   6) High temperature disconnect
   7) Lightning and transient surge protection
   8) Loads protected from voltage spikes
   9) Automatic recovery with all protections

2. The charge/controller shall be Morningstar TS-45, Prostar series or equal

2.03 AC POWER INVERTER

A. For equipment loads requiring AC power a 120 vac power inverter shall be provided sized to power the AC load plus 25 percent. The inverter input voltage shall be compatible with the DC power source and provide a modified sinewave output to the load.

B. Automatic shutdown and protection features shall be provided to shutdown the inverter on the following conditions:

   1. Low Voltage
2. Inverter Overload

C. The power inverter shall meet the following:

1. Surge Capability (Peak Power) 200%

2. Optimum Efficiency approx. 90% efficient

3. Output Voltage 115 VAC RMS +/- 5%

4. Input Voltage 10 – 30 VDC

5. Output Frequency 60 Hz quartz crystal controlled

6. Output Waveform Modified Sine Wave, phase corrected

D. The power inverter shall be Xantrex, Prowatt series, or equal.

2.04 PHOTOVOLTAIC MOUNTING STRUCTURES

A. Mounting hardware and module frame assembly shall be provided to mount the photovoltaic module to the pole and shall be manufactured of aluminum. The modules shall be secured with stainless steel tamper proof fasteners. The mounting structure shall be provided with a variable tilt angle from 10 to 75 degrees.

2.05 BATTERIES

A. Batteries shall be sized to meet the operational autonomy and load requirements specified. Batteries shall be 12 Volt Sealed Lead Acid Gel Cell designed for the use in solar power applications.

B. Batteries shall be installed in a ventilated cabinet section isolated from the power distribution and control equipment. Battery disconnecting and grounding means shall be provided and labeled in accordance with NEC article 690.

2.06 BATTERY MONITOR

A. Battery voltage shall be monitored by high and low voltage relay(s). The voltage relay(s) shall be adjustable for high and low battery voltage settings. The relay(s) shall provide a contact closure on a high and low battery voltage condition.

B. Battery voltage relay shall be Crompton Industries, Timemark, Thiim or equal.

2.07 TEMPERATURE SWITCH (THERMOSTAT)

A. Temperature switches shall be located in the control, battery and power distribution sections to monitor cabinet temperature.

B. The temperature switch shall be DIN rail mounted and shall be adjustable via a front panel mounted potentiometer with an adjustable range of 30 – 140 degrees Fahrenheit.
1. The thermostat adjustment potentiometer shall be graduated in twenty degree intervals with a single turn adjustment.

C. The switch shall be provided with a NO/NC dry contact output for interfacing with the temperature monitoring and control circuitry.

1. Contacts shall be rated for 10 amps at 120 VAC and 24 VDC.

D. The temperature switch shall be Hoffman A-TEMN series or equal.

2.08 EXHAUST FAN

A. The exhaust fan shall be low power draw DC axial fan with brushless motor. The exhaust fan shall be 24 VDC and provide for 100 cfm of air flow capacity.

B. Exhaust fan shall be Dayton, or equal.

2.09 DC DISCONNECT

A. DC disconnection and protection means shall be supplied in accordance NEC Article 690 for photovoltaic source, batteries and load. The disconnecting means shall be rated for a maximum 250 VDC and shall be UL listed for DC applications.

2.10 MOUNTING POLES

A. Mounting poles shall be of the material and heights as indicated, complete with handhole and gasketed cover, anchor bolts with leveling and locking screws and base cover.

B. Poles, anchoring, and foundation shall be designed to a minimum yield safety factor of 1.5 when subjected to a sustained wind velocity of 100 MPH and wind gusts of 130 MPH. In addition, the deflection of pole length shall be limited to 3% under these conditions.

C. The mounting pole shall be equipped with handhole of sufficient size to permit the pulling and routing of wires and grounding of the pole. Provide a grounding lug accessible through the handhole to accept a ½-inch diameter copper conductor. Handhole shall be provided with a cover.

D. The mounting pole shall be provided with a top mounted two inch pole with weatherhead for antenna installation. Install antennas, with antenna mounting hardware, and provide weatherproof wrap on the exposed mating connectors as shown on the Contract Drawings.

E. Install photovoltaic array with pole mounting hardware.

F. Provide pole with 2” couplings for PV array power entry and terminal box mounting. Coupling shall be located centrally behind PV array assembly and shall be provided with grounding connector for array grounding termination. Provide 2” coupling below RTU panel installation for routing power and antenna conductors to the RTU and battery enclosures.

G. Couplings shall be factory welded and supplied with pole.
H. Mounting pole shall be Whitco, Millerbend or equal.

PART 3 EXECUTION

3.00 INSTALLATION

A. The Contractor shall install all photovoltaic modules, antennas, pole, conduit, wire, control cabinets and associated supports and fittings as called for in these Specifications, and contained within applicable specification sections, as shown on the Drawings and in accordance with the manufacturer's instructions and recommendations.

B. Photovoltaic modules shall remain covered during the course of assembly and wire to prevent current sourcing. Prior to acceptance by the Owner, the Contractor shall remove the cover material and thoroughly wipe the photovoltaic modules clean.

C. All photovoltaic modules shall be aligned and directed as required by the solar manufacturer to achieve maximum solar gain. The Contractor shall obtain the direction and angle required for the solar array from the solar equipment provider based on the site latitude and longitude coordinates. Notify Owner at least three days in advance of installation.

D. All poles and photo-voltaic modules shall be directly grounded to the site grounding system by means of a conductor of a size not less than that required by NEC.

E. Install watertight UV rated flex conduit to/from photovoltaic array junction box to the pole mounted termination enclosure.

3.01 PV MODULE WIRING

A. Photovoltaic modules shall be wired in accordance with NEC. All conductors shall be 90 degree C rated for wet locations. Minimum wiring requirements shall be as follows:

1. Photovoltaic module wiring shall be routed in conduit as indicated on the contract drawings. Unless otherwise indicated PV array to power system wiring shall be #6 THWN-2.

2. Exposed wiring at the PV module utilized for interconnection of PV array to termination enclosures, tracking modules and pole/mast transitions shall be weather resistant and UV listed. Cable shall be USE-2 sized in accordance with NEC.

3.02 LABELING

A. Labeling shall be provided for PV array, battery and system disconnecting means in accordance with NEC Article 690.

B. System labels identification voltage, current and grounding parameters shall be provided in accordance with NEC Article 690.

3.03 WARRANTY

A. Provide warranty as specified in Electrical Section 16050 - Warranty.
B. Photovoltaic modules shall be provided with a 20 year warranty.

END OF SECTION
SECTION 17000
SCADA INFORMATION SYSTEMS

PART 1 GENERAL

1.00 REQUIREMENTS

A. This section covers the general requirements for SCADA computer and network information systems. Provide labor and materials as required for complete and operating hardware and software systems. The CSS shall furnish and install all hardware and software on the project.

B. The CSS shall install, ready for use, the SCADA system computer and network hardware and software as specified herein and shown on the Contract Drawings. This document describes the function and operation of the system and particular components, but does not necessarily describe all necessary devices and required software modules. All modules and devices shall be furnished and installed as required to provide a complete, operable and reliable system for accomplishing the functions and meeting the performance set forth hereinafter.

C. Furnish all required labor, materials, wiring, cables, project equipment, tools, test and diagnostic equipment, incidentals, and services to provide a complete and operational system as shown on the Drawings, included in these Specifications, or required for fully operating facilities.

D. This project consists of the modification of existing SCADA servers, workstations, networking components and equipment racks. The purpose of the SCADA system modifications is to provide for a Client/Server based distributed SCADA accessed from a Wide Area Network, (WAN), log to a Centralized SCADA Historical Data Server (HDS), provide global monitoring and alarm functions and allow SCADA operators the ability to view and control the remote systems from anywhere within the City environment.

E. The CSS shall install software, computer and network hardware as specified in related sections and indicated on the drawings.

F. The software shall be supplied on CD ROM media with a standard Windows Installation package. It shall be possible for personnel with basic computer skills to install the SCADA workstation components on a Windows based machine. Both components shall appear in the Add/Remove programs window of Windows operating systems and provide for the repair, or removal of the software components.
G. SCADA system software upgrades associated with the Inteelution IFix or Proficy Historical Data Software shall be provided by the City.

1.01 RELATED SECTIONS

A. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the System Integrator and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.02 CODES AND STANDARDS

A. All network equipment and materials, including installation and testing, shall conform to the following applicable codes and standards:

1. ANSI - American National Standards Institute, Inc.
2. EIA - Electronics Industries Association.
3. ETL - Electrical Testing Laboratories.
4. IEEE - Institute of Electrical and Electronics Engineers.
5. ISA - International Society for Measurements & Control (ISA) Standards (formerly Instrument Society of America).
10. UL - Underwriter's Laboratories, Inc.
11. FCC – Federal Communications Commission

B. The revisions of these codes and standards in effect on the date of issuance of the Contract Documents shall apply.

C. All work shall also be performed in accordance with the State, County or Owner standards, and local Utility codes.

1.03 SYSTEM INTEGRATOR QUALIFICATIONS

A. It is the intent of this and related Divisions that the complete responsibility for management, installation, and commissioning of the
SCADA computer and network information systems required for this project is by a single Control Systems Supplier.

B. Reference Section 13300 for Technical Qualifications and Requirements.

1.04 CONTRACT DOCUMENTS

A. The contract drawings and specifications are intended to be descriptive of the type of computer and network system to be provided; any minor details missing in either shall not relieve the CSS from the obligations there under to install in correct detail any and all materials necessary for a complete operational system at no additional cost.

B. Exact locations of computer workstations, equipment racks and communications products shall be verified in the field with the Owner. The Owner shall make minor adjustments to locations of equipment required by the field conditions at no additional cost.

C. The CSS shall provide all necessary cabling, power strips, adapters, interface components, wallplates and switches as required.

D. All equipment shall be installed and located so that it can be readily accessed for operation and maintenance. The Owner reserves the right to require minor changes in location of equipment, without incurring any additional costs. These minor changes are changes that would provide adequate clearance and work areas in front of and around equipment.

1.05 SUBMITTALS

A. The CSS shall prepare detailed submittals for the SCADA system WAN, LAN, Networking, hardware and software systems specified. The CSS shall provide the systems submittals in two phases as follows:

1. Hardware

   a. The hardware and software submittal shall be prepared based on purchased equipment required for implementation and programming. The submittal shall be tabulated in a three ring binder and organized as follows:

      1) Table of Contents: The table contents shall be provided at the front of the binder and list each tabulated section.
2) Bill of Material: Bill of material shall delineate all system components and systems and shall be grouped by area of installation, location, rack assembly and function.

3) Computer Hardware: Computer hardware data sheets and catalog data shall be provided and highlighted with all supplied features, options and configurations. Datasheets not marked or highlighted shall be returned unreviewed.

4) Peripheral Equipment: Peripheral equipment shall include cabling, wall jacks, power strips, UPS, installation materials etc. Data sheets and catalog data shall be provided and highlighted with all supplied features, options and configurations. Datasheets not marked or highlighted shall be returned unreviewed.

b. SOFTWARE

1) Computer Software: Computer Software data sheets and catalog data shall be provided and highlighted with all supplied features, options and configurations. Datasheets not marked or highlighted shall be returned unreviewed.

2) Network Hardware: Network Hardware data sheets and catalog data shall be provided and highlighted with all supplied features, options and configurations. Datasheets not marked or highlighted shall be returned unreviewed.

3) Network Software: Network Software data sheets and catalog data shall be provided and highlighted with all supplied features, options and configurations. Datasheets not marked or highlighted shall be returned unreviewed.

2. System Diagrams

a. Network Node Diagram: Provide a system diagram that indicates all networked devices and their associated IP address. The node diagram shall include all switches, routers, computers, devices and connection locations for a complete view of the system network.

b. Data Logging Chart and Reporting Access diagram indicating all nodes that are logging, importing or exporting data to and from the HDS.

c. System Diagram: The system diagram presented in the RFP shall be modified and expanded to reflect the final system configuration.
3. Equipment Racks
   a. Drawings
      1) Provide scaled equipment rack layout drawings depicting all equipment locations, wireways, filler panels, fans and other components that will depict how the panel is assembled.
      2) Provide heat load/loss calculations.
      3) Provide power distribution wiring diagram
      4) Provide cable and termination labels for review.

1.06 COORDINATON
   A. The CSS shall coordinate specific hardware configurations, software application requirements and implementation efforts with the Owner's Information Systems.

1.07 PROJECT MEETINGS
   A. Attend project meetings as specified and conduct workshops in accordance with Section 13300.

1.08 SCADA CONFIGURATION SCHEDULE
   A. The CSS shall prepare a SCADA implementation and configuration schedule. The schedule shall be a CPM of the SCADA implementation effort and shall delineate all meetings, workshops and milestones for project implementation.
      1. The schedule shall delineate the requirements for equipment and software to be furnished by the owner.
      2. The schedule shall take into account software submittals and review time.
      3. The schedule shall establish the factory testing, commissioning and final acceptance testing dates and periods and identify the equipment requirements from other suppliers necessary to conduct the testing specified.
      4. The schedule shall address anticipated durations for testing, system commissioning and final acceptance test.

PART 2 PRODUCTS

2.00 QUALITY
A. It is the intent of the contract specifications and drawings to secure the highest quality in all materials and equipment in order to facilitate operation and maintenance of the facility. All equipment and materials shall be new, the products of reputable suppliers that have adequate experience in the manufacture of these particular items. Provide the manufacturer’s latest products and software versions that conform to these specifications.

B. To account for the rapid change in technology and insure system compatibility the Owner has elected to procure computer system hardware, operating system software and networking components utilizing a cost allotment. These items shall be furnished as a part of the listed items in Section 17110.

C. All equipment shall be designed and packaged for the service intended and shall be of rugged construction, of ample strength for all stresses, which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed, braced, and anchored, and shall be installed in a neat and workmanlike manner.

D. Products that are specified by manufacturer, trade name, or catalog number, establish a standard of quality and does not prohibit the use of approved equal of other manufacturers. However, all provided products specified or not, must be favorably reviewed and approved by the Engineer prior to installation.

2.01 CABLES:

A. Provide all cables and cords for interconnection and installation of the computer and communications equipment required and as illustrated on the PLC/SCADA communications and network drawings.

B. Cat 6 cables installed by Contractor shall meet the following specifications:
   2. #24 AWG copper conductors, 4 pair shielded twisted pair.
   3. Thermoplastic Dielectric type overall foil shield with drain wire.
   4. PVC jacket.
   5. NEC rating: CM, MP.
   6. UL listed for NEC compliance.
   7. Non-plenum usage.
   8. Color Code:
      a. Information Network (YELLOW)
b. Control Network (BLUE)
c. Administration Network (GEY)
d. T1 Telco Communications (RED)

C. Fiber Optic Cables
   1. Provide factory terminated fiber optic cables Single Mode and Multi-Mode as required for equipment connection. Fiber cables shall be paired and color coded.

2.02 Universal Data Termination Patch Panels

A. The patch panel be 19" rack mount and shall meet or exceed the requirements for Category 6 described in TIA/EIA-568-B.2-1 as well as the Class E requirements described in ISO/IEC 11801-B. The panels shall feature both T568A and T568B wiring configurations, mounting standoffs for cable management bars, and front write-on labeling. The panels shall be made of 16 gauge steel, and shall have a black painted finish with white silk-screening. The plastic elements shall be fire-retardant with a UL flammability rating of 94V-0. The panel shall be offered in 24- and 48-port configurations.

B. The panel shall support the interconnection of modular multimedia jacks and connectors. The Panel shall have the ability to allow for single port replacement of inoperative ports.

C. Patch panels shall be Panduit, Corning Lanscape, “Or Equal”

2.03 Wallplate and Patch panel connectors

A. Wallplate and patch panels shall be modular construction and provided for all communication terminations of networking, telephone and data circuits. Data communications connectors shall be modular and color-coded per application.

B. The modular connector shall meet or exceed the requirements for channel and component-level performance described in TIA/EIA-568 standards. The modular connector shall be individual snap-in style. The connectors shall also be in compliance with all National Electrical Codes; compliant with FCC Part 68; UL listed; and independently verified.

C. All plastics used in construction of the connector bodies shall be fire-retardant with a UL flammability rating of 94V-0. Connector wiring is universal and will accommodate installation color codes for T568A and T568B wiring schemes.
1. Category 6 jacks shall provide state-of-the-art printed circuit technology to handle unshielded twisted-pair (UTP) data requirements. The connector shall have the ability to support high megabit and shared-sheath applications. Connectors shall be snap-in Keystone mounted jacks capable of a minimum of 100 Mbs with integral board mounted 110 connections and 50 micro-inch gold plated modular contacts. Jacks shall meet TIA/EIA 568A and TSB40A requirements for connecting hardware T568A (ISDN) and T568B (AT&T) wiring configurations. Termination of all connectors shall be 110-type insulation displacement connectors (IDC). The connector shall provide a ledge directly adjacent to the 110-style termination against which the wires can be directly terminated and cut in one action by the installation craftsperson.

D. Connectors shall be Corning Lanscape, Leviton Quickport, “Or Equal”

2.04 ELECTRONIC EQUIPMENT RACKS

A. GENERAL

1. Equipment racks shall be engineered and provided as indicated on the contract drawings. Rack assembly shall be a modular constructed system provided complete with all assemblies, mounting hardware, thermal management, shelving, trays, filler panels and wire management components required to wire and house the electronic equipment specified.

2. Rack assemblies to be provided under desks or as a part of a modular computer desk assembly shall be a complete and manufactured assembly. The rack shall fit under the computer desk. The SI shall coordinate all measurements and provide a panel of sufficient size to fit under the desk.

B. RACK ASSEMBLY

1. The rack assembly shall be a welded 12-gauge rigid open steel frame design. The assembly shall be 24” wide with 19” wide rack mountable interior frame and mounting brackets. The assembly shall be designed to accept standard 19” rack mountable equipment and shall be constructed as a modular equipment rack system.

C. Rack Power Distribution

1. Equipment racks shall be provided with a Rack Mounted Power Distribution Unit (PDU) for distributing AC power to equipment and plug strips. The PDU shall be provided with the following:
a. Front mounted illuminated switch/circuit breaker.

b. Integral surge and spike protection.

c. Minimum of six 15 amp, 120 vac rated rear mount receptacles

2. PDU shall be Black Box, APC or equal

D. Equipment racks shall be Emcor Enclosures 10 Series, Hoffman or equal

2.05 COMPUTER PERIPHERALS

A. Port Sharing Switch

1. The port sharing switch shall be a keyboard-mouse-monitor sharing switch capable of switching between (4) four computer servers. The switch shall be rack mountable. The switch shall support both manual and hot key transfer between computers. The switch shall allow for auto reboot of computers not selected on the switch.

2. Switch shall be KVM, ATEN, or Blackbox

3. A port sharing switch shall be provided for each equipment rack housing computer servers.

2.06 NETWORKING

A. INFORMATION SYSTEM ETHERNET SWITCH

1. Information switches shall be located at:

   a. Thornton WTP Communications Shelter

2. Ethernet 10/100 network server switches shall be deployed at the locations designated on the contract drawings. Switch shall support the designated channels plus an additional 25 percent for future expansion. Ethernet switch shall support the latest IEEE 802.3 for 10/100BaseTX. The Ethernet switch shall support the following minimum requirements:

   a. 10/100 auto sensing per port. Switch shall automatically detect and set the speed for any 10/100/1000 Base device.

   b. Automatically adjust for straight-through or crossover cables on all 10/100 ports.

   c. Full-Duplex flow control communications.
d. Comprehensive LED display with per-port indicators

e. Automatic polarity correction: helps find and fix common cabling problems

f. Half/full-duplex auto-negotiation on every port: shall automatically double the throughput to each device, up to 200 Mbps

g. Switch design shall deliver dedicated bandwidth to each device and use segmentation to improve network utilization

h. 24 port minimum.

i. Two high speed dual purpose uplink ports

j. SNMP manageable

k. 256K DRAM

3. The network switch shall be Cisco WS-C2960 series

B. CONTROL NETWORK ETHERNET SWITCH

1. Control network switches shall be provided at the following locations;

2. Ethernet 10/100 network server switches shall be modular and deployed at the locations designated on the contract drawings. Control network switch shall support Single and Multi-mode fiber optic modules and applications for PLC and SCADA server connectivity. Switch shall support the designated channels plus an additional 25 percent for future expansion. Ethernet switch shall support the latest IEEE 802.3 for 10/100BaseTX.

3. The Switch Assembly Shall Be N-Tron Series 900

4. The Ethernet switch shall support the following minimum requirements:

   a. 8 - 10/100 auto sensing per port. Switch shall automatically detect and set the speed for any 10/100Base device.

   b. 4 – 100BASE FX Multimode Fiber Optic Module with ST connectors

   c. Automatically adjust for straight-through or crossover cables on all 10/100 ports.
d. Full-Duplex flow control communications.

e. Comprehensive LED display with per-port indicators

f. Automatic polarity correction: helps find and fix common cabling problems

g. Half/full-duplex auto-negotiation on every port: shall automatically double the throughput to each device, up to 200 Mbps

h. Switch design shall deliver dedicated bandwidth to each device and use segmentation to improve network utilization

i. 12 port minimum.

j. SNMP manageable

k. 19" Rack Mount Assembly, N-Tron 900-RM

l. 3 slot Chassis with N-View, Software N-Tron 900B-N

PART 3 EXECUTION

3.00 GENERAL

A. SCADA system programming is provided by the Owner’s system programmer as a complete and integrated system for plant monitoring and control.

B. The CSS is responsible for the procurement, base configuration, installation and commissioning of the SCADA hardware and software components. The CSSI shall configure and load all base software applications on the equipment including network diagnostics software to verify the basic operation of the networked systems and its components. Network routing algorithm shall be programmed by the SP.

C. The CSS shall coordinate installation, commissioning and testing efforts with the Owner’s Operation and Information’s Systems.

3.01 EXISTING RACK MODIFICATIONS

A. The CSS shall modify the existing SCADA racks to provide for the additional switching components and peripherals necessary to include the new SCADA equipment. Existing racks shall be modified in accordance with this specifications section.
3.02 CABLE MANAGEMENT

A. Labeling:

1. All cables shall be labeled in a permanent, consistent manner, in accordance with the best practices of the industry. Label both ends of each cable. Labels shall be permanently affixed to the cable per the manufacturer’s recommendations, and shall meet the applicable requirements of specifications.

2. Labels shall be machine printed, hand marked labels are not allowed. Prior to installation, the CSS shall provide interconnection schematics showing all cabling, including suggested cable naming.

B. Routing:

1. All cables shall be routed in an orderly fashion. Groups of compatible cables routed to/from the same locations shall be bundled, run in channel, horizontal wireways and wire tied when transitioning between equipment enclosures and wireways.

2. Cables shall be routed parallel to equipment structures and shall be of sufficient length not to cut corners. Excess cable length shall be neatly coiled and wire tied.

3. Cable systems contained within rack assemblies shall be routed though horizontal and vertical cable trays.

4. Provide sufficient slack in all cables for equipment removal.

5. Wire and bundle ties shall be adjustable velcro straps.

C. Support:

1. All cables and cable bundles shall be periodically supported by wire tie anchor points and plastic D rings contained within rack cabinets. Where possible, wire ties shall loop through fixed equipment attachment points. When fixed equipment anchor points are not available, wire tie anchors shall be adhesive type and shall be sized according to the wire tie size and mechanical cable load.

D. Cable Penetrations:

1. Passageways for cabling shall be logically located and finished off with grommet, compression fittings or other suitable means.

3.03 FACTORY TESTING
A. The factory test shall include all equipment, set-up and configured as if it were operating in the field with all equipment connected and operational to simulate field conditions.

B. The CSS shall furnish and provide all, labor, test cables, cabling, equipment, communications simulators, testing and diagnostics tools required to exercise the system to its full extent of operation with the Owner.

C. The factory test shall be successfully completed prior to the switchover and conversion to operate the process.

3.04 SYSTEM INSTALLATION

A. The CSS shall attend general system-commissioning meetings that shall address the testing, implementation, and commissioning requirements of the system.

3.05 WARRANTY AND CUSTOMER SUPPORT

A. All computer hardware and software shall be provided with 3 year same day onsite service including parts and onsite service.

3.06 SCADA TECHNICAL SERVICES

A. In addition to the specified requirements for application programming and testing, the CSS shall provide an additional 160 hrs of on site SCADA programming and technical support. These hours are not associated with any technical requirements specified for programming, start-up and commissioning efforts.

B. Allotted hours are in addition to the requirements of the specification to provide for a complete and operational system. Allotment hours are to be utilized to provide for interfacing with equipment not specified or implied in the contract documents, enhancement of operation and interfacing with new equipment added during the course of contract implementation.

C. Onsite service shall be defined and directed by the Owner on a task basis during the course of construction. Hours shall be applied in the field and logged accordingly by the Project Manager or Owner’s Field Representative.

D. Remaining hours shall be included as a part of a one year service contractor upon completion of the project.

END OF SECTION
Not Used
PART 1 -- REQUIREMENTS

1.01 GENERAL

A. The Phase 2 SCADA System Upgrade consists of SCADA system development and configuration associated with the development of new graphic screens, symbols, navigation and databasing requirements for the Owner’s remote sites which are comprised of distribution system sites, raw water sites and sewage collection systems.

B. The Phase 2 SCADA System Upgrade requirements presented are based on a GE/Intellution IFix SCADA foundation for monitoring, control and information systems implementing Modicon based PLC controls for existing and new system processes.

1.02 EXISTING SYSTEM OPERATION

A. The existing distribution system SCADA interface is implemented based on a Motorola MOSCAD platform that is to be replaced with the equipment and materials covered as a part of the phase 2 SCADA System Upgrade – Phase 2A. The new remote distribution SCADA system will be replaced in its entirety with new SCADA system graphics, tagging conventions and navigation to support a standardized system configuration.

1.03 Additional Bid Items for SCADA phases 2B, 2C and 2d as indicated in the “Scope of Work” are to be implemented as new system additions to the SCADA system.

1.04 SCOPE OF WORK

A. The Control System Supplier (CSS) shall provide all computer system configurations, SCADA configurations and programming, testing and implementation services referenced and contained within the Contract Documents.

B. The SCADA systems programming and implementation effort shall be provided complete, ready for use and operational by the CSS. The CSS shall provide all services required to complete the following general scope of work items:
1. The CSS shall furnish submittal data, conduct workshops, coordinate configuration efforts and furnish all services to finalize the configuration requirements for the SCADA system upgrade.

2. The CSS shall add to, modify, program and reconfigure the existing SCADA system applications in conformance with the Contract Documents. All new graphic screens shall be developed for Phase 2A in accordance with the standards and methods presented in the Contract Documents.

3. The CSS shall provide SCADA programming to develop new graphics, trends and navigational screens. The CSS shall coordinate the SCADA configuration and screen development with the owner in a workshop environment.

4. The CSS shall modify, configure test and implement the existing Historical Database (HDS) and Storage Server (NAD) for historical data archiving, analysis, reporting trending and system back-up and recovery applications of all data presented by the remote systems.

5. The CSS shall provide network programming and configuration services to reconfigure the network as indicated on the drawings.

6. The CSS shall provide all services required to install, precommission, commission and final acceptance test the SCADA system operation.

7. The CSS shall provide Training

8. The CSS shall provide Operations Manuals.

1.05 WORKSHOPS

A. The CSS shall conduct a series of workshops associated with the system configuration and development effort. The following workshops shall be conducted by the SI:

1. Existing System Review, Standards and Methods for Graphic Screen Development

2. System Definition and Tag naming

3. Historical Database System Logging, reporting and back-up.

4. New Graphics Development Workshop

1.06 TAGNAME DATABASE
A. The CSS shall develop a tagname database in accordance with the tagging conventions outlined in Section 13371. The existing tagname database shall be reconfigured to utilize a consistent tagnaming convention for SCADA system applications and interfacing with the Master PLC. The tagname database shall be printed out and submitted to the Owner for review and comment. The requirements for tagging shall be coordinated with the Owner for review and approval prior to final development of the Tagname database.

B. The CSS shall meet with the Owner in a workshop environment to review the tagname database and address the following on a tag-by-tag basis:

1. Tag reference and description
2. Logging requirements local and to HDS
3. Validity of the tagname and its function
4. Alarm configuration and type
5. Event or State Change
6. Event logging or alarm logging requirement
7. Reporting functionality
8. Grouping (Raw Water, Wastewater, Distribution or Treatment)
9. Security Requirements

C. The CSS shall modify the tagname database in accordance with the workshop requirements.

1.07 COMPUTER SYSTEM HARDWARE
A. All computer system hardware and Software is existing.

1.08 NETWORK AND COMMUNICATIONS
A. Provide networking and communications interface equipment as indicated.

1.09 SCADA SYSTEM SOFTWARE
A. All SCADA system IFIX application software is existing.

B. The CSS shall utilize their own development software for system configuration.
1.10 SCADA SYSTEM APPLICATION CONFIGURATION

A. The existing SCADA system software shall be modified at all servers and workstations to support secure view and control anywhere functionality with the City’s SCADA Wide Area Network. Services will include but not necessarily be limited to:

1. Modify the Thornton WTP application, scripting and tag naming convention to be consistent with the Wes Brown WTP server applications.

2. Create a distribution overview screen of the entire radio system to navigate from the overview screen to the Thornton system, Wes Brown system, raw water system and the remote site system. Include other systems under applicable phases.

3. Develop, configure, test and implement graphics displays that are specific to the requirements for distribution, sewer and raw water system monitoring. The graphic displays shall be created to present data based on area, process and display requirements. The CSS shall prepare the following graphic displays:

   a. Distribution System Overview Phase 2A – The Distribution System Overview shall consist of graphical map display(s) indicating the location and available data for the distribution monitoring sites. A sample map will be provided by the Owner.

   b. Sewer Collection System Overview Phase 2A – The sewage collection System Overview shall consist of graphical map display(s) indicating the location and available data for the sewage collection monitoring sites. A sample map will be provided by the Owner.

   c. Raw Water System Overview Phase 2B and 2D – The Raw Water System Overview shall consist of graphical map display(s) indicating the location and available data for the raw water monitoring sites. A sample map will be provided by the Owner.

   d. Individual Site Process Displays – Process displays shall be provide for each site and area and include the associated type data as indicated in appendix A. Place holders for future information shall be included in the display for easy configuration when the data becomes available from SCADA.
e. Process Configuration and Pop-Up Displays – Provide setpoint, control pop-up, equipment and informational displays to represent all configuration data in conformance with Section 17040.

f. Flow Production and Calculated Data Displays – The graphical displays shall be provided to include realtime level and calculated flow data based on formulas to be provided by the Owner.

g. Instrument and Equipment Setpoint Screens.

h. Equipment Statistics and Maintenance Screens.

i. Trend Displays shall be provided for all analog data.

j. Equipment Diagnostic Display

4. Develop, configure, test and implement a PLC diagnostic system display. The graphics shall implement a single PLC system in the plant as a model for future PLC diagnostic displays to be developed by the City.

5. Additional screen displays shall be provided at the direction of the owner to facilitate additional information requirements. The CSS shall provide for an additional 20 graphic displays in addition to those specified and required for SCADA monitoring and control.

1.11 SCADA SERVER REDUNDANCY AND TERMINAL SERVICES

A. Configure, test, modify and implement SCADA software applications on the existing redundant SCADA system server application the existing SCADA Servers SSA and SSB to include all new SCADA system configurations.

B. Configure, test, modify and implement SCADA software applications on the existing Terminal SCADA Server (TSS) system application to allow for terminal service client (TSC) machines to view and control all aspects of the SCADA system. The existing TSC machines shall be configured with the appropriate securities. Each TSC shall be provided with securities to isolate treatment, distribution, sewage collection and raw water operations. Security shall also provide for view only or view and control operations.

C. Configure and test the existing process and secondary system clients (PCL) and (SCL) clients for monitoring and control of the system.
These clients shall access the servers directly and operate independent of the status of the Terminal Server (TSS).

1.12 HISTORICAL DATA SERVER CONFIGURATION

A. Configure, test and implement changes to the existing Historical Data Server (HDS). The HDS shall be configured to store data, provide data for reporting, provide historical trends, back-up data to the storage server and interface with the reporting and query system software. The following data shall be logged to the HDS from the SCADA Servers SSA/B and SST:

1. Equipment Runtime
2. Equipment Start Counters
3. All analog data (Process, Level, Flow, Pressure, etc)
4. Equipment Starts, Stops, Fails
5. Setpoint Changes (with user ID)
6. Alarms, Alarm Acknowledgements and Alarm Resets

B. Modify historical data logging to be both time and differential change based.

1.13 SCADA SYSTEM NETWORK APPLICATION

A. Reconfigure, test and implement changes to the existing local and wide area network applications located at the Thornton and Wes Brown Treatment Plants to provide for two distinct and separate SCADA information (SIN) and process control (PCN) system networks as indicated on System Diagram (1-1). The CSS shall provide all network configuration services to separate the networks as required to optimize system operation. The CSS shall provide the following:

1. Routers shall be programmed utilizing the same type of router algorithms and configurations currently deployed by the City.

1.14 SYSTEM REPORTING

A. The shall develop new reports, modify all existing reports and implement changes to the existing reporting system. The existing reports shall be reconfigured, modified and implemented to work with the Historical Data Server applications.

B. New reports shall be generated to provide for the following:
1. Flow Production
2. Chemical Usage
3. Process Data (Min, Max, Average)
4. Raw Water System Calculated reports. A total of 20 – two page reports with 50 variables each.
5. Equipment Maintenance (Runtime and Starts)

C. The CSS shall conduct a report generation workshop that will address the reporting system requirements and present various reporting samples for review by the Owner.

D. Modify the existing raw water client system to include the raw water system RTU's to provide for total water usage, calculated and distribution of raw water flow production, usage, return and accumulated flow data.

1.15 SYSTEM TESTING AND IMPLEMENTATION

A. Overview

1. The CSS shall provide all programming services referenced and contained within the RFP. The systems programming effort shall be provided complete, ready for use and operational by the Systems Integrator in accordance with the technical requirements governed by the RFP. In addition to the programming services, the CSS shall provide all implementation and commissioning services required to complete the following:

   (1) Install, Set-up and Configure all Hardware and Software
   (2) Conduct SCADA Precommissioning Test
   (3) Prepare a SCADA Testing and System Conversion Plan
   (4) Conduct SCADA Commissioning Test
   (5) Conduct SCADA Final Acceptance Test
   (6) Provide Operator Training
   (7) Provide As-Programming Documentation

B. Precommissioning
1. The precommissioning test shall include as a minimum a SCADA Server, Operator Workstation and the HDS to demonstrate the basic configuration and operation of the SCADA system prior to the commissioning phase testing.

2. The precommissioning test shall be conducted by the SI to illustrate the general operation and functionality of the overall SCADA system. The precommissioning test will be provide to the City to demonstrate the revised system configuration and its overall functionality.

3. The Precommissioning test shall be presented in a workshop type environment to be reviewed by the City with respect to its operation and adherence to the system requirements. The Precommissioning test shall demonstrate the following:
   a. Graphic Screen Configuration
   b. System Consolidation
   c. System Navigation
   d. Data Logging Integrity

4. The City shall provide a deficiency list, make comment and request minor modifications to the system based on the software demonstration provided.

5. System modifications that result in additional screen development of programming efforts outside the “Scope of Work” shall be addressed with the programming allotment hours.

6. Prior to the commissioning test, the SI shall make all modifications and corrections to the system.

C. Commissioning

1. The new SCADA servers shall be installed and connected in parallel with the existing system for the commissioning effort. Prior to witnessed testing, the SI shall conduct preliminary tests to verify the following:
   a. PLC communications is established to all PLC nodes.
   b. SCADA Information network is operational and the HDS, TSS, SSA, SSB and the Operator Workstations are communicating on the SIN.
c. A local Terminal Server Client is operational

d. Data is being logged to the HDS.

2. When the above functionality has been established the SI shall conduct the commissioning test in cooperation with the City to Verify Screen by Screen, Register by Register and Point by Point that the system is operating correctly.

3. A test operator workstation will be installed next to the existing servers to allow for testing and verification of operation. The SI shall provide a printout of all graphics for testing. The graphic prints will serve as the comments and notes to address all operational items on a screen to be corrected by the SI. The commissioning test for the SCADA application shall include the following:

a. View screen data on existing and new system graphics to match.

b. Start equipment in manual from existing system, verify running and start command graphics. Stop equipment from new system verify graphic on new and existing. Repeat by starting equipment from new and stopping from existing.

c. Change setpoint from existing system, verify change on all associated new system screens. Change setpoint from new system and verify change at existing system.

d. Initiate, confirm and acknowledge all alarms at the existing system and new system. Confirm alarm receipt and acknowledgement.

e. Verify operation of all pop-screens.

f. Verify operation of all trend screens.

4. Demonstrate system operation

a. Demonstrate operation of the Terminal Server and TS Client

b. Demonstrate the redundant system operation to include:

   (1) SCADA Server Failover

   (2) HDS Failover Logging
(3) Terminal Server Failover

(4) Client Failover

5. Demonstrate HDS operation
   a. View trends
   b. View log files
   c. Print daily test report utilizing real data
   d. Query data from Client
   e. Query data from Terminal Server Client
   f. Demonstrate Data Integrity – Disconnect HDS and verify local data collection, reconnect HDS after 24 hours and confirm data collector transfer.
   g. Demonstrate the configuration of a machine from scratch utilizing the Storage Server.

D. Final Acceptance Testing

1. Upon acceptance of the commissioning test, the system will undergo a Final Acceptance Test for a period of 30 days. The final acceptance test will be conducted by the owner.

2. The Acceptance test will stop if any of the following occurs and restart after the deficiency is corrected.
   a. Incorrect operation of the SCADA system that does not lock-up fault or shutdown the computer.
   b. Excessive unrelated SCADA Ifix Error Messages (More than 10)
   c. Excessive Terminal Server Client Failure (More than 5)
   d. Excessive Incorrect data representation (More than 10)

3. The Acceptance Test will be considered failed and restart from day one if the following occurs:
   a. Server Lock-up of Failure
   b. HDS Lock-up or Failure
c. Terminal Server Lock-Up or failure

d. Process or Secondary SCADA Client Workstation Failure

4. The CSS shall correct all deficiency and have completed a satisfactory Final Acceptance Test Prior to project close-out and final acceptance.

E. SCADA System Training

1. Provide 5 days of applications training as follows:

   a. One Day General SCADA
   
   b. One Day Distribution
   
   c. One Day Raw Water
   
   d. One Day Sewage Collection
   
   e. One Day System Operation, Communications

END OF SECTION
PART 1  SCADA SYSTEM GRAPHICS

1.00  GENERAL
A. Graphic displays shall be grouped functionally, by equipment, process and system for ease of operation. Process graphics shall be generated based on the process P&ID and sample graphics presented. Both analog and discrete functions associated with an item of equipment or a group of equipment shall be provided on the same display and tagged by its associated equipment or ISA reference.

B. Section 17040-A provides sample graphic displays for the various types of facilities utilized by the Owner. Samples are presented to provide the CSS with a level of detail and development effort required. The samples shall be modified to meet the site specific requirements and submitted for review by the Owner prior Factory Operational Test.

C. Given that there is a significant amount of scripting and background programming methods utilized in the SCADA configuration. The CSS shall review the existing applications and provide configuration services that utilize the same procedures and methods for new systems as that contained within the existing systems, where those systems are not covered by the Contract Documents. Equipment and process items that are not covered in these specifications shall be programmed and configured in conformance with the Owner standards and methods utilized within the existing applications.

D. The CSS shall adhere to the following formats contained in the sample application:
   1. Text size, font, foreground and background color, style and on/off triggers
   2. Graphics resolution, Display Organization, Navigation Bars, Pop-Ups
   3. On/Off Color, Foreground/Background Color, button styles, symbols
   4. General arrangement, navigation methods, alarm management, and trending and formats shall be adhered to.

E. The CSS shall coordinate the requirements for trigger registers, internal setpoints, reset functions and feedback communications that are necessary for the development of reporting functions as they relate to the various reporting formats. The CSS shall coordinate these requirements with the existing report generation software configurations and formats.

1.01  GRAPHICS DEVELOPMENT
A. The Contract Documents present methods and procedures represented by sample displays to indicated the level of information and functionality of the pop-up displays, equipment displays and process displays. The CSS shall
coordinate all development factors such as text size, font, colors and amount of information displayed.

1.02 PROCESS DISPLAY
A. Graphic displays shall be grouped functionally, by equipment, process and system for ease of operation. Process graphics shall be generated based on the process P&ID or samples provided for review.
B. Stations without representative samples shall be prepared in a P&ID format that shall be coordinated during the development workshop with the Owner.
C. Both analog and discrete functions associated with an item of equipment or a group of equipment shall be provided on the same display and tagged by its associated equipment description and ISA reference per the tagging conventions.
D. The CSS shall coordinate all equipment and process labels with the Owner.

1.03 PLC DIAGNOSTIC DISPLAY
A. A PLC diagnostic display shall be provided for each PLC processor, I/O module, communications module and rack configuration. The PLC diagnostic display shall be configured as follows:
   1. Rack configuration display shall indicate the rack configuration as provided for in the as built configuration. Processor health, rack I/O status and general CPU fault and diagnostic data shall be provided for on the PLC rack configuration display.
   2. By highlighting and selecting a module in the rack, the SCADA will navigate to the specific module configuration and display all associated module data. Modules shall be configured to display all relevant physical and virtual data as indicated in the sample graphics.
   3. Modules not addressed in the sample configurations shall be configured similar to the sample providing sufficient I/O and diagnostic data for PLC testing and trouble shooting. New diagnostic modules shall be coordinated with the City.

1.04 MAINTENANCE DISPLAYS
A. Maintenance displays are provided for the monitoring and control of non-essential operational data or data that is not associated with the process such as power-monitoring, generator system data, intrusion/security, network and communications data. These screens are also provided with tuning parameters that are rarely modified or changed and are normally not accessible by operations.
B. Tunable parameters would be equipment fail delays, PID tuning parameters, Process Tuning parameters and other tuning variables. The creation of these displays shall be coordinated with the City to determine what setpoints and control registers are to be considered as maintenance display only parameters.
1.05 **ALARM AND EQUIPMENT SETPOINT DISPLAY**

A. The following represents typical alarm and equipment setpoint displays. Displays shall be arranged by process and equipment groups.

B. Alarm and equipment setpoint displays shall be created and grouped by equipment process, loop and function.

C. Alarm and Equipment Setpoint Display Example

<table>
<thead>
<tr>
<th>Pump #1 Setpoints</th>
<th>Alarm Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>YCKX-9010 Motor Start Delay</td>
<td>90 S</td>
</tr>
<tr>
<td>YKFX-9010 Motor Failure Delay</td>
<td>120 S</td>
</tr>
<tr>
<td>LKHX-9010 Motor Moisture Alarm</td>
<td>120 S</td>
</tr>
<tr>
<td>KAQX-9010 Motor Fail To Start Delay</td>
<td>30 S</td>
</tr>
<tr>
<td>PAHH-9010 Pump High PSI Shutdown Delay</td>
<td>30 S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Station Power System Alarms</th>
<th>Alarm Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>JALX-1001 Station Power/Phase Failure</td>
<td>120 S</td>
</tr>
<tr>
<td>YAFX-1010 Generator System Failure</td>
<td>30 S</td>
</tr>
<tr>
<td>JALX-9001 Loss of Control Power</td>
<td>30 S</td>
</tr>
<tr>
<td>EALX-9001 UPS Low Battery</td>
<td>30 S</td>
</tr>
<tr>
<td>YAFX-9001 UPS Failure</td>
<td>30 S</td>
</tr>
</tbody>
</table>
1.06 INSTRUMENT SETPOINT DISPLAYS

A. Process instrument and equipment displays shall be created and grouped by process, loop and function.

B. Motor Current Example

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Description</th>
<th>Alarm State</th>
<th>Alarm Delay</th>
<th>Alarm Setpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISHH-9010</td>
<td>CURRENT HIGH-HIGH SETPOINT (AMPS)</td>
<td>○</td>
<td>90 S</td>
<td>32 A</td>
</tr>
<tr>
<td>ISHX-9010</td>
<td>CURRENT HIGH SETPOINT (AMPS)</td>
<td>○</td>
<td>120 S</td>
<td>20 A</td>
</tr>
<tr>
<td>ISLX-9010</td>
<td>CURRENT LOW SETPOINT (AMPS)</td>
<td>○</td>
<td>120 S</td>
<td>10 A</td>
</tr>
<tr>
<td>ISLL-9010</td>
<td>CURRENT LOW-LOW SETPOINT (AMPS)</td>
<td>○</td>
<td>30 S</td>
<td>4.0 A</td>
</tr>
<tr>
<td>ISHH-9010</td>
<td>CURRENT RATE OF CHANGE (AMPS)</td>
<td>○</td>
<td>10 S</td>
<td>20 A</td>
</tr>
<tr>
<td>ISHH-9010</td>
<td>CURRENT SIGNAL FAIL</td>
<td>○</td>
<td>60 S</td>
<td>1</td>
</tr>
</tbody>
</table>

Legend:
E (Error) D (Debug)
1.07 GRAPHIC SYMBOLS

A. The following section describes the equipment symbols used for the graphic development. This has been developed based on the graphic convention described in the earlier section, the symbol represented is for discussion purposes, actual symbol requirements shall be coordinated with the City,

B. Constant Speed Motors (Pumps/ Blowers)

- Equipment Name
- Equipment Mode Indicator (Text)
  - SCADA Manual
  - Remote Auto
  - Local
  - OOS
- Equipment Status (Color) and Control
  - Running – Green (Black Outline)
  - OFF – Red (White Outline)
  - Fault – Yellow
- Fail or Fault Indicator
  - FAIL
  - CTO
  - SD (Shutdown)
- Mouse Click brings Control Pop-up

- Equipment Status (Text)
  - RUNNING (Green Color)
  - OFF (Red Color)
  - READY (Blue Color)
  - FAILURE (Red)
  - OOS
  - MLO (Yellow)
C. Variable Speed Motors (Chemical Feed)

<table>
<thead>
<tr>
<th>Equipment Name</th>
<th>Equipment Mode Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Remote Manual</td>
</tr>
<tr>
<td></td>
<td>- Remote Auto</td>
</tr>
<tr>
<td></td>
<td>- Local</td>
</tr>
<tr>
<td></td>
<td>- OOS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment Status (Color) and Control</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Running – Green (Black Outline)</td>
</tr>
<tr>
<td></td>
<td>OFF – Red (White Outline)</td>
</tr>
<tr>
<td></td>
<td>Fault – Yellow</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fail or Fault Indicator</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAIL</td>
</tr>
<tr>
<td></td>
<td>CTO</td>
</tr>
<tr>
<td></td>
<td>UNC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment Status (Text)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RUNNING (Green Color)</td>
</tr>
<tr>
<td></td>
<td>OFF (Red Color)</td>
</tr>
<tr>
<td></td>
<td>Actual Speed (%)</td>
</tr>
</tbody>
</table>

Note: Fault and/or Fail symbol will be added for valves having feedback

D. Modulating Valve

<table>
<thead>
<tr>
<th>Equipment Name</th>
<th>Equipment Mode Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Remote Manual</td>
</tr>
<tr>
<td></td>
<td>- Remote Auto</td>
</tr>
<tr>
<td></td>
<td>- Local</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment Status (Color) and Control</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open – Green (Black Outline)</td>
</tr>
<tr>
<td></td>
<td>Close – Red (White Outline)</td>
</tr>
<tr>
<td></td>
<td>Fault – Yellow</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment Status (Text)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual Position (%)</td>
</tr>
</tbody>
</table>

Mouse Click brings Control Pop-up

Note: Fault and/or Fail symbol will be added for valves having feedback
E. Non-Modulating Valve

- Equipment Name
- Equipment Mode Indicator
  - Remote Manual
  - Remote Auto
  - Local
- Equipment Status (Color) and Control
  - Open – Green (Black Outline)
  - Close – Red (White Outline)
  - Fault – Yellow
- Equipment Status (Text)
  - Actual Position (%)

Note: Fault and/or Fail symbol will be added for valves having feedback

F. Measuring Instruments

- Instrument Name
- Alarm or Fault Indicator (White Window)
  - Color Change to Yellow - Fault
  - Color Change to Red - Alarm
- Actual Value and Units
1.08 EQUIPMENT CONTROL POP-UP

SAMPLE PROCESS GRAPHIC

EXHAUST FAN (EF)
SUPPLY FAN (SF)

SUBMERSIBLE PUMP

CHEMICAL FEED PUMP (CFP)

EQUIPMENT DEVICE LEGEND

EQUIPMENT DATA MODULE

EQUIPMENT STATUS AND CONTROL LEGEND

EQUIPMENT STATUS AND CONTROL MODULE

PMP-9010 LS-17 PUMP #1

PLC AUTO

RUNNING

HAND

AUTO

SETPOINTS

OOS

DATA

ALARM RST

ALARM SETPOINTS

ALARMS DELAY

CTO-9010 MOTOR CONTROL TIME OUT 90 S  E  D
KCS-9010 MOTOR START DELAY 120 S  E  D
YAF-9010 MOTOR FAIL DELAY 120 S  E  D
LAH-9018 PUMP MOISTURE ALARM 30 S  E  D

MOTOR DATA

START COUNTER (RESET) 00:00 17
ELAPSED TIME (RESET) 00:00 45
ELAPSED TIME (NON-RESET) 827

PMP-9010 LS-17 PUMP #1

PLC AUTO

RUNNING

HAND

AUTO

SETPOINTS

OOS

DATA

ALARM RST

ALARM SETPOINTS

ALARMS DELAY

CTO-9010 MOTOR CONTROL TIME OUT 90 S  E  D
KCS-9010 MOTOR START DELAY 120 S  E  D
YAF-9010 MOTOR FAIL DELAY 120 S  E  D
LAH-9018 PUMP MOISTURE ALARM 30 S  E  D

MOTOR DATA

START COUNTER (RESET) 00:00 17
ELAPSED TIME (RESET) 00:00 45
ELAPSED TIME (NON-RESET) 827
### A. Motor Control Pop-Up Example

**PMP-9010 LS-17 PUMP #1**

- **SPEED CMD**: 100%  
- **RUNNING**: 97%  
- **HAND**  
- **AUTO**  
- **START**  
- **STOP**  
- **SETPOINTS**  
- **DATA**  
- **OOS**  
- **ALARM RST**

### ALARM SETPOINTS

<table>
<thead>
<tr>
<th>Alarm Point</th>
<th>Description</th>
<th>Delay</th>
<th>E</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTO-9010</td>
<td>MOTOR CONTROL TIME OUT</td>
<td>90 S</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>KCS-9010</td>
<td>MOTOR START DELAY</td>
<td>120 S</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>YAF-9010</td>
<td>PUMP/MOTOR FAIL DELAY</td>
<td>120 S</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>YAFF-9010</td>
<td>VFD FAIL DELAY</td>
<td>120 S</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>LAH-9010</td>
<td>PUMP MOISTURE ALARM</td>
<td>30 S</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>SCLK-9010</td>
<td>VFD MINIMUM SPEED (%)</td>
<td>30 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCHK-9010</td>
<td>VFD MAXIMUM SPEED (%)</td>
<td>30 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MOTOR DATA

- **KQI**: START COUNTER (RESET)  
- **KQI**: ELAPSED TIME (RESET)  
- **KQI**: ELAPSED TIME (NON-RESET)  
- **KQI**: MOTOR AMPS  
- **KQI**: MOTOR TEMPERATURE

<table>
<thead>
<tr>
<th>KQI Description</th>
<th>Reset Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>START COUNTER (RESET)</td>
<td>24 HR</td>
</tr>
<tr>
<td>ELAPSED TIME (RESET)</td>
<td>24 HR</td>
</tr>
<tr>
<td>ELAPSED TIME (NON-RESET)</td>
<td>827</td>
</tr>
<tr>
<td>MOTOR AMPS</td>
<td>827</td>
</tr>
<tr>
<td>MOTOR TEMPERATURE</td>
<td>827</td>
</tr>
</tbody>
</table>
B. Motorized Valve Control Pop-Up

EQUIPMENT MODE:
- PLC AUTO
- SCADA MANUAL
- [HOA IN AUTO]
- [HOA IS OFF]
- OOS - OUT OF SERVICE
- LOCAL HAND - [HOA IN HAND]
- LOCAL OFF - [HOA IS OFF]

EQUIPMENT STATUS:
- OPENED - VALVE CONTACT
- CLOSED - VALVE CONTACT
- READY - EQUIPMENT READY
- FAILURE - EQUIPMENT FAILED
- TRAVELING - VALVE TRAVELING
- OFF - VALVE OFF
- MLO - MOTOR LOCK-OUT

STATION FLOW CONTROL VALVE

ALARM SETPOINTS

<table>
<thead>
<tr>
<th>ALARM SETPOINTS</th>
<th>ALARM DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZAO-9010 VALVE FAIL TO OPEN</td>
<td>90 S</td>
</tr>
<tr>
<td>ZAC-9010 VALVE FAIL TO CLOSE</td>
<td>120 S</td>
</tr>
<tr>
<td>YAF-9010 VALVE FAILURE</td>
<td>120 S</td>
</tr>
<tr>
<td>ZA-9010 VALVE POSITION FAILURE</td>
<td>120 S</td>
</tr>
</tbody>
</table>

POSITION SETPOINTS

<table>
<thead>
<tr>
<th>POSITION SETPOINTS</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZKO-9010 VALVE MAXIMUM POSITION</td>
<td>97 %</td>
</tr>
<tr>
<td>ZKC-9010 VALVE MINIMUM POSITION</td>
<td>5 %</td>
</tr>
<tr>
<td>ZK-9010 VALVE POSITION DEADBAND</td>
<td>2 %</td>
</tr>
<tr>
<td>ZLO-9010 VALVE FULL OPEN POSITION</td>
<td>100 %</td>
</tr>
<tr>
<td>ZLC-9010 VALVE FULL CLOSE POSITION</td>
<td>0 %</td>
</tr>
</tbody>
</table>
C. Motorized Gate Control Pop-Up

[Diagram showing gate control states: Gate Closed, Gate Open, Gate Traveling Open, Gate Traveling Closed, Gate Closed, Gate Open, Gate Closed, Gate Open, Gate Failure]

[Graphical representation of PLC control with indicators for various statuses and setpoints]

[Table listing alarm setpoints and percent accuracy:
- ZAO-9010 Gate Fail To Open: 97 %
- ZAC-9010 Gate Fail To Close: 97 %
- YAF-9010 Gate Failure: 97 %
- ZA-9019 Gate Position Failure: 97 %
- ZKO-9010 Gate Maximum Position: 97 %
- ZKC-9010 Gate Minimum Position: 97 %
- ZK-9018 Gate Position Deadband: 97 %
- ZLO-9010 Gate Full Open Position: 97 %
- ZLC-9010 Gate Full Close Position: 97 %]
1.09 PROCESS CONTROL POP-UP

A. PID Controller
B. Setpoint Controller (Typical)

SETPOINT CONTROLLER MODULE (PID)
C. Typical Diversion Structure

D. Typical Pressure Reducing Station
E. Pump Control Setpoint Screen or Pop-Up Graphic (Typical)

LIFT STATION PUMP CONTROL SETPOINT

- LCHH-7011 LAG PUMP START (ft) 10
- LCHK-7011 LEAD PUMP START (ft) 8
- LCLK-7011 LEAD PUMP STOP (ft) 4
- LCLL-7011 LAG PUMP STOP (ft) 4
- KCKX-7011 CYCLE TIME CONTROL (hrs) 16

END OF SECTION
SECTION 17050  
HISTORICAL DATABASE SERVER

PART 1    GENERAL

1.00    WORK INCLUDED

A. This Section covers Database programming, configuration, and implementation. Provide software, development tools, programming, custom programming, configuration, set-up and testing as required for a complete operating local and global client/server City wide SCADA database system.

B. Data logging shall consist of logging all analog datapoints based on both time and differential.

C. Data logging shall consist of logging all timers and counters for flow, equipment runtimes, start/stops and kilowatt hours.

D. Data logging shall log all equipment starts and runs.

E. The CSS shall furnish all necessary configuration and custom programming labor to provide data collection, data services, data storage, data archiving and client access in a user friendly format configured for operations personnel.

F. The CSS shall furnish all data transfer functions, data manipulation calculations and formats for report generation operations as specified in section 17060 and other applicable specification sections.

G. The CSS shall configure and program a manual entry data user interface specifically tailored for the manual entry of raw water, environmental, analytical, and laboratory data.

H. The database system shall be configured to provide the functions and database operations listed. The CSS shall provide all database and client programming necessary to provide those functions in a point and click selection based format. The operator shall not be required to program, generate SQL statements, query text or any programming of scripts to implement the required functions.

I. The CSS shall provide all configuration labor to log all variables (analog, digital, internal, timers, counters), setpoints, operator actions, events (process and system) and alarms to the HDS.

1.01    RELATED SECTIONS

A. Division 17

1.02    SUBMITTALS
A. Submittals shall be provided in accordance with Section 17010, submittals.

PART 2  HISTORICAL DATABASE (EXISTING)

PART 3  EXECUTION

3.00  GENERAL

A. The CSS shall add to, modify and reconfigure the existing Database software on the Historical Data Server located at the Wes Brown WTP.

B. The CSS shall optimize the data transfers between systems residing on the information network.

C. The CSS shall furnish and install all report generation software configurations, interfaces and configuration tools utilized on the SCADA servers, workstations, client workstations and Historical Data Servers.

D. The CSS attend an eight hour meeting with the Owner to identify the database logging requirements and address the following:

1. Database Variable Tagging

2. Logging rate of individual variables and groups of variables

3. Differential Change of individual variables and groups of variables

4. Variable grouping.

E. The CSS shall successfully conduct a witnessed factory test of all database and report generation functions in accordance with section 17010, Factory Acceptance Testing.

3.01  TRAINING

3.02  WARRANTY AND CUSTOMER SUPPORT

A. The CSS shall provide one year of technical service for the correction of operational inconsistencies resulting from the configuration and application programming effort. The support shall include two site visits for diagnostics and file maintenance of the entire file system application. The site visit shall also include a full system and configuration back up to restorable media compatible with the storage equipment.

B. In addition to the warranty service the CSS shall provide up to 40 hrs of on site technical service and 20 hrs of telephonic support for one year from final acceptance. This be presented as a service contract to the Owner.

END OF SECTION
SECTION 17060
SYSTEM REPORT GENERATION

PART 1  GENERAL

1.00  WORK INCLUDED

A. This Section covers system report generation, complete. Provide software, development tools, programming, custom programming, configuration, set-up and testing as required for a complete operating local and global client/server based report generation system.

B. The CSS shall furnish all necessary database and reporting programming and configuration labor, all supplemental programming tools, and all appurtenances as indicated herein and as required for the development of an operational reporting system.

C. The CSS shall provide local client reporting operations at the Water Treatment Facilities and the IMC. The operator shall be able to access specified reports for viewing and printing operations from the local SCADA workstations.

D. The CSS shall provide report generation for the Raw Water System at local client workstations located at the IMC.

E. The CSS shall modify existing reports, report configurations, report access and report scheduling operations for client/server operation on the Historical Data Server. The existing report formats shall remain and be converted to the supplied local and global reporting software packages. New site and system reports shall be created as specified.

F. The CSS shall configure the new and existing reports for client access from any location within the SCADA WAN. The client shall be capable of running, viewing and printing reports at any location in the WAN environment.

G. The CSS shall configure scheduled reports to print automatically at the specified locations in the SCADA WAN.

H. Report functions or procedures not supported by third party, spreadsheet based report generators shall be custom developed utilizing SQL compliant report development tools.

I. Report software shall be client/server based and support up to 5 concurrent users.

1.01  RELATED SECTIONS

A. Division 17

1.02  SUBMITTALS
A. The CSS shall provide submittals in accordance with Section 17010.
B. The CSS shall provide a sample of each report specified.
C. The CSS shall submit the user interface printouts specified for selecting and scheduling report functions.
D. The CSS shall submit the report configuration scripting and configuration files, including tools for creating the reports.

1.03 TYPES OF REPORTS

A. Daily Reports

1. Daily reports shall be generated on a user definable 24 periods and shall print each day. A daily report shall consist of hourly average, min. max and totalized data for each process area, location, report type or variable described herein and as required to present the process data in an organized and legible format. Daily reports consisting of totalized data shall be provided with a total daily value and accumulated total for each variable reported.

B. Weekly Reports

1. Weekly reports shall be generated on a user definable 7-day period and shall print locally each week. A daily report shall consist of daily average, min. max and totalized data for each process area, location, report type or variable described herein and as required to present the process data in an organized and legible format. Weekly reports consisting of totalized data shall be provided with a weekly total value and accumulated total for each variable reported.

C. Monthly Reports

1. Monthly reports shall be generated the end of the last day of each month and shall print locally on the first day of each month for the previous month. A monthly report shall consist of weekly average, min. max and totalized data for each process area, location, report type or variable described herein and as required to present the process data in an organized and legible format. Monthly reports consisting of totalized data shall be provided with a monthly total value for each variable reported.

D. Yearly Reports

1. Yearly reports shall be generated the last day of the year and shall print locally. A yearly report shall consist of monthly average, min. max and totalized data for each process area, location, report type or variable described herein and as required to present the process data in an organized and legible format. Yearly reports consisting of totalized data shall be provided with a monthly total value for each variable reported.

E. On Demand Report
1. On demand reports shall be generated based on a user entered start time/date and end time/date, and select the data calculation increment as hourly, daily or weekly. The on demand report shall consist of report increment average, min. max and totalized data for each process area, location, report type or variable described herein and as required to present the process data in an organized and legible format. On demand reports consisting of totalized data shall be provided with the selected reporting period total value for each variable reported.

F. Event Reports

1. Event reports shall include any predefined or operator-selected events. Each event shall be logged on an equal, fixed number of lines in the event reports. The event reports shall be printed at regular intervals, regardless of the number of events logged by the report. The operator may also manually print an event report at any time, with a selectable history length.

G. Operations Report

1. Operational reports shall include equipment operational runtimes and starts over a selected interval and history length. The total hours and starts shall be totalized per interval time (hourly, daily, weekly, monthly) and then totalized for the history length. The operations report shall be printed at regular intervals. The operator may also manually print an operations report at any time, with a selectable history length.

PART 2 REPORTS

2.00 REPORTING GENERAL

A. System reporting operations shall consist of two separate reporting functions Global Historical Reporting and Local Process reporting.

B. Global Historical reporting operations shall be accomplished via a client/server interface with the Ihistorian Historical Data Server. Reporting functions shall be accessible as a client from anywhere in the WAN to initiate reports, view reports and print reports from and server, workstation or printer residing within the SCADA system.

C. Local process reporting shall be handled by a local report generation software package capable of producing the specified reports. The local report generation software shall access data from the SCADA server and HDS generate the specified reports.

D. Reports providing minimum and maximum values shall display the value with it time and date stamp. For the smallest period or interval requested. Hourly min/max values shall be displayed with their time of occurrence in the hour.

2.01 REPORT GENERATION FUNCTIONALITY
A. The Microsoft Office-based reporting software shall be capable of running on Windows XP. The reporting software ("the software") shall allow users to build reports in Microsoft Excel and run the reports for any time frame. The software will retrieve data for the reports from Human Machine Interface (HMI) or Supervisory Control and Data Acquisition (SCADA) software systems as well as SQL compliant databases. The software shall support connections to multiple data sources ("databases") simultaneously.

B. The report generation software shall be compatible with the IHistorian data structures and Native IFix local data structures. The local report generation interface shall support the OPC interface.

C. The local report generation software shall reside at the individual plant locations and shall be configured to run local reports based on the WTP process requirements and the native IFix database structures. Reports shall be configured to run locally based on the local IFix server database. The local Report Interface for a nonnative interface shall be OPC between the IFix SCADA Server and the Report Generation Work Station.

D. Global report generation software shall be provided at the Auburn Business Center Historical data server and shall be configured to provide consolidated reporting capabilities from the IHistorian Database Server. The Database shall be accessed from client nodes located at the various treatment facilities and shall provide for the reporting functions and report formats specified at any location within the WAN information system environment.

E. The software shall consists of the following components (A complete reporting system shall consist of a single Server Component at each facility with one or more clients):

1. **Server Component**
   a. The software shall include a server component for configuring a project specific configuration file. The configuration file shall consist of the following entities:
      1) Databases
      2) Tables
      3) Tag Groups
      4) Tags

2. **Client Component**
   a. The software shall include a client component for configuring reports within Microsoft Excel.

F. **SERVER FUNCTIONS**

1. The system shall include an easily configurable database definition list. Database(s) that contain tags in the HMI/SCADA system(s) and/or values contained in the SQL compliant Database(s) for which reporting is desired will have a corresponding entry in the reporting software database.
definition list. The software shall allow users to automatically build the OLE Connect string to each database by clicking a button.

2. The system shall include an easily configurable table definition list. Database Table(s) that contain tags in the HMI/SCADA system(s) and/or values contained in the SQL compliant Database(s) for which reporting is desired will have a corresponding entry in the reporting software table definition list. Non-normalized and fully normalized table structures ("schemas") shall be supported.

3. The system shall include time conversions when selecting and returning data to and from data sources that log date/time in proprietary and non-Windows date/time values. It shall be possible to convert a Windows date/time value to a value recognized by the data source when selecting data. It shall be possible to convert the date/time value returned from the data source into a Windows date/time value.

4. The system shall include an easily configurable tag group definition list. Tags can be split into groups to better organize the project configuration file.

5. The system shall include an easily configurable tag definition list. Tags in the HMI/SCADA system(s) and/or values contained in the SQL compliant Database(s) for which reporting is desired will have a corresponding tag in the reporting software tag definition list. The software shall allow users to abstract the reporting system tagname from the actual item name.

6. The system shall include a feature that allows users to make modifications to tag attributes and apply them to a group of tags simultaneously.

7. The current definitions for Databases, Tables, Tag Groups, and Tags shall be exported on demand to separate .xls files. Each of these .xls files can be modified and imported to facilitate software configuration.

G. CLIENT FUNCTIONS

1. The software shall support automatic output to the following destinations:
   a. Printer
   b. Email
   c. Web Page (.htm) file
   d. Excel Workbook (.xls) file

2. When outputting to a Web Page or Excel Workbook file, the software shall be capable of generating unique files. The files shall be named according to the date that they were created.

3. A user interface shall be provided to allow users to place functions into an Excel Workbook in order to build reports. These functions will return data for the specified time frame. The following functions shall be supported:
   a. Average
   b. Count
   c. First and/or date/time stamp
d. Last and/or date/time stamp  
e. List and/or date/time stamp  
f. Maximum and/or date/time stamp  
g. Minimum and/or date/time stamp  
h. Sum  

4. The user interface shall include a tag browser that displays the available databases, tag groups and tags that have been previously configured through the server component. Users shall be able to drill down to each tag and list the functions available for that tag.  

5. The user interface shall be a “context sensitive window” the contents of which shall change based on the function selected.  

6. The user interface shall support more than one value attribute per tag if supported by the database table schema.  

7. The user interface shall allow users to specify List Options and Sorting Options for the data, where applicable.  
   a. List Options shall include:  
      1) Time Only  
      2) Value Only  
      3) Time then Value  
      4) Value then Time  
   b. Sorting Options shall include:  
      1) Time Ascending  
      2) Time Descending  
      3) Value Ascending  
      4) Value Descending  

H. REPORT FUNCTIONS  

1. Each report function shall support variable Report Times, thus making it possible to display data from different time frames in the same report.  

2. Each report function shall support optional parameters for passing in Report Times, source Database, Source Table, and Source Column Name where applicable.  

3. Each report function shall return “No Data” if no records are returned to the function. Each report function shall return “Null” if a blank record is returned. Each report function shall return “Error” if an error is encountered during the execution of the function.  

4. A user interface shall be provided to allow users to specify a condition in order to filter the data returned. The following filter conditions shall be supported:  
   a. Greater than
b. Greater than or equal to
c. Less than
d. Less than or equal to
e. Not equal to
f. Is Like
g. Is Not Like

5. A user interface shall be provided to allow users to Build compound condition statements in order to further filter the data returned.

6. The software shall provide Tag Functions that return the following attributes for tags. These attributes shall be retrieved from the project configuration file:
   a. TagName
   b. Description
   c. Engineering Units
   d. Type
   e. Table Name
   f. Column Name
   g. Database Name
   h. Group Name

7. The software shall support connections to multiple databases (data sources) and be network compatible (i.e., the data can reside on a different computer than the reporting software). The configuration file (server component) and the client component may also reside on separate computers on the network. As a minimum, the software must connect to Microsoft Access and Microsoft SQL Server compliant systems.

8. The software shall generate a logfile consisting of any errors encountered during the execution of a report.

9. The system shall have an on-line help reference for both Server and Client components.

I. AUTOMATIC REPORTS

1. Reports shall be capable of being run automatically via the Windows Scheduled Tasks application. Reports can be configured to run for any custom time frame or for the following time periods:
   a. Today
   b. Yesterday
   c. This Week
   d. Last Week
   e. This Month
2. Reports can be run for any time frame. Buttons shall be available for scrolling forward and backward in time. The scroll time shall be configurable enabling the user to scroll for different time periods as listed in item 3.10. A user interface shall be provided for running reports manually for specific dates and times. The software shall incorporate a drop-down calendar that supports browsing for a specific date and time. The user interface shall also provide easily selectable report spans from a drop-down list. The list shall contain as a minimum (hour, day, week, month, year).

3. The report reporting generation software system shall be ReportBuilder™ as manufactured by WorkSmart Automation, XLReporter as manufactured by Sytech

2.02 REPORT DEVELOPMENT SOFTWARE

A. Custom development report generation software shall be provided to prepare custom and complex reporting functions not supported by spreadsheet based reporting tools.

B. Custom report generation software shall be provided to aid in the development of complex report sequences, batches and formats.

C. Custom report development software shall be Crystal Reports 9 Developer Edition.

2.03 FLOW PRODUCTION REPORT

A. The daily flow production report shall be configured to process based on a scheduled interval period configurable by the operator.

B. Flow production reports shall be configured to process and run locally at each WTP and globally at each historical data server.

C. The Historical Data Servers shall be configured to process the following flow production Reports

1. Daily for Each WTP, ZONE, Raw Water
2. Weekly for Each WTP, ZONE, Raw Water
3. Monthly for each WTP, ZONE, Raw Water
4. Quarterly for each WTP, ZONE, Raw Water
5. Yearly for each WTP, ZONE, Raw Water

D. Combined production report shall be provided that accumulates total flow production for all systems totalized on a weekly basis.
2.04 STORAGE LEVEL REPORT

A. The storage level report shall be configured to process based on a weekly period configurable by the operator.

B. The storage level report shall be configured to process and run locally at each WTP and globally at each historical data server. The chemical storage report shall be configured utilizing SCADA historical data and manually entered daily data.

C. The Historical Data Servers shall be configured to process the following Storage Level Reports

1. Daily for Each WTP
2. Weekly for Each WTP
3. Monthly for each WTP
4. Quarterly for each WTP
5. Yearly for each WTP

D. The report shall be based on SCADA historical data for the storage tank level for hourly, daily and weekly etc. The report shall contain the following data for storage calculations:

1. Treatment Plant or Zone
2. Storage Tank Name
3. Min. max. and average level for reporting interval.
4. Calculated usage (gallons) for each interval.
5. Total usage (gallons) for the reporting period.

2.05 PROCESS REPORT

A. The process report shall be configured to process based on a weekly period configurable by the operator.

B. The process report shall be configured to process and run locally at each WTP and globally at the historical data server. The process report shall be configured utilizing SCADA historical data.

C. The Historical Data Servers shall be configured to process the following Process Reports

1. Daily for Each WTP
2. Weekly for Each WTP
3. Monthly for each WTP
4. Quarterly for each WTP
5. Yearly for each WTP

D. The process report shall be based on SCADA historical data for the process operation interval hourly, daily and weekly etc. The report shall contain the following data for storage calculations:

1. Treatment Plant or Zone
2. Process Variable Name(s)
3. Min. max. and average level for reporting interval.

2.06 EQUIPMENT OPERATIONAL REPORT

A. Weekly and monthly automatically print a report that summarizes run time and number of starts over the preceding time frame listed for all pieces of equipment one line per piece of equipment.

PART 3 EXECUTION

3.00 GENERAL

A. The CSS shall furnish, configure and install all report generation software, client access and configuration tools on the SCADA servers, workstations, client workstations and Historical Data Server.

B. The CSS shall configure the specified report and reporting functions. In addition to the specified reports the SI shall provide for an additional 20 reports to be defined by the City. A report shall be based on a two-page minimum with up to 50 variable tags, calculation based utilizing standard arithmetic operations and statistical functions.

C. The CSS shall successfully conduct a witnessed factory test of all report generation functions in accordance with section 17100 factory operational readiness testing.

3.01 TRAINING

A. The CSS shall schedule, reserve, purchase and coordinate report generation training for three individuals in each training class. The training classes shall be provided as follows:

1. Report Generation Tools
2. Configuring Reports
3. Report Scheduling, Printing, Viewing and Access
3.02 WARRANTY AND CUSTOMER SUPPORT

A. In addition to the warranty service the CSS shall provide up to 80 hrs of on site technical services for the development of additional reporting functions beyond that which is specified and 20 hrs of telephonic support for one year from final acceptance. This shall be presented as a service contract to the Owner.

END OF SECTION
Not Used