



**GUAM WATERWORKS AUTHORITY**

Gloria B. Nelson Public Service Building  
688 Route 15 | Mangilao | Guam 96913 Tel. (671)300-6052

**Invitation For Bid:** IFB-07-ENG-2019  
Pressure Zone Realignment Construction- Phase 1  
GWA Project No. W18-001-BND

**Addendum No.:** 04

**Date:** November 15, 2019



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**All Potential Bidders:**

This addendum is issued to modify the previously issued bid documents and/or given for informational purposes, and is hereby made a part of the bid documents. Failure to acknowledge receipt of this addendum shall be grounds for the bidder's disqualification and rejection of the bidder's proposal.

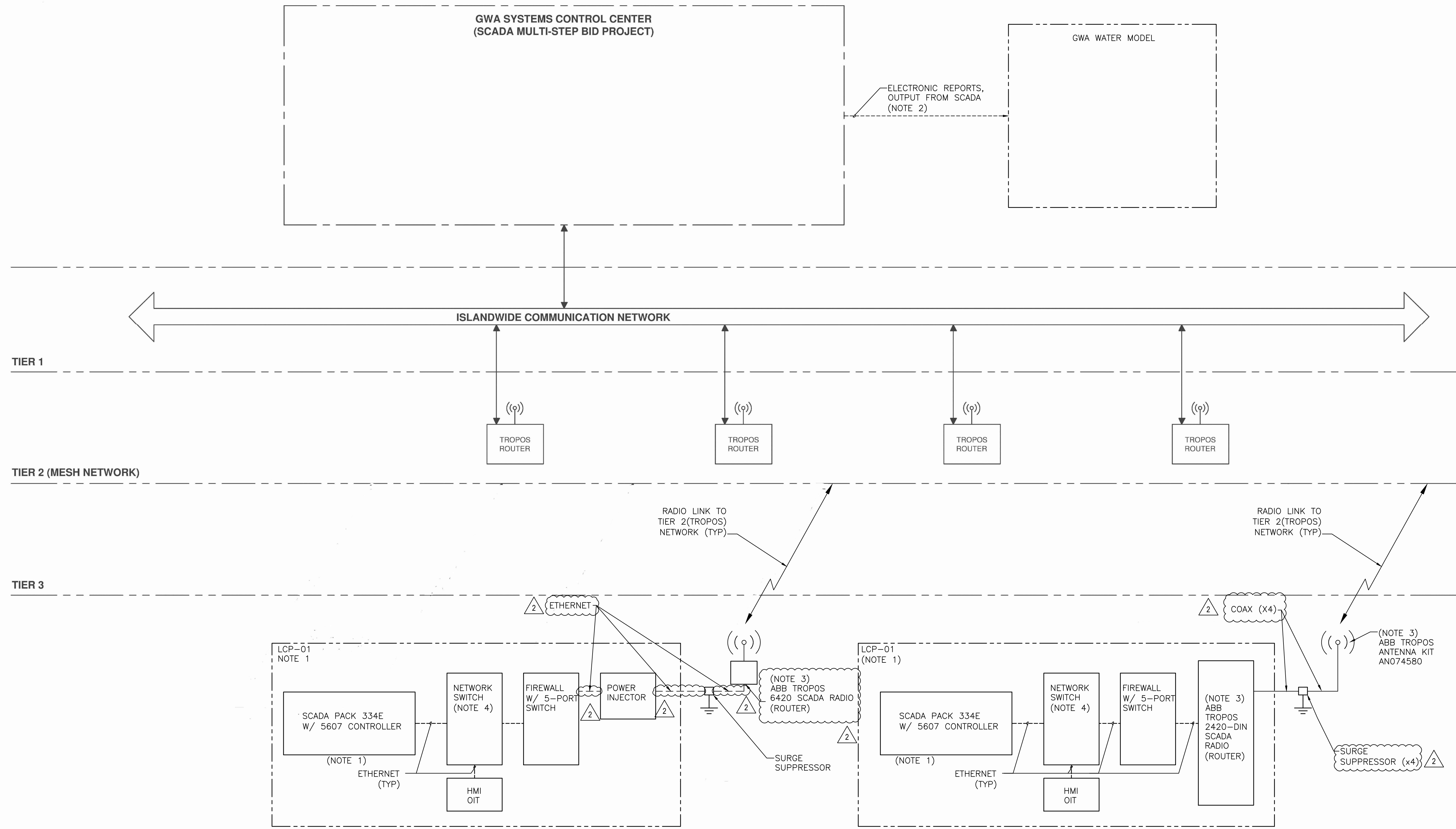
1. Drawing Sheet(s) – J-002 shall be replaced in its entirety with attached Drawing Sheet(s) J-002– Revision 2.
2. Specification Section 409443- Programmable Logic Process Controllers—Revision 1, shall replace previous version(s) in its entirety.

Bidders are also notified to visit GWA website: [www.guamwaterworks.org](http://www.guamwaterworks.org) to ensure that all addenda to the bid, answers to questions, and reminders are communicated to all bidders throughout the solicitation process.

  
MIGUEL C. BORDALLO, P.E.  
General Manager  


Attachments

MCB; jm



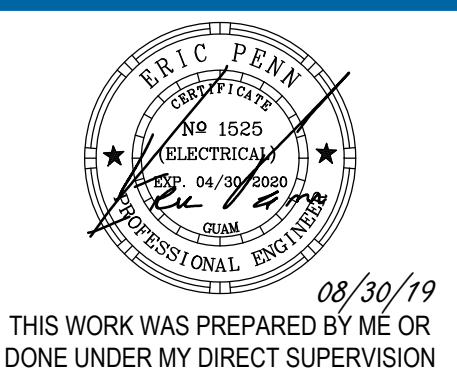
- NOTES:**
1. NOT USED
  2. IMPORT OF WATER DATA FILES FROM SCADA IN TO THE WATER MODEL WILL BE EXECUTED MANUALLY BY GWA PERSONNEL, ON A PERIODIC BASIS.
  3. DIAGRAM IS TYPICAL FOR SITES WITH THE RADIO MOUNTED INSIDE LCP-01. SOME SITES VARY WITH AN ANTENNA/RADIO COMBINATION UNIT MOUNTED ON A MAST.
  4. NETWORK SWITCH TO BE USED FOR FLOW TRANSMITTER CONNECTIONS TO SCADA PACK AND HMI.

TYPICAL FOR THE FOLLOWING SITES:  
-CARNATION (PRV 11)

- TYPICAL FOR THE FOLLOWING SITES:
- OKKODO (PRV 30)
  - YSENGSONG (PRV 77)
  - CLARA (PRV 78)
  - KAISER (PRV 79)
  - TERAO (PRV 12)
  - MAI MAI (PRV 71)
  - ASTUMBO #1 AND #2 RESERVOIRS
  - (NOTE 1)
  - YIGO #1, #2, #3 AND #4 RESERVOIRS
  - (NOTE 1)

**FINAL SUBMITTAL**

1	REMOVED NOTE 1	JO	ACS	ACS	11/12/19	
2	REVISED RADIO MODEL NO. AND REVISED FOR ETHERNET CABLE	JO	ACS	ACS	11/15/19	
No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date



Drawn	JO	Designer	EP
Drafting Check	EP	Design Check	RG
Approved (Project Director)	Date		
Scale	AS NOTED		

Client	GUAM WATERWORKS AUTHORITY		
Project	PRESSURE ZONE REALIGNMENT CONSTRUCTION - PHASE 1		
Title	SCADA BLOCK DIAGRAM		
Contract No.	Original Size		
ANSI D	Drawing No: J-002		Str 57 of 62
Rev:			

## SECTION 409443 - PROGRAMMABLE LOGIC PROCESS CONTROLLERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Programmable controllers, remote terminal units, programming software, programming, and accessories.

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 260500 – Common Work Results for Electrical.
- B. Section 260526 – Grounding and Bonding for Electrical Systems
- C. Section 260553 – Identification for Electrical Systems.
- D. Section 409000 – Industrial Instrumentation & Process Controls

#### 1.3 REFERENCES

A. International Electrotechnical Commission

1. IEC 61131-3 Programmable Controllers- Part 3: Programming Languages

B. International Society for Automation (ISA):

1. S5.1 - Instrumentation Symbols and Identification.
2. S5.4 - Standard Instrument Loop Diagrams.
3. S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
4. S50.1 - Compatibility of Analog Signals for Electronic Industrial Process Instruments.
5. ISA-5.06.01 - Functional Requirements Documentation for Control Software Applications

C. National Electrical Manufacturers Association:

1. NEMA IA 2.2 - Programmable Controllers-Equipment Requirements and Tests.
2. NEMA IA 2.3 - Programmable Controllers - Programming Languages.
3. NEMA IA 2.8 - PART 8: Guidelines for the Application and Implementation of Programming Languages
4. NEMA ICS 3 - Industrial Control and Systems: Factory Built Assemblies.

D. Underwriters Laboratories:

1. UL 1449 – Standard for Surge Protective Devices

#### 1.4 ABBREVIATIONS

- A. HMI – Human Machine Interface
- B. OIT – Operator Interface Terminal

C. RTU – Remote Terminal Unit

D. SCADA – Supervisory Control And Data Acquisition

## 1.5 SYSTEM DESCRIPTION

A. Configuration:

1. Non-proprietary networked programmable controllers shall be incorporated into fully assembled control panels for controlling, communicating with and monitoring of controls, control systems, instrumentation and SCADA system with all required components and programming for a fully functional system.
2. Programmable controller shall use a combination of discrete, analog, PID functions, programmable logic and programmable algorithms to control, annunciate and interface with connected systems.
3. Programmable controller shall be part of a completely assembled control panel with all components required for operation, including all associated components shown and where specified in other sections. Control panels shall be assembled by a UL508A certified contractor and contain labeling indicating UL508A compliance with a unique UL serial number.

B. Special Requirements:

1. Programmable Logic Controller shall be constructed of non-proprietary components and shall use an open source code programming protocol for programming and unit configuration.
2. All Programmable Logic Controllers shall be from a single manufacturer.

## 1.6 SUBMITTALS

A. Programming Approach: Indicate listing of I/O Points, device specific communications translation protocols (e.g. HART), HMI to RTU programming approach and SCADA I/O interface description, complete with tag designations for new and existing system.

B. Programming narrative: Include a narrative that describes device and I/O functionality. Narrative shall include connected devices, derived values and runtime scenarios to demonstrate function.

C. Shop Drawings: Provide shop drawings indicating the arrangement and layout of panel, component spacing and enclosure size. Indicate electrical characteristics and connection requirements, including layout of completed assemblies, interconnecting cabling, dimensions, weights, and external power requirements.

1. Control System Block Diagram

The drawing must include media, protocol, and network level information. The protocol must be identified for each media line. The network level must also be indicated by using the following abbreviations written parallel to the media line on the drawing. Possible network levels are:

- a. HMI
- b. RTU/Controller
- c. I/O

The Control System Block Diagram drawing must also include protocol converters (i.e., Fiber-to-Ethernet) which are external to network devices.

2. Controller Layout Detail

The Controller Layout Detail must indicate the physical location of every device. It also includes the power supply part number, the processor part number, and the I/O module name and part number.

3. Controller Wiring Detail

The Controller Wiring Detail shall be according to ISA-5.1. Drawings shall include the I/O module part number and name, the I/O tag name, and point number. The controller wiring detail drawings shall be functionally equivalent to the ISA Standard S5.4, Instrument Loop Diagrams. They shall show all conductors and terminations fully labeled. In addition, the drawings shall identify field equipment brand and model as shown in the O&M manual for the equipment. All field instruments shall be labeled with the tag name, as well as brand and model. Tag names as used on the drawings shall exactly match the tag names indicated on the ISA Standard Form S20 furnished for the instrument.

- D. Product Data: Submit catalog data for each component specified showing electrical characteristics and connection requirements.
- E. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.
- F. Testing Documentation Submittals:
  - 1. Thirty (30) days prior to testing, submit Site Acceptance Test (SAT) plan. Prepare and submit for review a SAT plan that includes contact information, planned dates, step-by-step functional testing procedures and special considerations. The plan shall comprehensively identify all systems being tested and list each testing procedure in detail with the expected outcome.
    - a. Format of plan shall be tabulated and at a minimum include the following information:
      - 1) Title, including commissioning description and date.
      - 2) Test number in ascending order.
      - 3) Completion check off box.
      - 4) Description of test.
      - 5) Completion notes indicating what is being checked and expected result.
      - 6) Space for field notes.
      - 7) Space for signature indicating testing has been completed.
  - 2. Test Reports: Upon completion of commissioning tests, prepare and submit for review a complete test report indicating results of system commissioning, deficiencies, corrective measures and recommendations.
- G. Field Reports: Indicate activities on site, adverse findings, and recommendations.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of controller cabinets and input and output devices connected to system. Include interconnection wiring and cabling

information, and terminal block layouts in controller cabinets. Include copy of as-built drawings.

- B. Operation and Maintenance Data: Submit bound copies of operating and programming instructions, and include card replacement, adjustments, and preventative maintenance procedures and materials. Provide Compact Disk (CD) containing all programmable logic code to GWA upon project closeout with full copies of programs required to both upload and download Code to controller and related components.

## 1.8 PROGRAM ORGANIZATION

A. Program organization provides general guidelines to be used for developing controller software that will establish a common approach to software. A typical program consists of the following general hierarchy:

1. Task - Program Routine  
There can only be a single scheduled task or routine in many controller types with various subroutines for subtasks within the main program structure. The program structure is generally managed by the software provided by the manufacturer for each type of control processors. The main program shall be named MainTask. Each task consists of multiple programs which are scheduled to run one after another within the MainTask. There are 5 sections or components/subroutines in the main program to manage main aspects of a controller program and are listed in this section.
2. Each of the component programs will consist of one or more routines. There will always be a main routine for each program. Its name is <program>\_Main and its primary purpose is to call the other routines within the program. <program> as above is the one-word name of the program as denoted below. All routines within the program are names <program>\_<function> where <program> is the one-word name of this program and <function> is a one-word function name for the routine. This scheme will insure all routines have a unique name and can be readily placed within the over task structure by name alone.
3. Standard Program Sections
  - a. System  
The first program called on every scan. It is responsible for initializing values, performing housekeeping, global definitions, functions that are required on a global level for the entire controller. There is at minimum the routine SYSTEM\_Main that calls the other routines in the program.
  - b. IO\_Mapping  
This program is responsible for moving data from physical modules into the internal controller tags where it can be acted on by the program logic. Changes in the I/O configuration will require corresponding changes be done within this routine.
  - c. Control Modules  
The processing of field equipment is simplified by using object oriented programming techniques. This program is where object oriented programming code would be developed.
  - d. Process Modules  
Application logic unique to this program is organized here. This will be a collection of routines organized by a PROCESS\_Main routine that orchestrates the interaction of objects managed by the previous program.
4. Optional Programs

The following programs may or may not exist with a controller task depending on process requirements.

- a. Message  
This program manages all inter-processor messaging between the main processor and other processors within the system. Most water remote sites will have one processor and not require this section but treatment plant and larger sites may have multiple processors that require this function.
- b. Security  
This program is only present if there is a need to interface controller points to a security system.
- c. Protocol interface  
If there is a need to interface to Modbus communications or similar protocol due to interfacing with packaged systems, management of the interface used is placed here.
- d. Alarming  
Alarm detection shall take place in controller logic and not rely on HMI software. Alarm conditions are determined by the controller and shall result in controller bits being set. OIT / HMI software can make use of these bits to extend the alarm conditions to graphical displays, annunciators, and alarm call-out systems. If required the alarm bits can be mapped to digital output signal lines to trigger alarm autodialers or similar external alarms that utilize such signals.

#### B. Program Annotation and Comments

1. The controller programming environment has provisions for copious descriptions and comments to be added throughout. It is important that these facilities are not overlooked and all programs delivered to or developed by GWA must have an adequate level of commentary in the source code.
2. Descriptions
  - a. Programming components need to have descriptions applied which serve to clarify their purpose. Descriptions are free-form text fields of limited size that identify the purpose and functionality of the software components.
  - b. Most controllers allow descriptions to be attached to tasks, programs, routines and tags, including the constituent fields within ladder logic. It is important that useful descriptions be applied that offer succinct identification of all tags created or functions developed. This greatly improves the ability to maintain and enhance programming, especially when done many years after the original programming. Tag descriptions added to software definitions will often be duplicated to the other instances a particular device or function is used.
  - c. Task, program and routine descriptions must, at a minimum, describe the purpose of the code.
3. Code Comments
  - a. All code must contain comments describing in plain language what functionality is being performed in the code. Not every rung needs to be commented when the function is intuitive unless additional description will add value. Providing a synopsis block of comments preceding a section of code is often the most useful. Individual rung comments are useful for particularly difficult code, or where the actual functionality is

not obvious. Sheets of function blocks can make use of text boxes to contain comments.

- b. External conditions that affect code sections must have comments explaining those conditions and the effects they drive.

## 1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Supplier: Authorized distributor of specified manufacturer with minimum five years experience.

## 1.10 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Product Requirements.
- B. Conform to specified service conditions during and after installation of programmable controllers. Maintain area free of dirt and dust during and after installation of products.

## 1.11 MAINTENANCE SERVICE

- A. Division 01 - Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of programmable controllers for (3) three years from project close out.

## 1.12 MAINTENANCE MATERIALS

- A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish (1) one spare RTU module for each unique module type installed.

## PART 2 - PRODUCTS

### 2.1 REMOTE TERMINAL UNIT

- A. Manufacturers:
  - 1. Schneider SCADAPack, models as noted on drawings
  - 2. Substitutions: Not Permitted.
- B. Product Description: Controller conforming to NEMA IA 2.2, and with required memory and functional capacity to perform specified sequence of operation with scheduled input and output points, and communications capability. Provide on-board I/O expansion board, plus standalone I/O modules as required to provide required I/O.
- C. Service Conditions: Conform to NEMA ICS 3 and the following:
  - 1. Temperature: 0°F to 150°F
  - 2. Altitude: 500' above sea level.
- D. Protocol: DNP3-SA.



- A. Programming Language: Programming language shall be IEC 61131 compliant. The standard languages used shall be Ladder Diagrams and Function Block. Ladder Diagram programming must be used for Boolean logic or sequential control operations, while Function Block shall be used for all analog control. These two types of programming may be mixed within a given program if desired. Programming shall be done using manufacturer's software. Where function blocks are used, they shall be drawn from the standard function blocks supplied with the software provided by the manufacturer. Deviation from these requirements will only be allowed with written permission from GWA.
- B. Programming Software: latest IEC61131-3 programming software for SCADAPack E-Series RTU
- C. 5209 Controller
  - 1. Digital I/O: 8x user selectable dry contact inputs or open drain outputs (12/24VDC)
  - 2. Analog inputs: 5x 4-20mA
  - 3. Analog outputs: 2x, 4-20mA (with 5303 module)
- D. 5606 I/O Board
  - 1. Digital inputs: 32x (12/24VDC)
  - 2. Digital outputs: 16x, dry contacts
  - 3. Analog outputs: 2x, 4-20mA (with 5303 module)
- E. Serial Ports: Three (3), RS232, capable of half and full duplex operation, and RS485.
- F. Networking Connections: Ethernet, RJ45, 10/100BaseT.
- G. Input Voltage: 11-30 VDC.

## 2.2 SCADA WIRELESS RADIO

- A. Manufacturers:
  - 1. ABB TropOS 2420 w/ AN074580 Antenna kit including surge arrester
  - 2. ABB TropOS 6420 w/ antenna for outdoor applications
  - 3. Substitutions: Not Permitted.
- B. Product Description: Wireless router and bridge for field automation applications, supporting Modbus and DNP3.
- C. Protocols: Modbus, DNP3, and IEC 61850.
- D. Hardwire Networking Connections: Ethernet, RJ45, 10/100BaseT, per IEEE 802.3u.
- E. Wireless Networking Connections: IEEE 802.11b/g/n
- F. Input Voltage: 7-32 VDC (ABB TropOS 2420).
- G. Input Voltage : 12-48 VDC IEEE 802.3 at power over ethernet (ABB TropOS 6420).

2.3 ETHERNET SURGE ARRESTER

A. Manufacturers:

1. Cambium 600SSH
2. Substitution: Not Permitted.

B. Surge suppressor shall have an energy dissipation of 2.1 joules, maximum common mode voltage for Ethernet of 75V and 93V for dc power line.

C. Maximum common mode Ethernet current shall be 200A and 16A for dc powerline.

D. Operating temperature range shall be -40 degrees F to 140 degrees F.

E. Dimensions shall be 5.1”H x 3.5”W x 1.6”D.

2.4 POWER OVER ETHERNET INJECTOR

A. Manufacturers:

1. Phoenix INJ 1000
2. Substitutions: Not Permitted

B. Product Description: IEEE 802.3at compliant POE Injector

C. Ports: 2x RJ45

D. Mounting: DIN rail

E. Voltage: 24VDC

2.5 HUMAN-MACHINE INTERFACE

A. Manufacturers:

1. Maple Systems HMI5121XL
2. Substitutions: Not Permitted.

B. Product Description: Size: 10 inch, 800 x 480 pixels display with 4-wire resistive touch input screen

C. Serial Ports: 1x RS-232, 1x RS-485

D. Mounting: Control panel door

E. Ethernet Ports: 1x 10/100 BASE-T

F. Voltage: 24VDC

2.6 NETWORK FIREWALLS

A. Manufacturers:

1. Phoenix FL MGuard RS2005 TX VPN
2. Substitutes: Not Permitted

B. Product Description: NERC CIP compliant firewall

C. Ports: 1x RJ45 (IWAN), 5x RJ45 (LAN), 1x USB

D. Mounting: DIN rail

E. Voltage: 24VDC

## 2.7 MANAGED NETWORK SWITCHES

A. Manufacturers:

1. Phoenix FL SWITCH 2005
2. Substitutions: Approved equal

B. Product Description: Managed Ethernet switches are required. Hubs or unmanaged switches will not be accepted. Auto negotiation, autocrossing, IEEE 802.3 compliant, and store-and-forward functionality.

C. Serial Ports: 5x RJ45

D. Transmission speed: 10/100 Mbps

E. Mounting: DIN rail

F. Voltage: 24VDC

## 2.8 CONTROL PANELS

A. As specified in Section 40 90 00 Industrial Instrumentation and Process Controls.

B. Door shall swing open 90 degrees without interference to provide access to rear panel.

C. Provide adequate space for conduit entry, termination of control cable, device wiring and raceway.

D. Each component shall be identified with readily visible engraved identification tags.

E. Panel shall have a metal protective pouch to hold wiring diagrams and process system information.

F. Enclosure:

1. Provide suitable grounding stud on door and body.
2. Provide oil-resistant door gasket attached with oil resistant adhesive.
3. Provide integral door stop.
4. Where provided with louvered openings, provide louver filter assembly.
5. Covers/Doors:
  - a. Provide continuous hinge door.
  - b. Provide multi point quarter turn single point latch and semi flush key cylinder.
  - c. Door hardware shall be stainless steel and shall maintain NEMA rating of enclosure.

6. Provide interior metal panel for mounting components, finished with white enamel.
7. Manufacturer:
  - a. Hoffman
  - b. Hammond
  - c. B-Line
  - d. Or equal

#### G. Terminal Blocks

1. Fused and Non-Fused Modular Terminal Blocks: Terminal blocks shall use screw type modular connector assemblies and shall have no exposed conductive terminals. Mount using din rail assembly secured to enclosure back panel.
2. Material: Self extinguishing, UL94-V2 listed.
3. Fused Type Terminal Blocks:
  - a. Minimum 15-Amp rated.
  - b. Feed through type with side terminating terminals.
  - c. No loose parts which may fall off when replacing fuse.
  - d. Latch in open position.
  - e. Externally accessible testing terminals
4. Non-Fused Type Terminal Blocks:
  - a. Minimum 10-Amp rated.
  - b. Feed through type with side terminating terminals.
  - c. Externally accessible testing terminals
5. Labeling: Provide printed plastic terminal strip markers indicating circuit identification to match drawing designation. Markers shall be readily visible and mounted on terminal block. Identification tag designations for each terminal block shall match those shown on the wiring diagrams.
6. Terminal Block Color Code:
  - a. Data/Communications – Blue
  - b. AC Power – Orange
  - c. DC Power - Tan, Brown, Grey or Black
  - d. Ground – Green
  - e. Intrinsic Barrier – Red
  - f. Discrete, Analog, and systems not listed elsewhere – Tan, Brown, Grey or Black
7. Manufacturer:
  - a. Wago
  - b. Phoenix
  - c. Weidmuller
  - d. Or equal

#### H. Plastic Raceway

1. Product Description: Non-metallic plastic channel with hinged or snap-on cover, suitable for control wiring, branch circuit wiring, data and other low voltage wiring.
  - a. To be utilized only in dry interior locations. The raceway and all system components must be UL listed and exhibit non-flammable self-extinguishing characteristics.
  - b. Both raceway and cover shall be manufactured from rigid molded polyvinyl-chloride compound.

- c. Raceway splices shall incorporate overlapping joints so that enclosed cables are completely protected.
  - d. Raceway shall be securely fastened to the back panel.
  - e. Color: White or gray
2. Wireway Size: Size wireway so that fill ratio does not exceed 20% of the interior cross section area of the wireway. As a minimum, provide 2 inch x 3 inch wireway.

I. Control Relays

- 1. Intrinsically Safe Control Relay
  - a. Product Description: Din rail mounted, sealed, isolated relay for use in class I and class II listed areas.
  - b. Contacts: Form A or B (normally open / normally closed or both) as required.
  - c. Contact Ratings: Minimum 8 amperes continuous.
  - d. Coil Voltage: 24VDC
  - e. Listing: UL
  - f. Manufacturer: Rockwell, Model 897H-S120, or equal
- 2. Solid State Relay
  - a. Product Description: Panel Mount, Solid-state electronic relay with optically isolated output (Non-Intrinsically Safe Control Relay)
  - b. Contacts: Form A (normally open).
  - c. Contact Ratings: 10 through 90 amperes continuous, as required.
  - d. Enclosure: Hermetically sealed, suitable for Class 1, Division 1 and 2 installations.
  - e. Coil Voltage: As required.
  - f. Manufacturer: IDEC, RSSAN Series or equal
- 3. Time Delay Relay (On-Time Delay and Off-Time Delay)
  - a. Product Description: Din rail mount solid-state time delay relay with base and retainer. Time delay after energization or after de-energization, as required.
  - b. Provide with surge suppressor diode.
  - c. Contacts: Form A or B (normally open / normally closed or both) as required.
  - d. Contact Ratings: Minimum 10 amperes continuous.
  - e. Coil Voltage: As required.
  - f. Manufacturer: IDEC, RTE Series or equal
- 4. General Purpose Plug-in Relay
  - a. Product Description: Din rail mount miniature, sealed relay with base and retainer and Light Emitting Diode (LED) indicator.
  - b. Provide with surge suppression diode.
  - c. Contacts: Form A or B (normally open / normally closed or both) as required.
  - d. Contact Ratings: Minimum 10 amperes continuous.
  - e. Coil Voltage: As required.
  - f. Socket: To match relay and meet conditions of installation.
  - g. Manufacturer: IDEC, RJ Blade Series or equal
- 5. Under Voltage Relay
  - a. Product Description: Din rail mount, AC/DC sealed under voltage relay. Relay provides actuation based on under voltage condition.
  - b. Interface: Front face dial based adjustment with LED status indication.

- c. Contacts: Form A or B (normally open / normally closed or both) as required.
- d. Contact Ratings: Minimum 10 amperes continuous.
- e. Socket: To match relay and meet conditions of installation.
- f. Accessories: Provide with hold-down retainer.
- g. Manufacturer: Macromatic, VA Series or equal

J. Analog Signal Isolators

- 1. Provide analog signal isolators for analog signals that are sent from one control panel to another.

K. Communication Protocol Converters

- 1. The communications system shall utilize communication protocol conversion devices where required to transform and transmit device level communication protocols to a common system level protocol.
- 2. Unless specified elsewhere, the common system protocol shall be DNP3 encapsulated within the TCP/IP Ethernet protocol (IEEE 802.3).
- 3. Each native device I/O bit shall be accessible over the network using this common system protocol. Media converters shall be manufacturer listed for use in industrial environments. Media converters shall be din rail mounted within a listed and suitable enclosure.

L. Blocking Diodes

- 1. Description: Used in DC power distribution circuits to segregate power sources where two DC power sources are used for redundancy. Provides a means of preventing DC power from the primary source to back feed the secondary power source. Provides automatic switching between DC power sources.
- 2. Power Ratings: 24VDC, Minimum 40 amperes continuous.
- 3. Mounting: DIN rail mounted
- 4. Manufacturer: Phoenix Contact, Quint Diode/40 Series or equal

M. Power and Distribution

- 1. Circuit Breakers: Panel mount NEMA AB 1, bolt-on type thermal magnetic and instantaneous magnetic trip circuit breaker. Circuit breaker thermal elements shall be of the bimetallic type and shall be capable of withstanding sustained overload and short-circuit currents without injury and without affecting the calibration of the bimetallic element. The thermal element shall have inverse time characteristics. The instantaneous elements shall trip the circuit breaker at the minimum standard trip setting.
  - a. Provide common trip handle for multiple pole circuit breakers.
  - b. Minimum integrated short circuit rating:
    - 1) Circuit Breakers rated 240-Volts - 10,000 amperes RMS symmetrical.
    - 2) Circuit Breaker rating shall match or exceed the serving panels interrupting rating.
    - 3) Series rated breakers shall not be acceptable.
- 2. Incoming Power And Power Distribution Blocks:
  - a. Material: High impact thermoplastic with tin plated copper lugs, size and ampacity per requirements.
  - b. Manufacturer listed finger safe cover.
  - c. Panel mounted.

- d. Manufacturer: Square D, Class 9080, or equal.
3. Incoming Power Ground Bus:
  - a. Provide ground bus for power connection to enclosure back panel.
  - b. Bond back panel to enclosure using panel manufacturer provided back panel bonding washer.
  - c. Provide connection to door mounted ground studs.
  - d. Manufacturer: GE, TGK24CP, or equal.

N. Electrical Transient Protection

1. Description: All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting cabling from lightning discharges and nearby electrical systems.
  - a. Panel mount Surge Protection Device (SPD).
  - b. UL 1449 Listed.
  - c. LED Status indicator.
  - d. 100,000 amps per phase surge capacity
  - e. Voltage rating to match panel supply voltage
  - f. Manufacturer: Schneider, XW Series, or equal
2. Provide each SPD with panel mounted circuit breaker rated per manufacturer requirements.
3. As specified in Section 264313 Surge Protection Devices.

O. Control Power Transformer

1. Description: Panel mounted industrial control transformer:
  - a. Epoxy encapsulated copper windings.
  - b. 55°C rise, 105°C insulation.
  - c. NEMA ST-1 compliant.
  - d. Integral fusing with finger safe covers.
  - e. Voltage: Primary: As Indicated On Drawings, Secondary: 120-Vac
  - f. Rating: As required for system, plus 25 percent spare capacity
2. Use Limitations: Control Power transformers shall be permitted for use in transforming power for use as control panel general control and distribution power for use by relays, indicating lamps, panel mount receptacles and power supply input source. Where providing system control power for use by system controls and active system components, refer to Power Supply section within this specification for requirements.
3. Fusing: Control transformers shall be equipped with primary and secondary fusing and sized for all connected equipment and components, plus 25% spare capacity.
4. Each control transformer shall be provided with manufacturer listed “finger safe” terminals.
5. Provide fused disconnecting means for each connected control power distribution leg.
6. Maintain a minimum 12 inch separation from radios, RTU’s and other active components located within the control panel.
7. Manufacturer: Sola, SBE Series or equal

P. Power Supply

1. Description: Panel mounted linear power supply:
  - a. Regulation: .05 percent output variation at rated voltage with 10% input variation.

- b. Ripple; 3.0mV max peak to peak
- c. Transient Response Time: 50 msec.
- d. Stability .5 percent
- e. Operating Temperature Range: 0°C to 50°C
- f. Voltage: Primary: 120-Vac, 60-Hz, Secondary: 24-Vdc
- g. Rating: As required for system, plus 25 percent spare capacity
2. Use Limitations: Power supplies shall be used for powering RTU's, wireless transmitters, and other active low voltage control panel devices.
3. Provide fused disconnecting means for each connected control power distribution leg.
4. Maintain a minimum 2 inch separation from adjacent devices located within the control panel.
5. Manufacturer: Phoenix UPS power supply as indicated on Process Drawings Bill of Materials. Substitutions not permitted.

Q. Mounting Hardware

1. Description: General mounting hardware requirements associated with mounting equipment and components.
  - a. Control Panel mounted hardware: Grade 5 (minimum), zinc plated bolts, screws washers and lock washers.
  - b. Follow manufacturer's requirements for mounting hardware size and mounting requirements.

2.9 SOURCE QUALITY CONTROL

- A. Test programmable controller in accordance with NEMA IA 2.2.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install hardware per manufacturer's recommendations.
- B. Ground and bond controllers in accordance with Section 26 05 26.
- C. Connect and configure input and output devices.
- D. Verify intended system function and commissioning.

3.2 CONTROL PANEL WIRING METHODS

- A. Maintain Separation of Systems Within Enclosure:
  1. Communications circuits - Maintain minimum 1" physical separation.
  2. Less than 50V line-to-ground - Maintain minimum 1/4" physical separation (discrete I/O, analog, digital, etc).
  3. 50V line-to-ground through 120V line to ground - Maintain minimum 1" physical separation (discrete I/O, power distribution, etc).
  4. Greater than 120V line-to-ground - Maintain minimum 3" physical separation (power distribution, etc).
  5. Provide group marker for each terminal block system grouping.



- B. Use a color code scheme to differentiate connected systems within panel. As a minimum use the following color scheme;
  - 1. Three phase power: Per voltage and phase
  - 2. 120 volt power: Black and White
  - 3. Discrete 120 volts: Red
  - 4. Discrete 24 volts: Purple
  - 5. Analog 4-20mA: Yellow and Orange
  - 6. Ground: Green
- C. Route and secure control panel conductors in a craftsman like manner using smooth bends. Do not bend conductors at sharp angles.
- D. Arrange wiring neatly, cut to proper length, and remove excess wire.
- E. Secure conductors to avoid incidental contact and to prevent contact with sharp surfaces where conductor damage may occur.
- F. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
- G. Secure cable to enclosure where routed outside of wireways using nylon tie wraps. Secure nylon tie wraps using supports secured to enclosure and back panel with epoxy based adhesive.
- H. Provide hinged wiring loop where transitioning from fixed face to hinged component. Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve using nylon sock material. Spiral wrap shall not be acceptable.
- I. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
- J. Splice and tap wires only at device terminals or terminal blocks.
- K. Arrange wiring to allow ease of access for testing, removal, and maintenance of circuits and components.
- L. All RTU and instrumentation interface points shall be terminated on terminal blocks or fused terminal blocks as specified.
- M. Provide interposing relays for all input and output circuits connected to RTU's, control devices where driving loads or interfacing with external devices.
- N. Power feeds, external power supply outputs, and other power distribution wiring to external equipment shall be terminated on a fused terminal. All fuses shall be provided for all fuse terminals.
- O. Terminal ground bus: Provide ground bus terminal blocks, with each connector bonded to enclosure through terminal strip din rail for control power grounding connections.

### 3.3 SEQUENCE OF OPERATIONS

- A. Program the RTU to perform the control sequences and monitoring functions as described in the Sequence of Operations.

### 3.4 HMI AND REPORT DEVELOPMENT

- A. Coordinate with GWA for specific HMI design requirements prior to commencing work. Any re-work required as a result of not coordinating with GWA prior to commencing work shall be provided by the Contractor at no additional cost to GWA.
  - 1. GWA will provide concept level HMI design criteria to the contractor to be used as a basis of development for the HMI layout and graphics. All necessary software programming to meet the HMI design intent and as directed by GWA to develop the HMI screens shall be provided by the contractor.
- B. Provide preliminary coordination, sixty-five (65) percent, and one-hundred (100) percent design meetings to review design criteria, initial HMI design, report design, GWA requirements for HMI, operational requirements and all general HMI screen design elements required.
  - 1. The preliminary coordination meeting shall occur prior to submittals being finalized and within sixty (60) days of the notice to proceed.
    - a. Review concept level HMI navigation screens with GWA and provide copies of developed material for review.
  - 2. Intermediate sixty-five (65) percent design meeting shall occur after successful submission of submittals and within ninety (90) days of notice to proceed.
    - a. Review concept level HMI navigation screens with GWA and provide copies of developed material for review.
  - 3. Final one-hundred (100) percent design meeting shall occur within sixty (60) days of the intermediate sixty-five (65) percent design meeting.
    - a. Review functional HMI navigation screens with GWA and provide copies of developed material for review.
- C. Provide simulated HMI elements during the review meetings to demonstrate graphic functions, system response and system interactions.

### 3.5 FACTORY TEST

- A. Prior to shipping control panel to site, provide a full-function factory test to verify intended operation and proper function of all connected devices. Where interfacing with other systems, simulate inputs and outputs as necessary to verify proper operation. Where the testing of a control panel has failed the test, the deficiencies shall be corrected prior to shipping the control panel to the site for installation.

### 3.6 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Perform operational testing on control systems to verify proper operation and field wiring connections.

3.7 DEMONSTRATION AND TRAINING

- A. Furnish 8 hours of instruction each for four (4) Operators, to be conducted with manufacturer's representative. Coordinate with GWA for times and locations of training. Training times and locations shall be as directed by GWA.

END OF SECTION 409443