SECTION 16924

PROGRAMMABLE LOGIC CONTROLLER (PLC) AND ACCESSORIES

PART 1   GENERAL

1.1   Summary

A.   Contractor shall furnish the PLC's, touchscreens and required programming as specified.

B.   Furnish factory training and training courses to meet the requirements of PART 2 of this Section.

C.   Related Work:
  1.   Section 16900 thru 16950

1.2   References:

A.   Applicable Codes and Standards:

  1.   Contractor shall furnish Equipment which conforms in all respects to applicable industry standards and sound engineering practice.

  2.   Design, fabricate, assemble, install, and test Equipment to conform to the applicable provisions of the following standards:

  a.   Institute of Electrical and Electronics Engineers (IEEE):
    1)   472 – Surge Withstand Capability Test.

    2)   518- IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources.

  b.   National Fire Protection Association (NFPA):
    1)   70 - National Electrical Code (NEC).

  c.   National Electrical Manufacturers Association (NEMA):
    1)   ICS – Industrial Controls and Systems.

  d.   Underwriters Laboratories (UL):
    1)   508 - Industrial Control Equipment

        e.   Scientific Apparatus Manufacturer's Association (SAMA).

        f.   Instrument Society of America (ISA).

        g.   National Electrical Safety Code (NESC).

  3.   **Safety Codes:**

        a.   National Fire Protection Association

            i.   National Electrical Code, NFPA 70
           ii. Standard for Electrical Safety in the Workplace, NFPA 70E

        b.   National Electrical Safety Code, IEEE C2.

        c.   Occupational Safety and Health Administration, OSHA.

1.3   Submittals:

A.   **Submit as specified in SECTION 16900.**

B.   **Specific Submittals to be furnished for Equipment shall include at least the following:**

  1.   Device list and bills of material.

  2.   Data sheets on all PLC and touchscreen components.

  3.   System architecture drawing (Control System Block Diagram) showing all input/output cabinets, communications interfaces controller cabinets, operator interfaces devices, data storage devices, prefabricated cables and interfaces to other systems, and related components. This drawing shall represent the physical composition of the system.

  4.   Program documentation for all software operating systems, editors, compilers, utilities, application, control, and logic programs, both for the control, data acquisition, and processing functions.

  5.   Instruction manuals.

  6.   Description of operation of control Equipment.

  7.   Description of power failure and restoration mode.

C. **Provide an O&M Manual for the complete system including hard copy documentation of all PLC and touchscreen programming and I/O addressing including programming documentation comments.**

1.4 Quality Assurance

A. **Experience:**

1. All Equipment and Materials furnished shall have an acceptable history of satisfactory reliable service in similar use for a period of at least two years.

2. Equivalent newly developed Equipment with less than two years' actual service will be considered from established manufacturers, if it has been adequately tested, meet the requirements of this Contract, and is approved by Engineer. Such Equipment shall be noted in the proposal for review.

1.5 Training:

A. Provide qualified factory trained personnel to provide a training session at Owner's facility to train Owner's personnel in the configuration, operation, and maintenance of all hardware/software provided. The training session shall be of sufficient content and duration to provide a basic understanding of the hardware/software in general and specific instruction on the Site-specific implementation. Training shall include implementation and development of control and monitoring schemes specific to control of Owner's Equipment. **This training shall be a minimum of 3 days in duration.** The training session shall be coordinated with Owner and Engineer. Document

B. Owner may videotape all on-Site training for future use. Any charges for this videotaping shall be included in this proposal.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers:

A. **PLC's:**
1. Allen-Bradley – Micrologix Series.

B. **Operator Interface Touchscreen:**
1. Allen-Bradley.
2. Homer APG.

3. Idec Corporation.

4. Maple Systems, Inc.

2.2 General

A. Contractor shall provide a complete system with all I/O, communications modules, processors, power suppliers, and other necessary items to meet the functional requirements of this Part.

B. The system shall consist of at least the following:

1. Base unit including power supply.

2. Processor, including memory.

3. Communication hardware.

4. Input/output hardware.

5. Real-time clock/memory module.

6. Cables.

7. Touchscreen.

8. Spare parts.

2.3 Programmable Logic Controller (Micrologix 1500):

A. General:

1. The programmable controller shall receive status intelligence, perform logic functions, issue control commands, and provide alarms and status information for this systems described in these Specifications.

2. The programmable controller Equipment shall consist of a solid-state control system which has user programmable memory for storage of instructions to implement specific functions.

3. The PLC Equipment shall be purposely designed as an industrial control system which can perform functions equivalent to a relay panel or a wired sold-state logic system.

4. All PLC Equipment provided shall be capable of operation in ambient temperatures of $0^{o}C$ to $55^{o}C$, and 5 to 95% relative humidity (non-condensing), without fans or other cooling equipment.

5. All external connection points shall be capable withstanding the ANSI surge withstand capability (SWC) test as defined in ANSI C37.90a.

6. The PLC's shall operate without damage according to IEEE

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Standard 281.

7. The PLC's shall be capable of reporting by exception to a master PLC.

8. The PLC shall operate from 120 VAC, 60-hertz, single-phase power.

B.   Processor Module:

1. The processor shall provide a minimum of 14K words of user configurable memory and two RS-232 communication ports.

2. The processor shall be of solid-state design and modular printed circuit boards.

3. The processor shall have user-programmable memory with provisions to prevent unauthorized changes.

   a. All memory shall be non-volatile.

4. The processors shall continuously perform diagnostics analysis with a predetermined failure mode in the event of a fault.

5. The ladder diagram logic shall be scanned and solved at a rate not to exceed 1 milliscends per kiloword of logic.

6. All I/O including analog shall be scanned and updated at a rate not to exceed 0.3 milliseconds for all I/O.

7. The ladder logic programming shall include support for subroutines.

8. The processor shall have at least Two (2) operating modes: Run and Program. These operating modes shall be user changeable over the PLC communications network.

9. The processor shall allow the logic to be modified, in ladder logic format, while the processor is in the Run mode without affecting the operation of those portions of the logic not being modified.

10. The processor shall allow disabling and forcing on and off of individual input and output when the processor is in the Run mode.

11. The processor shall provide selectable timed interrupt capabilities for the user to incorporate into the ladder logic.

12. The processor shall provide user defined fault routine capabilities.

13. The processor shall automatically clear all output and update all input on power-up and prior to scanning and solving any logic.

14. The processors shall provide the user wit a status bit for use in the ladder logic for initialization purpose. This status bit shall be set/reset based on the indicating the first ladder logic scan.

15. The processor shall provide a comprehensive instruction set including:

    a. Relay Contact Input:
        1) Normally open
        2) Normally closed
        3) Transitional

    b. Relay Coil Output:
        1) Standard.
        2) Retentive.

    c. Timers:
        1) On delay.
        2) Off delay.
        3) Duration.
        4) Retentive
        5) Time bases of 1.0 sec, 0.1 sec, and 0.01 sec.

    d. Counters:
        1) Count up.
        2) Count down.

    e. Arithmetic
        1) Single-precision.
        2) Double-precision.
        3) Signed Integer.
        4) Add.
        5) Subtract.
        6) Multiply.
        7) Divide.
        8) Square root.
        9) Less than.
        10) Greater than.
        11) Equal.
        12) Floating point.

    f. Logical:

        1)   And.

        2)   Or.

        3)   Exclusive or.

        4)   Compare.

g.   PID.

h.   Data Manipulation

        1)   Copy.

        2)   Move.

        3)

i.   Program Flow Instruction

        4)   Jump.

        5)   Subroutine.

C.   **Real-Time Clock/Memory Module:**

1.   The module shall provide a real time clock allow the PLC to perform operation at set times.

2.   The module shall provide 8K words of memory backup.

D.   **Communications Hardware:**

1.   The PLC shall be provided with a DF1 (RS-232) to Ethernet/IP (Ethernet) interface module for connection of the PLC to the Ethernet network. The module shall be equipped with an RJ-45 port. Provide all required cable between the PLC and interface module.

2.   All data within a PLC shall be accessible via the RS-232 and Ethernet ports.

3.   Programming functions shall be possible through the RS-232 and Ethernet ports.

4.   Unloading and downloading of programs shall be possible through the RS-232 and Ethernet ports.

5.   The operating mode of the PLC shall be changeable through the RS-232 and Ethernet ports.

E.   **PLC Input and Output Module:**

1.   The PLC base unit shall be provided with 12, 120Vac digital inputs and 12 relay outputs rated 2.5 Amps at 120Vac

continuous.

    2.   Digital Input Modules:

        a.   Provide 16, 120 VAC digital inputs.
        b.   Maximum signal delay time of 20 ms
        c.   Provide modules as required.

    3.   Relay Output Modules:

        a.   Provide 8 individually isolated 120Vac relay outputs.
        b.   Current per output of 1.0 Amp.
        c.   Provide modules as required.

    4.   Analog Input Modules:

        a.   Provide 8 4-20 mA current inputs.
        b.   16 bit resolution.
        c.   Provide modules as required.

    5.   Analog Output Modules:

        a.   Provide 8, 4-20 mA current outputs.
        b.   16 bit resolution.
        c.   Provide modules as required.

F.   **Expansion Power Supply:**

    1.   Provide expansion power supply as indicated.
    2.   Input voltage 120Vac.
    3.   Output of 2 Amps at 5Vdc and 0.8 Amps at 24Vdc.
    4.   Over-voltage and short circuit protection.

2.4   Operator Interface Touchscreen:

A.   Provide as required for control and monitoring of equipment.

B.   Touchscreen display shall be 256-color minimum, TFT type, with a minimum resolution of 640 x 480 pixels.

C.   LCD type with backlight.

D.   Shall be quipped with an Ethernet type RJ-45 communication port and RS-232 port for programming and communication of data with the PLC.

E.   Display size shall be a minimum of 10-inches measured diagonally.

F. NEMA 4 rated.

G. Operated temperature of 50°C.

H. Minimum of 16 Mbytes of memory.

I. Designed for panel mounting.

J. Hard and soft copies of the touchscreen program shall be provided to the Owner.

2.5 Software:

A. Provide the Owner with one licensed copy of the latest version of RSLogix 500 programming

B. Provide the Owner with one licensed copy of the latest version of the Windows based touchscreen programming software.

C. Include any cables connecting to the PLC or HMI to a remote laptop for programming confirmation.

2.5 SCADA RTU PLC and SCADA Interface:

A. Provide equipment, installation and interface to the existing radio based Sanitary Lift Station SCADA System. Provide new Remote Telemetry Unit (RTU) and interface with existing RTU and SCADA System.

1. Provide DF1 to Ethernet/IP interface to a separate micrologic 1500 PLC dedicated to the radio communication SCADA system. This work shall be fully integrated into the existing system installed in 2007 by HSQ Technology.

2. Radio equipment shall be MDS, 175Mhz class communication to match existing.

3. Provide programming and configuration of status and alarm points at the SCADA Master MTU and HMI located at the Island WWTP. Transfer this data from the pump control PLC to the SCADA RTU and via radio to the SCADA Master.

4. Provide power loss and communication loss alarms.

5. Provide all required cables and connectors for programming of the PLC, connection of the PLC to the Ethernet/IP interface

module, and connection of the expansion I/O module.

6. The existing Centre Pump Station shall remain on-line past the completion of the construction. As a result it is necessary to have the existing Centre Pump Station report its data to the new Centre Pump Station RTU for relaying to the Master MTU. Provide connection to existing Centre Pump Station RTU. Install Ethernet module in existing Station and transfer data points from the existing station to the new RTU. Upon completion of this Ethernet Data link, remove the radio data link from the existing Centre Pump Station. Coordinate work with Owner and Engineer.

2.6 Spare Parts:

A. Provide the following spare parts:

1. Pump Control PLC processor unit. (1 Ea)

2. SCADA PLC processor unit. (1 Ea)

3. One spare input/output module of each type provided.

4. One spare communication module for each type provided.

B. Provide five (5) spare fuses of each type used.

2.7 Test Equipment: Any special test kits, cables, software, or other test accessories that are unique to the manufacturers' Equipment, used in operation or maintenance of this Equipment shall be provided.

PART 3 - EXECUTTON

3.1 Installation:

A. Programmable Logic Controllers:

1. Install PLC in enclosure as indicated and specified.

2. Wire all inputs and outputs to terminal blocks within the PLC Panel.

3. Install all communication modules and required cables.

B. Touchscreen:

1. Install touchscreen in the door of the PLC Panel.

2. Install communication cable between the PLC and touchscreen.

3. Configure touchscreen for proper communication with the PLC.

3.2 PLC and Touchscreen Programming:

A. PLC:

1. The PLC shall be programmed to perform the required logic functions and control loops for proper operation of the equipment as indicated.

2. The PLC shall monitor power status to the control panel. Logic shall implemented that shall clear run contacts when power is lost and perform routine startup of equipment after a power restoration.

3. The PLC program shall be thoroughly documented with explanations in the program of the operation performed in each program line or rung.

4. Shall be programmed utilizing the latest version of Windows based programming software from the manufacturer.

5. Both a hard and soft copy of the program shall be provided to the Owner.

B. Touchscreen:

1. The touchscreen shall be programmed to provide the Operator with an interface to the controlled equipment.

2. Screens shall be developed to allow the Operator to start and stop equipment, place equipment in auto or manual modes, adjust set points, view the status of all monitored points and view alarms.

3. Shall be programmed utilizing the latest version of Windows based programming software from the manufacturer.

4. Screens shall be laid out in a logical order with a main overview screen and links from each screen back to the main overview screen.

5. Operator adjustable set points shall be password protected.

6. Both a hard and soft copy of the program shall be provided to the Owner.

3.3 Field Testing: Specified in SECTION 16950

PART 4   MEASUREMENT AND PAYMENT

4.1   Measurement

A. No measurement will be made for this item.

4.2 Payment

A. Payment will be made at the contract lump sum price bid and shall be considered full payment for providing labor and materials to perform this work.

** END OF SECTION 16924 **