

SECTION 13450 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

SUMMARY

Section Includes:

1. Programmable Logic Controller (PLC):
 - a. Central processing unit.
 - b. Process input/output.
2. Small Programmable Logic Controller (SLC):
 - a. Central processing unit.
 - b. Process input/output.
 - c. Programming device.
 - d. Memory module.
3. Remote Communication:
 - a. Serial network interface radios.
4. Program Development Software.

SUBMITTALS

Shop Drawings: Submit Shop Drawings covering the items included under this Section.

QUALITY ASSURANCE

Manufacturer Qualifications: Manufacturer shall be regularly engaged in manufacturing equipment complying with requirements of these Specifications.

WARRANTY

Special Warranty: CONTRACTOR shall purchase 1-year upgrade and technical support warranties for all software purchased under this Section. As part of these services, there shall be no intermediaries. They shall be between OWNER and OEM.

PART 2 - PRODUCTS

MANUFACTURERS

Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Programmable Logic Controller (PLC):
 - a. Allen-Bradley.
2. Small Programmable Logic Controller (SLC):
 - a. Allen-Bradley.
3. Serial Network Interface Radios:
 - a. Microwave Data Systems - TransNet
4. Program Development Software:
 - a. Rockwell Software Co. (RSLogix Series).

PROGRAMMABLE LOGIC CONTROLLER (PLC)

PLCs shall be general purpose process data acquisition and control devices. The PLC shall be microprocessor-based driven by a stored program, and shall be compatible with and work in harmony with remote devices specified herein.

Central Processing Unit:

1. Each central processing unit shall consist of a 16-bit parallel processor with scan not to exceed 150 milliseconds for all program steps and input/output time servicing. The processor(s) shall have memory capacity as shown on Drawings.
2. The system shall contain a general purpose set of instructions. Watchdog timer protection shall be provided. The processor shall have self-diagnostic capabilities. Each processor shall be supplied with adequate random access memory to support tasks covered in these Specifications. Memory shall be semiconductor with on-board lithium battery backup power for at least 4 months prime source outage.
3. PLCs shall have permanently installed system software for process input/output servicing, PLC intercommunications, LAN communication, diagnostics, and process control. The basic model for PLC operations shall be "ladder diagram."
4. Data elements shall be grouped according to type or function into registers or files. Provide a consistent addressing structure for PLC and external machines to reference data elements. The following basic data types shall be provided:
 - a. Input.
 - b. Output.
 - c. Bit.
 - d. Integer (16-bit).
 - e. Timer.
 - f. Counter.
 - g. Character (ASCII).
5. Process Control: Program elements shall be provided to execute the following kinds of actions:
 - a. Basic Relay Logic.
 - b. Timers: On-delay, Off-delay, Retentive.
 - c. Counters: Count-up, Count-down.
 - d. Arithmetic: Add, Subtract, Multiply, Divide, Square Root.
 - e. Logic: Negate, And, Or, Exclusive Or.
 - f. Conditionals.
 - g. Data transition.
 - h. One-shot.
 - i. Stepper Switches (sequencers).
 - j. Branching Instructions.
 - k. Subroutines.
 - l. File Instructions.
 - m. Analog PID Control:
 - 1) ISA Algorithm.
 - 2) Independent Gain Algorithm.
 - 3) Ratio Control.
6. Process Input/Output: Complete process input/output assemblies shall be provided. Process input/output shall consist of modules of each major function to be monitored or controlled. Each input/output module shall plug into processor frame assembly and be interconnected to input/output terminal strip cable connections.

- a. Remote input/output modules shall be separately housed as shown on Drawings. Where remote modules are used, they shall communicate with PLC via PLC's manufacturer's standard data highway.
7. Analog Input: Analog inputs to system shall be in form of differential (non-grounded) direct current voltages. Input circuitry shall be high-impedance such that external sensing circuits will not be adulterated by presence of this equipment. In all cases this equipment shall be passive with respect to analog sensing circuits. External power supplies shall be provided as necessary.
 - a. Milliampere loops shall be sensed in concert with precision resistors appropriately sized. Such resistors shall be applied at termination point in a way that input card removal does not affect loop continuity. Each analog signal shall be connected to system via a barrier-type terminal strip.
 - b. Input impedance shall be a minimum of 10 megohms and common mode rejection shall be 120 dB or better. Accuracy shall be plus 0.1 percent full scale and resolution shall be 25 percent. Analog to digital conversion shall yield a signed 12-bit integer. Provide 8 inputs per card.
8. Analog Outputs: Control signals in form of 4-20 mA analog signals into 500 ohms shall be provided. Each analog output shall be provided on a barrier-type terminal strip.
 - a. Analog output modules shall be provided to interface each output to appropriate terminal strip. Each output shall be continually maintained by a sample and hold circuit with a drift rate no greater than 1 percent in 12 hours. Digital to analog conversion shall accept signed 12-bit integers. Provide 4 outputs per card.
9. Discrete Inputs: Discrete inputs to be monitored shall consist of isolated dry contact closures and 120 VAC inputs as shown. Barrier-type terminal strips capable of terminating inputs shall be provided.
 - a. A discrete input circuit board shall be equipped with a photo isolation for each discrete input. Noise and contact bounce less than 20 milliseconds shall be rejected. Provide 16 inputs per card.
10. Discrete Outputs: Control signals in form of discrete outputs shall be provided. Each discrete control signal shall be provided on a barrier-type terminal strip. They shall make use of relays or zero-angle fired triacs having a capability of at least 2 amps. They shall include any necessary arc suppression or other conditioning circuitry to ensure their proper operation in conjunction with field elements specified.
 - a. Each output shall be fused and shall be equipped with a status indicator. A blown fuse indicator shall also be provided.
 - b. Outputs used to control devices external to enclosure in which module is located shall be isolated type, allowing use of a different external 120 VAC power source for each output. Outputs used to control devices within enclosure in which module is located need not be isolated. Provide 16 outputs per card.
 - c. Outputs used to control devices external to enclosure in which module is located shall be relay type. Outputs used to control devices within enclosure in which module is located may be zero-angle fired triacs where compatible with devices.
11. Rack Configuration: Provide I/O to meet requirements shown on Drawings, plus 20 percent spare I/O of each type used. I/O assignments must not put more than 50 percent of similar equipment on same card to prevent catastrophic failures based on loss of 1 card. Equipment rack layout must allow for addition of 20 percent more cards per rack; minimum space 2 slots. This requirement is totaled for each rack; it is not based on overall network.

SMALL PROGRAMMABLE LOGIC CONTROLLER (SLC)

Modular small programmable logic controllers (SLC) shall be general-purpose process data acquisition and control devices. The SLC shall be microprocessor-based, driven by a stored program, and shall be compatible with and work in harmony with remote devices specified herein.

SLCs shall be capable of sensing, monitoring, and reporting all external signals connected to them.

Central Processing Unit:

1. Each central processing unit shall consist of a 16-bit parallel processor with scan, not to exceed 150 ms for all program steps and input/output time servicing.
2. The system shall contain a general-purpose set of instructions. Watchdog timer protection shall be provided. The processor shall have self-diagnostic capabilities. Each processor shall be supplied with adequate random access memory to support all tasks covered in these Specifications. Further, memory shall be semiconductor with on-board lithium battery backup power for at least 4 months prime source outage. The processor(s) shall have memory capacity as shown on Drawings.
3. The modular programmable logic controller shall be supplied complete with manufacturer's standard CPU, power supplies, battery, chassis, and discrete and analog input/output modules.
4. PLCs shall have permanently installed system software for process input/output servicing, PLC intercommunications, LAN communication, diagnostics, and process control. The basic model for PLC operations shall be "ladder diagram."
5. Data elements shall be grouped according to type or function into registers or files. Provide a consistent addressing structure for PLC and external machines to reference data elements. The following basic data types shall be provided:
 - a. Input.
 - b. Output.
 - c. Bit.
 - d. Integer (16-bit).
 - e. Timer.
 - f. Counter.
 - g. Character (ASCII).
6. Process Control: Program elements shall be provided to execute the following kinds of actions:
 - a. Basic relay logic.
 - b. Timers: On-delay, Off-delay, Retentive.
 - c. Counters: Count-up, Count-down.
 - d. Arithmetic: Add, Subtract, Multiply, Divide, Square Root.
 - e. Logic: Negate, And, Or, Exclusive Or.
 - f. Conditionals.
 - g. Data transition.
 - h. One-shot.
 - i. Stepper switches (sequencers).
 - j. Branching Instructions.
 - k. Subroutines.
7. Analog PID Control:
 - a. ISA Algorithm.
 - b. Independent Gain Algorithm.
 - c. Ratio Control.

8. Process Input/Output: Complete process input/output assemblies shall be provided. Process input/output shall consist of modules of each major function to be monitored or controlled. Each input/output module shall plug into processor frame assembly and be interconnected to input/output terminal strip cable connections.
 - a. Remote input/output modules shall be separately housed as shown on Drawings. Where remote modules are used, they shall communicate with SLC via SLC manufacturer's standard data highway.
9. Analog Input: Analog inputs to system shall be in form of differential (non-grounded) direct current voltages. Input circuitry shall be high-impedance such that external sensing circuits will not be adulterated by the presence of this equipment. In all cases, this equipment shall be passive with respect to analog sensing circuits. External power supplies shall be provided as necessary.
 - a. Milliampere loops shall be sensed in concert with precision resistors appropriately sized. Such resistors shall be applied at termination point in a way that input card removal does not affect loop continuity. Each analog signal shall be connected to system via a removable, barrier-type terminal strip.
 - b. Input impedance shall be a minimum of 10 megohms and common mode rejection shall be 120 dB or better. Accuracy shall be plus or minus 0.1 percent full scale and resolution shall be 25 percent. Analog to digital conversion shall yield a signed 12-bit integer. Provide 4 inputs per card.
10. Analog Outputs: Control signals in form of 4-20 mA analog signals into 500 ohms shall be provided. Each analog output shall be provided on a removable, barrier-type terminal strip.
 - a. Analog output modules shall be provided to interface each output to appropriate terminal strip. Each output shall be continually maintained by a sample and hold circuit with a drift rate no greater than 1 percent in 12 hours. Digital to analog conversion shall accept signed 12-bit integers. Provide 4 outputs per card.
11. Discrete Inputs: Discrete inputs to be monitored shall consist of isolated dry contact closures and 120 VAC inputs as shown. Removable, barrier-type terminal strips capable of terminating inputs shall be provided.
 - a. A discrete input circuit board shall be equipped with a photo isolation for each discrete input. Noise and contact bounce less than 20 milliseconds shall be rejected. Provide 8 inputs per card.
12. Discrete Outputs: Control signals in form of discrete outputs shall be provided. Each discrete control signal shall be provided on a removable, barrier-type terminal strip. They shall make use of relays or zero-angle fired triacs having a capability of at least 2 amps. They shall include any necessary arc suppression or other conditioning circuitry to ensure their proper operation in conjunction with field elements specified.
 - a. Each output shall be fused and shall be equipped with a status indicator. A blown fuse indicator shall also be provided.
 - b. Outputs used to control devices external to enclosure in which module is located shall be isolated type allowing use of a different external 120 VAC power source for each output. Outputs used to control devices within enclosure in which module is located need not be isolated. Provide 8 outputs per card.
 - c. Outputs used to control devices external to enclosure in which module is located shall be relay type. Outputs used to control devices within enclosure in which module is located may be zero-angle fired triacs where compatible with devices.
13. Rack Configuration. Provide I/O to meet requirements shown on Drawings, plus 20 percent spare I/O of each type used. I/O assignments must not put more than 50 percent of similar equipment on same card, to prevent catastrophic failures based on loss of 1 card. Equipment

rack layout must allow for addition of 20 percent more cards per rack; minimum space 2 slots. This requirement is totaled for each rack; it is not based on overall network.

- a. Unused Slots. Provide blank filler cover for all unused slots.
14. Programming Device:
 - a. Provide manufacturer's standard hand-held portable programming device which shall be capable of the following:
 - 1) Monitor PLC status.
 - 2) Enable/disable inputs/outputs.
 - 3) Force On/Off internal coils.
 - 4) Modify/monitor all internal registers.
 - 5) Troubleshoot application program.
 - b. Provide carrying case, battery, memory pack, and wall-mounted power supply for programming device. Provide complete with user manuals and manufacturer's standard software licenses.
15. Memory Module: Provide manufacturer's standard EEPROM memory module for each PLC, unless otherwise shown on Drawings.
 - a. Memory module shall be provided complete with ancillary components required to save and read a processor program to/from a non-volatile memory source of modular form.

DATA HIGHWAYS

Link the PLC's, Operator Interface Computers and associated equipment into an integrated network. Programmable Logic Controllers (PLCs) and Small Logic Controllers (SLCs) shall be equipped with communication channels as depicted on Drawings.

Plant-wide Networks:

1. PLCs shall include an Ethernet Adapter port where shown on Drawings. The selected messaging protocol for this port shall be TCP/IP and shall provide high throughput with error detection and correction. Reliability shall be achieved through use of appropriate check sums, parity checking, redundant messages, and acknowledgment/rejection of messages. Networking software shall be open systems interconnect compliant.
2. The network shall operate at a speed of 10M bits per second or faster. Network protocol shall be carrier sense multiple access/collision detection (CSMA/CD) in compliance with IEEE 802.3. Alternate protocols conforming to IEEE 802 may be used only upon written permission granted by ENGINEER.

PLC Networks: Data highways shall be used to interconnect PLC or SLC with their remote input/output racks and to interconnect PLC with each other on a peer-to-peer basis. Highway topology shall be ControlNET or Ethernet.

PLC Network Interface: Provide networking interfaces as shown on Drawings. Where an operator interface computer is shown as a node on network, preferred interconnection shall be via Ethernet.

Fiber-Optic Converters: Provide fiber-optic communication compatible with PLC hardware and communication protocols. Converters shall be stand-alone or rack-mounted as shown on Drawings. Converters shall use multi-mode fiber and Type ST mating connectors. Transmit launch power shall be -15 dbm and receive sensitivity shall be -32 dbm.

Serial Networks: Programmable Logic Controllers and Small Logic Controllers shall include a 0-25 pin D-shell serial port, support standard EIA RS-232C and RS-423, and be RS-422 compatible. The port shall support ASCII or DFI full-duplex, half-duplex master, and half-duplex slave protocols.

Serial Network Interface Radios shall be used for communication with remote PLCs and SLCs and shall be point-to-point or multi-drop as shown on Drawings.

Provide cables as required to interconnect each network component. Provide all cables and connectors for programmable products. Cables shall be installed in conduit and/or underground duct under Division 16. Cables shall be shipped to Site in bulk with connectors not attached.

PROGRAM DEVELOPMENT SOFTWARE

Provide PLC program development software for PLCs and SLCs. Each copy shall be fully licensed and supported by software manufacturer. Refer to Drawings to determine whether additional licensed copies are to be supplied. Provide media and complete documentation with each copy of the software.

Program development software shall have the following features as a minimum:

1. Perform on-line configuration of all processors.
2. Modify programs off-line.
3. Store programs on hard disk and be able to upload/download programs of a processor.
4. Fully document and cross-reference programs including printed copies.
5. Support all logic functions of processors.
6. Show ladder diagrams on-screen.

PART 3 - EXECUTION

NOT USED

END OF SECTION 13450