
SECTION 25 13 13
PROGRAMMABLE LOGIC CONTROLLER (PLC) CONTROL SYSTEM

PART 1 - GENERAL**1.1 SUMMARY**

A. Section Includes:

1. Programmable logic controller (PLC) control system(s), including software, programming, and training.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

- (1) Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - (a) C37.90.2, Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
 - (b) C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- (2) National Electrical Manufacturers Association (NEMA):
 - (a) ICS 1, General Standards for Industrial Control and Systems.

B. Qualifications:

1. Installation supervisor shall have had experience in overseeing installation and startup of at least three (3) similar installations.
2. Programmer(s) shall have had experience in programming PLCs for at least two (2) projects of similar size and complexity.

1.3 SUBMITTALS

A. Shop Drawings:

1. As required by 01 33 00 Submittal.
2. Product technical data:
 - a. Annotated hard copies of PLC software programs.
 - 1) Submit program for logic in ladder diagram format as used for the specific PLC system.
 - 2) Annotate program listing to include the following:
 - a) Written description of each rung's function.
 - b) Reference to control loop number for each rung where applicable.
 - c) Reference to instrumentation tag number of I/O devices for each rung where applicable.
 - 3) Provide written descriptions completely defining all function blocks used in the program.

- 4) Provide list of all addresses referenced in logic diagram with description of data associated with each address.
 - b. Results of factory testing procedures.
 - c. Drawings containing the following information to be submitted as part of Section 01 33 00 submittals:
 - 1) Arrangement drawings for PLC system components.
 - 2) Panel and enclosure plans, sections and details.
 - 3) Access opening locations and required clearances for each panel and enclosure.
 - 4) Enclosure internal wiring and terminal blocks.
 - d. Catalog cut sheets containing information on PLC components to be submitted as part of this Specification Section submittals.
3. Certifications:
- a. Qualifications of installation supervisor.
 - b. Qualifications of programmer(s).
- B. Operation and Maintenance Manuals:
1. Submit maintenance procedures available to Owner.
 - a. Include the location and phone numbers of service centers (including 24 HR "hot lines").
 - b. Provide specific information including operation and maintenance requirements, programming assistance, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Rockwell Automation, Allen-Bradley CompactLogix -latest version (Must have Ethernet)

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. The PLC system shall accomplish the control requirements of the loop descriptions, Drawings, and Specifications.
- B. PLC programming shall be documented, and factory tested.
- C. The PLC system shall operate in ambient conditions of 32 to 140 Deg F temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.
- D. Environmental Controls:
1. Furnish circulation fans in solid state control system enclosures.
 2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.

3. Air conditioning applications shall include means of preventing moisture condensation.
- E. Where the PLC is utilized to control multiple trains of equipment and where the equipment in each train operates as a unit relatively independent of other equipment trains (e.g., facility with multiple boiler units or filter trains), the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of any one (1) component does not affect equipment on all trains.
1. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.
 2. Where several equipment units operate in parallel but are not considered assigned to a particular equipment train (e.g., multiple raw water pumps or chemical feed pumps all discharging into a common system), the PLC I/O modules associated with each equipment unit shall be assigned so that the failure of any one (1) I/O module does not affect all of the parallel operating equipment units.
- F. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per IEEE C37.90.2.
- G. Incorporate the following minimum safety measures:
1. Watchdog function to monitor:
 - a. Internal processor clock failure.
 - b. Processor memory failure.
 - c. Loss of communication between processor and I/O modules.
 - d. Processor ceases to execute logic program.
 2. Safety function wiring: Emergency shutdown switches shall not be wired into the controller.
 3. Safe wiring:
 - a. Unless otherwise specified, activation of alarms and stopping of equipment shall result from the de-energization of control circuits, rather than the energization of control circuits.
 - b. Low voltage control signal wires:
 - 1) Place in conduit segregated for that purpose only.
 - 2) Twisted shielded wire pair.
 - 3) Not located in the same conduit or bundle with power wiring.
 4. Initial safety conditions:
 - a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.
 - b. Utilize program each time PLC is re-initiated, and the control program activated.
 5. Monitoring of internal faults and display:
 - a. Internal PLC system status and faults shall be monitored and displayed.
 - 1) Monitored items shall include:
 - a) Memory ok/loss of memory.
 - b) Processor ok/processor fault.
 - c) Scan time overrun.
 6. Control of programs: Protect access to PLC program loading with password protection or

- with locked, key operated selector switches.
7. Design PLC system 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.
 8. Operator intervention:
 - a. Logic system failure shall not preclude proper operator intervention.
 - b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.

2.3 COMPONENTS

A. PLC System Central Processor Unit (CPU):

1. CPU shall provide communications with other control systems and man-machine interfaces as specified.
2. Memory:
 - a. Battery-backed RAM.
 - b. EEPROM program back-up:
 - 1) Automatically download to RAM in the event RAM is corrupted.
3. Memory battery backup shall be capable of 60 days memory retention with fresh battery.
 - a. Provide visual indication of battery status and alarm low battery voltage.
 - b. Memory battery backup shall be capable of 14 days memory retention after the "Battery Low" indicating LED is on.
4. Plug-in card design to allow quick field replacement of faulty devices.
 - a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.
5. 20 percent minimum spare useable memory capacity after all required programming is in place and operating.
6. Capable of executing all control functions required by the Specifications and Drawings.
7. Built-in three-mode (proportional-integral-derivative) control capabilities.
 - a. As directly selectable algorithms requiring no user knowledge of programming languages.
8. On-line reconfigurable.
9. Lighted status indicators for "RUN" and "FAILURE."
10. Capable of manual or automatic control mode transfer from the operating console stations or from within the control strategy.
 - a. Transfer shall be **umpless and balanceless.**

B. Input/output (I/O) Modules:

1. Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
2. Provide I/O system with:
 - a. I/O solid state boards with status lights indicating I/O status.
 - b. Electric isolation between logic and field device.

- c. Capability of withstanding low energy common mode transient to 1000 V without failure.
 - d. Incorporate noise suppression design.
 - e. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.
 - f. Install 20 percent spare I/O modules.
3. Input/output connection requirements:
Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
 - a. Prewire I/O modules to terminal blocks.
 - b. Provide terminal blocks with continuous marking strip.
 - c. Size terminals to accommodate all active data base points and spares.
 - d. Provide terminals for individual termination of each signal shield.
 - e. Field wiring shall not be disturbed when removing or replacing an I/O module.
4. Discrete I/O modules:
 - a. Interface to ON/OFF devices.
 - b. I/O status indicator on module front.
 - c. Voltage rating to match circuit voltage.
 - d. Output module current rating:
 - 1) Match maximum circuit current draw.
 - 2) Minimum 1.0 continuous A/point for 120 Vac applications.Isolated modules for applications where one (1) module interfaces with devices utilizing different sources of power.
5. Discrete outputs shall be fused:
 - a. Provide one (1) fuse per common or per isolated output.
 - b. Provide blown fuse indication.
 - c. External fusing shall be provided if the output module does not possess internal fusing.
 - d. Fuses provided external to output model shall:
 - 1) Be in accordance with module manufacturer's specifications.
 - 2) Be installed at terminal block.
6. Analog I/O modules:
 - a. Input modules to accept signals indicated on Drawings or Specifications.
 - b. Minimum 12-bit resolution.
 - c. I/O chassis supplied power for powering connected field devices.
 - d. Differential inputs and outputs.
 - e. User configurable for desired fault-response state.
 - f. Provide output signals as indicated on Drawings and Specifications.
 - g. Individual D/A converter for each output module.
 - h. Individual A/D converter for each input module.

C. Power Supply Units:

1. Provide regulated power units:
 - a. Designed to operate with PLC system and shall provide power to:
 - 1) All components of PLC system.
 - 2) All two-wire field instruments.
 - 3) Other devices as indicated on Drawings or Specifications.
 - b. Capable of supplying PLC system when all of the specified spare capacity is utilized.
 - c. Each power supply shall be sized such that it will carry no more than 75 percent of capacity under normal loads.
2. Electrical service to PLC system is 105 to 125 V, 60 Hz, +1 percent, 1 PH power.
3. Separate AC circuit breakers shall be provided for each power supply.
4. If the PLC system is field expandable beyond the specified spare capacity, and if such expansion requires power supply modification, note such requirements in the submittals and allow room for power supply modification in the PLC system enclosure.
5. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
6. Power distribution:
 - a. Immune to transients and surges resulting from noisy environment.
 - b. Shall provide constant voltage level DC distribution to all devices.
7. Provide uninterruptible power supply (UPS) to sustain full power to UPS powered loads listed below for a minimum of 10 minutes following loss of primary power and to ensure that the transient power surges and dips do not affect the operation of the PLC system.
 - a. UPS powered loads:
 - 1) All rack mounted PLC components.
 - 2) Local operator consoles.
 - 3) All power supplies furnished with the PLC and associated loads.
 - b. Input:
 - 1) 120 Vac +10 percent.
 - 2) 60 Hz.
 - 3) Line fuse protection.
 - c. Output:
 - 1) 120 Vac (5 percent.
 - 2) 60 Hz.
 - 3) Short circuit protected.
 - 4) Instantaneous transfer time.
 - d. IEEE C62.41 Class A voltage surges of 6000 V attenuated to less than 50 V on the output.
 - e. Battery: Maintenance free lead acid.

D. PLC System Enclosure:

1. Component placement:
 - a. Mount all controller components vertically within the enclosure to allow maximum convection cooling.

- b. Either install power supplies above all other equipment with at least 10 IN of clearance between the power supply and the enclosure top, or adjacent to other components, but with sufficient spacing for circulation of cooling air.
- c. Do not place I/O racks directly above the CPU or power supply.
- d. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.
- e. If items such as magnetic starters, contactors, relays, and other electromagnetic devices must be located within the same enclosure as the PLC system components, place a barrier with at least 6 IN of separation between the magnetic area and the control area.
- f. Place circulating fans close to major heat generating devices.
- g. Segregate input/output modules into groups of identical type.
2. Wiring and grounding to be in accordance with MSG standards provided in Design Guide.
3. Termination requirements:
Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the enclosure.
 - a. Prewire I/O modules to terminal blocks.
 - b. Size terminals to accommodate all active database points and spares.
 - c. Provide terminals for individual termination of each signal shield.
 - d. Field wiring shall not be disturbed when removing or replacing an I/O module.

E. PLC System Software and Programming:

1. Provide all hardware and programming required to provide communication between the PLC and the man-machine interface.
2. Provide programming to accomplish all control and monitoring requirements of the Drawings and Specifications.
3. Provide two (2) copies of control logic program on 3-1/2 IN disks or on CD.
4. IBM compatible software.
5. Full documentation capability.
 - a. Provide description for each rung.
6. On/off line programming.
7. Offline simulation prior to download.
8. Two-step commands requiring operator verification prior to deletion of any programming.

2.4 ACCESSORIES

Provide all accessories required to furnish a complete PLC control system to accomplish the requirements of the Drawings and Specifications.

2.5 SOURCE QUALITY CONTROL

- A. Provide a performance test after factory completion and prior to shipment. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
1. Conduct testing with dummy I/Os to verify each control loop operation.

2. Allow for Owner and Engineer representatives to witness testing program.
 - a. Provide a minimum of 15 days' notice prior to testing.
3. Do not ship prior to successful completion of this testing program.

2.6 MAINTENANCE MATERIALS

- A. Furnish Owner with the following extra materials:
 1. One (1) spare I/O card of each card type for every 10 cards or fraction thereof installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install PLC control system in accordance with manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

- A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
 1. Inspect equipment covered by these Specifications.
 2. Supervise adjustments and installation checks.
 3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
 - a. All commissioning functions may be witnessed by the Engineer.
 - b. All reports shall be cosigned by the Contractor and the Engineer if witnessed.
 4. Conduct startup of equipment and perform operational checks.
 5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.3 DEMONSTRATION

- A. On-Site Training:

Provide employee of the manufacturer or certified representative to provide one (1) week of operating and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.

- a. As a minimum, training shall cover:
 - 1) Hardware overview.
 - 2) Software overview.
 - 3) Maintenance.
 - 4) Trouble shooting.
 - 5) Operation, e.g., changing set points, passwords, etc.