

SECTION 40 94 43 – PROGRAMMABLE LOGIC CONTROLLERS (PLCs)

1.01 SUMMARY:

- A. ^{A17}**Scope:** This Section covers the performance requirements and requirements for programmable logic controllers (PLCs) and related components, as necessary, for process control systems (PCSs) as part of the Works.^{A17} The Sections listed in Table 40 91 00-1 shall be read in conjunction with this Section of the Employer's Requirements.
- B. **Related Sections:**

Table 40 91 00 – 1: Related Sections	
1.	Section 01 81 26 - Communications, Control, Safety, and Security Systems.
2.	Section 26 43 13 - Transient Voltage Surge Suppressors.
3.	Section 27 11 16 - Cabinets, Racks, Frames, and Enclosures.
4.	Section 40 00 00 - Process Systems Integration.
5.	Section 40 95 13 - Process Control Hardware.

1.02 REFERENCES:

- A. **Applicable Publications:** Refer to Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.02.

1.03 REQUIREMENTS:

- A. **General Requirements:**
1. **General:**
 - a. The Contractor shall meet all applicable requirements of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.03, and Section 40 00 00 (*Process Systems Integration*).
 - b. ^{A19}PLC and RIO offered shall have been field proven for at least four years since its initial commercial launch (excluding beta testing period). Leading edge of technology PLCs are not acceptable unless this time period is met.
 - c. PLCs and RIO's input/output points and spare capacity shall be as specified elsewhere and as required by final design Contract drawings.^{A19}
 2. **Certifications:** The Employer prefers that PLC manufacturer have valid ISO 20000 certification to ensure an ITIL style help desk.
 3. **Common Mode Fault (CMF) Avoidance:**
 - a. Where redundant devices are needed, the CMF avoidance principle shall be employed, by introducing differences in the instances of redundant equipment, where such differences mutually compliment each other and

together achieve better system robustness. This applies to power supplies, fiber optic modems, sensors, and other redundant equipment. The following are examples of employed differences:

- 1) ^{A16}Using different device models with different required ranges or tolerances to resist or withstand high temperature, vibration, amperage, voltage, noise or other adverse conditions. ^{A16}
- 2) Using instances of different technology, but each capable of achieving system goals.

b. **CMF Avoidance on Power Supply Output:**

- 1) Where two or more duplicate power supplies are used redundantly, specific circuit discrimination shall be introduced such that the primary supply voltage is set slightly higher than nominal and the standby supply voltage is set slightly lower than nominal to ensure that one unit is typically more loaded than the other. This measure shall avoid simultaneous or near simultaneous unit failures due to normal wear.
- 2) Both power supplies shall be independently monitored such that failure of either the primary or secondary supply is annunciated both locally and remotely.

4. **Communications:**

- a. ^{A19}Master PLCs, input / output (I/O) concentrators, and slave PLCs shall include two channels with IEC 61158 type 2 fieldbus protocol and two channels with EtherNet/IP for long distance communications, and serial communications for short distance communications. ^{A19}
- b. PLCs shall be capable of peer-to-peer (P2P) communication between processors.

5. **Fieldbuses:** Sub-network fieldbuses shall be in accordance with Section 40 91 00 (*Primary Process Measurement Devices*), ^{A9}Subparagraph 1.03 B.4^{A9}.

B. **Equipment:**

1. **Input/Output Concentrators (IOCs):**

- a. ^{A19}IOCs shall be a PLC platform hardware I/O rack capable of acquiring all local I/O, including I/O available through PCS sub-networks. The Employer does not require an on-board IOC processor. ^{A19} However, slave PLCs are acceptable alternatives to IOCs.

2. **Programmable Logic Controllers (PLCs):**

- a. Master PLCs shall be a single arrangement of hardware and software redundant PLCs, capable of managing facility wide I/O, and responsible of all PCS functions. Remote I/O shall be acquired by means of I/O Concentrators or Slave PLCs.
- b. All master PLCs shall have the same software as required for application redundancy.
- c. ^{A19}Programmable automation controllers meeting the requirements for PLCs are acceptable instead of PLCs. ^{A19}

3. **Memory:**

- a. ^{A16}PLCs shall have data and program memory sized as required to meet the Employer's Requirements. ^{A16}
- b. Data and logic memory shall be at least two times the maximum estimated for the functions assigned or 16 MByte, whichever is the largest.
- c. PLCs shall save data in a non-volatile memory so that it is not lost in case of energy failure. Such memory shall be compact flash, at least two times the maximum estimated for the functions assigned or 64 MByte, whichever is the largest.

4. **Modules:**

a. **General:**

- 1) PLCs shall consist mainly of multi-function modules and an adequate number and type of process interface modules.
- 2) All modules are excepted from the Single Point of Failure Avoidance requirements of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), ^{A10}Subparagraph 1.03. K. 3.a. ^{A10}
- 3) PLCs shall have hot-swappable modules. The general modules shall include, but are not limited to, the types listed below.
- 4) High speed counter modules are unacceptable.

b. ^{A19}**Communications Modules:**

- 1) Multiple communications cards shall be furnished to meet the requirements of the Employer's Requirements. ^{A16} The number shall be as required for the applicable links and protocols.
- 2) All PLCs and RIOs shall have the number of communications modules coordinated as required to sustain as many simultaneous communication sessions as the scope of the PCS requires. ^{A19}

- c. **Control Processor Unit (CPU) Modules:**
 - 1) CPUs shall process all the automation functions algorithms such as loop control, sequence control, as well a wide range of calculation functions, analog value corrections, and linearization functions.
 - 2) Master PLCs shall be capable of having multiple processors.
 - 3) If an I/O concentrator is equipped with a processor module and is used as a slave PLC to control the safe shutdown procedure in case of communication loss, removing the processor shall be indifferent to normal operations.
 - 4) ^{A19}All PLCs shall have the number of processor modules coordinated as required to sustain as many simultaneous communication sessions as the scope of the PCS requires. ^{A19}
- d. **Counter Modules:** Shall be unacceptable. ^{A19}In lieu of these, 4 to 20 mA, single or multi-turn Resolvers shall be employed, or the encoders shall be CENELEC EN 50325-2 enabled. ^{A19}
- e. **Highway Addressable Remote Transducer HART (Protocol) Modules:** Shall be used with all analog sensors where HART protocol is available.
- f. **Power Supply Modules:** Shall operate on 24 VDC output, and shall include analog monitoring signals for temp, output voltage and output current.
- g. **Signal Input or Acquisition Modules:** Shall take care of reading, validation, monitoring, and conditioning of all the process binary variables, as well as analog variables, making these values available for further use in the process control system (digital input modules, analogue input modules).
- h. **Signal Output Modules:** Shall generate the logic or the analog outputs to the process from orders issued from the multi-function processors (digital output modules and analogue output modules).
- 4. **Non-Redundant Master PLC:** Shall be a single master or slave PLC used as a master PLC, but without redundancy.
- 6. **Open Process Control (OPC) Servers:** An I/O server using OPC specification that may be used as a gateway to other remote I/O. If possible, OPC servers shall be avoided. Instead, integrating I/O into I/O concentrators is preferred.
- 7. **Programming Languages:** ^{A19}Languages shall be in accordance with IEC 61131-3. ^{A19} PLCs shall handle ladder logic diagrams, function block diagrams, instruction lists, sequential function diagrams, and structured text.

8. **Slave PLCs:** Shall be a networked PLC or an I/O concentrator that includes an on-board PLC processor.
9. **Terminal Blocks with Overvoltage Protectors:** Shall be in accordance with Section 26 43 13 (*Transient Voltage Surge Suppressors*).

C. ^{A19}**Installation:**

1. **General:** PLCs and RIO in machinery rooms shall be installed in cabinets meeting the requirements of Section 27 11 16 (*Cabinets, Racks, Frames, and Enclosures*).
2. **Programmable Logic Controllers:** ^{A19}
 - a. Redundant master PLCs in main control buildings shall be installed in separate, non-adjacent racks.
 - b. ^{A19}Tasks in PLCs shall be configured to eliminate overlaps and allow enough time for communications. In the case of multiple periodic tasks, these shall be configured with different priorities and rates as required.
3. **Remote I/O Concentrators:** Shall be linked to the master PLCs by means of redundant communications. ^{A19}

1.04 DESIGN CRITERIA/ SYSTEM PERFORMANCE:

A. **General:**

1. **Problem to be Solved:** The Contractor shall provide PLCs that solve the following business needs:
 - a. For vital PCSs, a highly reliable systems employing fault tolerance and CMF avoidance, with capacity for future expansion.
2. **Restrictions to be Considered:**
 - a. **General:** Prescriptive information is given in order to meet the Employer's PLC standards for locks machinery control systems (LMCSs).
 - b. ^{A9}(Reserved) ^{A9}

- B. **Design Criteria:** PLCs shall comply with all requirements of IEC 61131 parts 1, 2, and 3.

C. System Performance:

1. I/O Concentrators:

- a. I/O concentrators shall collect inputs, concentrate outputs, provide protocol translation as required, and emulate a PLC except for processing capabilities.
- b. If an I/O concentrator is used in a design where machinery operation is put at risk when communications with central control is lost, then a machinery safe shutdown procedure shall activate when a complete communications failure alarm is set. The safe shutdown procedure shall be controlled by complementary electrical circuit logic and shall be triggered when a communications watch dog timer has timed-out.

2. Programmable Logic Controllers:

- a. PLCs shall support calculations or derived tags specified elsewhere.
- b. PLCs shall be capable of operating in a safe mode should there be local processor or total communications failure.
- c. PLCs shall allow remote upload of user defined ladder logic and programs.
- d. Cold boot shall not exceed 25 seconds.
- e. PLCs shall be designed for operation in 0°C to 55°C (32°F to 131°F) or wider temperature range, and dirty or dusty conditions. PLCs shall have immunity to electrical noise, and high resistance to vibration and impact.
- f. The master PLC shall be regularly sending a watchdog relay timer reset signal to the I/O concentrator or slave PLC, to a communications watchdog timer relay output address. If reset signal is not received within a timeout period, the relay timer shall activate a limited relay logic electrical circuit that shall operate the machinery to a safe position.
- g. If a slave PLC is used in a design where machinery operation is put at risk when communications with central control is lost, then a machinery safe shutdown procedure in the slave PLC shall activate when a complete communications failure alarm is set.
- h. PLCs shall be designed to handle the required number of simultaneous communications connections and interrupts.

1.05 SUBMITTALS: Shall be in accordance with Section 40 00 00 (*Process Systems Integration*), Paragraph 1.05. In addition, the Contractor shall submit a list of clients from the proposed PLCs and RIO in the most recent four years.

1.06 QUALITY ASSURANCE: Shall be in accordance with Section 40 00 00 (*Process Systems Integration*), Paragraph 1.06.

END OF SECTION

^{A19}**THIS PAGE NOT USED**^{A19}