

SCOPE

- I 1.1 This practice covers the design, installation, programming, testing and documentation of Programmable Logic Controllers (PLCs) in non-protective system applications. This includes, but is not limited to, applications such as pump and valve control, motor load shedding/reacceleration, some types of sequencing, (e.g., Drier Regeneration), and analog control using PID algorithms.
- I * 1.2 The requirements for protective system applications or safety critical applications are covered by [IP 15-7-2](#).
- I 1.3 **An asterisk (*) indicates that a decision by the Owner's Engineer is required, that additional information is to be furnished by the Owner's Engineer, or that information for the Owner's Engineer's approval is to be supplied by the PLC Vendor or Contractor.**

SUMMARY OF ADDITIONAL REQUIREMENTS

- I 2.1 [Table 1](#) lists the practices and standards which shall be used with this practice.

TABLE 1

PRACTICES	
IP 15-6-2	Environmental Protection for Instrumentation
IP 15-7-1	Electrical Power Branch Circuit Design for Instruments
IP 15-10-1	Instrument Transmission Systems
IP 15-11-1	Instrument Control Panels
IP 15-12-1	Instrument Wire and Cable
IP 16-1-1	Area Classification and Related Electrical Design for Flammable Liquids, Gases or Vapors
IP 16-1-3	Protection of Electrical Equipment in Contaminated Environments
IP 16-8-1	Instrument and Essential Services Power Supplies
IP 16-13-1	Field Installation and Testing of Electrical Equipment
IP 20-1-1	Inspection of Equipment and Materials
STANDARDS	
ISA	
S.5.2	Binary Logic Diagrams for Process Operations
IEC	Basic Environmental Testing Procedures:
68-2-6	Test Fc and Guidance: Vibrations (Sinusoidal)
68-2-27	Test Ea and Guidance: Shock
68-2-34	Test Fd: Random Vibration Wide Band
IEC	Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment:
801-2	Electrostatic Discharge Requirements
801-3	Radiated Electromagnetic Field (Outside North America)
NEC	National Electric Code (North America Only)
ANSI / NEMA	
ICS 6-88	Enclosures for Industrial Controls and Systems
ANSI / IEEE	
C37.90.1-1989	Surge Withstand Capability (SWC) Tests
C63.2-1987	Electromagnetic Interference and Field Strength Instrumentation
NEMA	
ICS 3	Industrial Systems Equipment
Military Standards	
MIL-HDBK-217E	Reliability Prediction of Electronic Equipment
MIL-HDBK-472	Maintainability Prediction

IP 15-6-3		Programmable Logic Controllers	
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(This practice is appropriate for attachment to Inquiry or Purchase Document)

DEFINITIONS

- I 3.1 A **Programmable Logic Controller (PLC)** is a programmable electronic system capable of performing the same logic functions which have traditionally been performed by electro-mechanical relays and timers. It detects the change in state of input signals from push buttons, limit switches, field instruments, etc. and acts on this information to produce desired output signals to drive loads, such as pilot lights, solenoids, motor starters, and valves. Additionally, a PLC may contain analog processing, mathematical functions, and PID control capability.
- I 3.2 A **PLC system** consists of one or more programmable electronic system Central Processing Units (CPUs), power supplies, and multiple input/output (I/O) modules which interface with field instrumentation and operator control panels/ interfaces. A communications network interface to a higher level Digital Control System (DCS) is also possible.
- I 3.3 **Local I/O** refers to any input/output module located with the logic.
- I 3.4 **Remote I/O** refers to any input/output module located remote from the logic requiring data transfer to take place over a communications link between this I/O module and the CPU.
- I 3.5 A **Rack (or base)** is a slotted modular housing that contains and provides mechanical protection for individual PLC I/O modules. A rack also includes the electrical backplane which functions as a communication link between the CPU and the local I/O modules.
- I 3.6 A **termination assembly** is an electrically passive circuit board to which field wiring is attached. The termination assembly passes input and output signals between field circuits and I/O modules.
- I 3.7 **On-line programming** is when the application program is modified while the PLC is executing the application program.
- I 3.8 **Off-line programming** is when the application program is modified when the PLC is not executing the application; or when the application program is modified on a separate stand-alone programming device (e.g., Personal Computer) and later downloaded to the PLC's CPU memory.
- I 3.9 **Peer-to-peer communication** is data transmission from any PLC on a network to any other PLC on the same network.
- I 3.10 **Scan time** is the time necessary to completely execute the entire PLC application program one time, including any system overhead processing (i.e., diagnostics, updating the I/O table, system communications) that may be performed.

DESIGN

GENERAL

- C 4.1 A **redundant PLC system** may be required for some system applications. When redundant systems are required, they must be approved by the Owner's Engineer.
- M 4.2 **PLC system layout** shall be designed to allow for adequate working space and clearances to promote ease of maintenance. The PLC system layout shall be approved by the Owner's Engineer.

ENVIRONMENTAL REQUIREMENTS

- I,S 4.3 The **PLC system installation** shall be suitable for use in the specific electrical area classification.
- R 4.4 The **PLC system** shall be designed to operate in the following conditions:
 - a. Ambient Temperature: 32°F (0°C) to 140°F (60°C)
 - b. Humidity: 5% to 95% Non Condensing
 - * c. Power Supply: 120 or 220 Vac +10%, -20%, 24 or 120/125 Vdc
 - * d. Power Supply Frequency: 50 or 60 Hz ± 3 Hz
 - e. RFI/EMI Emissions: Comply with applicable regulatory agency
 - * f. RFI/EMI Susceptibility: IEC 801-3 or NEC
 - g. Shock and Vibration: IEC 68-2-6, IEC 68-2-27, IEC 68-2-34
- R 4.5 **Modules (i.e., CPU, I/O) used in a PLC system** should be encased in a sturdy enclosure designed to provide protection against electro-static discharge as specified by **IEC 801-2**.
- R 4.6 **When cooling and/or heating is required** to maintain the operating temperature range of the PLC system electronics, loss of the cooling/heating device shall be alarmed.

SYSTEM CAPACITY

- O ♦ 4.7 **Selection of PLC components** should be based on an accurate count of the number of function blocks (especially PIDs) and I/O points (especially analog points), allowing for an additional 50% growth of the application software.

INPUTS/OUTPUTS

- I,R ♦ * 4.8 The **number of I/O modules** shall include 20% installed spare capacity. Expansion to 50% additional I/O shall be possible.
- O,R ♦ * 4.9 All **input and output circuits must be electrically isolated to prevent transients in the field wiring** from affecting the internal PLC circuitry (components other than I/O modules). Optical or transformer isolation is acceptable.
The PLC Vendor must have tested the equipment for resistance to transient and common-mode voltage interference in accordance with ANSI/IEEE C37.90.1-1989 "Surge Withstand Capability Tests" (both sinusoidal and transient tests) or other test approved by the Owner's Engineer. The magnitude of the voltages that the equipment will resist must be acceptable to the Owner's Engineer.
- O,R * 4.10 When specified by the Owner's Engineer, **relay output design** shall employ resistor and capacitor filter networks to suppress transient voltages.
- M ♦ 4.11 **Termination assemblies** shall be equipped with standard screw type terminal connectors. Terminals shall be numbered for easy reference, and should be sized to contain at least the following:
Discrete Modules: Two 14 AWG (2.08 mm²) wires per terminal.
Analog Modules: One 16 AWG (1.31 mm²) wire per terminal.
Other connection types must be approved by the Owner's Engineer.
- I 4.12 **Termination assemblies for analog signals** shall include terminals for terminating one shield wire per signal loop.
- M 4.13 It must be possible to remove the **I/O modules** and replace them without:
 - a. Disconnecting the field wiring from the I/O module termination assembly.
 - * b. Removing power from the PLC or any field devices.
 - * c. Disrupting the operation of the PLC in any way except for the functions associated with the module being replaced.
 - d. Incurring any damage to any circuits.
- O,M ♦ * 4.14 **If I/O modules are internally fused**, blown fuse indication shall be provided on the front of the module. Remote indication of blown fuses shall be approved by the Owner's Engineer. Fuses shall be located such that they are easily accessible and that their replacement shall not disrupt the operation of any other part of the PLC system.
- O ♦ * 4.15 **The PLC I/O modules shall assume a predictable failure state** when any component of the PLC system fails. The output failure state of all outputs shall be approved by the Owner's Engineer.
- O ♦ 4.16 **Thermocouple and Resistance Temperature Detector (RTD) I/O modules** should have as minimum the following features:
 - a. Resolution of at least 12 bits (one part in 4000)
 - b. Be able to support thermocouple types J, K, and T.
 - c. Automatic cold junction compensation.
 - d. Open thermocouple detection.
 - e. Overall accuracy of at least $\pm 1.0^{\circ}\text{F}$ ($\pm 0.5^{\circ}\text{C}$).
 - f. RTD modules should support either 3 or 4 wire RTD types.
 - * g. Linearity of 0.1% over the temperature range.
- I ♦ * 4.17 If **remote I/O or extended communication links** between modules are used, this must be approved by the Owner's Engineer

POWER SUPPLY

- I,M * 4.18 The **external power to the PLC system** shall be designed in accordance with [IP 16-8-1](#). Each external power source shall be equipped with a fused disconnect switch for isolation. External power supply design shall be approved by the Owner's Engineer.