Automated Pump Control System – Functional Specification

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Project Definition

Title: Automated Pump Control with Safety Interlocks and HOA (Hand-Off-Auto) Interface

Objective: Implement a control routine for a pump that cycles automatically while enforcing safety interlocks for flow and pressure, with operator control via HOA and alarm handling.

Scope: PLC logic design, alarm management, HOA behavior, and verification against defined test criteria in an emulated environment.

Success Criteria: The system meets all cycling, interlock, alarm, and HOA behaviors described below and passes the test steps without faults or unintended operation.

Rephrased Specification (Formal Language)

1) Process Overview

Design a control program for a pump that operates in a continuous cycle: 30 seconds ON, followed by 10 seconds OFF. The system must include protective measures using:

• A flow switch, and

• A pressure sensor (0–55 psi range).

The control sequence shall terminate under either of the following conditions:

• When the pump is commanded ON, if no flow is detected within 5 seconds of startup, or

• If pressure exceeds 30 psi for 5 consecutive seconds.

These conditions generate alarms (fault bits) and must activate corresponding fault indicators (notification bits). The design must also incorporate HOA (Hand-Off-Auto) controls:

• HAND runs the pump only while the button is pressed (momentary).

• Upon release, the system returns to its prior state (OFF or AUTO).

• While any alarm is active, the pump must not enter AUTO; only OFF (and possibly HAND, per design choice) are permitted. The choice of allowing HAND during an active alarm is left to the designer, but it must be implemented consistently.

2) I/O and Memory Assignments

Inputs

• I:0/0 — Flow Switch

• I:0/1 — Alarm Reset Button

• I:0/2 — Alarm Silence Button

Internal Bits (HOA)

• B3:0/0 — HAND Pushbutton

• B3:0/1 — OFF Pushbutton

• B3:0/2 — AUTO Pushbutton

Analog Register

• N7:0 — Pressure Sensor Value (scaled 0–55 psi)

Outputs

• O:0/0 — Pump

• O:0/1 — Flow Fault Indicator

• O:0/2 — Pressure Fault Indicator

3) Operating Logic (Summary)

• AUTO Mode: The pump cycles ON for 30 seconds and OFF for 10 seconds.

• HAND Mode: The pump runs only while the HAND button is pressed; upon release, the system reverts to its prior OFF/AUTO state.

• OFF Mode: The pump remains stopped; no automatic cycling occurs.

• Interlocks and Trips:

• No-Flow Trip: If the pump is ON and flow is not detected within 5 seconds, stop the pump and latch a Flow Fault; energize O:0/1.

• Overpressure Trip: If pressure exceeds 30 psi for 5 seconds, stop the pump and latch a Pressure Fault; energize O:0/2.

• Alarm Handling:

• Silence via I:0/2 should mute audible/visual notification as designed, without clearing the fault latch.

• Reset via I:0/1 clears latched faults after the unsafe condition is no longer present.

• Mode Restriction During Alarms: With any active alarm, AUTO is inhibited. Only OFF (and optionally HAND, per design decision) are available.

4) Test Procedure (Emulate)

1. Initial State: No cycling; no faults. Set N7:0 = 8192 ($\approx$ 27.5 psi).

2. Flow Fault via HAND:

• Toggle B3:0/0 (HAND) ON. Pump energizes.

• After 5 seconds without flow, pump stops and O:0/1 (Flow Fault) energizes.

• Release HAND. Toggle I:0/2 (Silence) ON then OFF as needed per annunciation scheme.

• Press HAND again; pump behavior depends on your design choice about allowing HAND with active alarm.

3. AUTO Cycling:

• Turn HAND OFF. Press B3:0/2 (AUTO). Initially, pump should not cycle if alarms are active.

• Force I:0/1 (Alarm Reset) ON then OFF to clear faults.

• Force I:0/0 (Flow Switch) ON to indicate valid flow.

• Toggle B3:0/2 (AUTO) ON then OFF (or as required) so the pump begins automatic 30s/10s cycling.

• While cycling, pressing HAND should run the pump continuously; releasing HAND returns to cycling.

4. Overpressure Fault:

• Set N7:0 = 10000 ($\approx$ 33.5 psi).

• After 5 seconds above the 30 psi threshold, pump stops and O:0/2 (Pressure Fault) energizes.

Completion: All behaviors above must occur as specified.

System Diagram

FLOW
SWITCH

PUMP

PRESSURE
SENSOR

O:0/0

N7:0

I:0/0

PLC

O:0/1

O:0/2

I:0/1

I:0/2

FLOW
FLT
IND

PRES
FLT
IND

ALM
RESET
BTN

ALM
SILENT
BTN