INDUSTRIAL MAINTENANCE

Teachers Notes for

CP0539 - Industrial Maintenance of Closed Loop Systems
CP6773 - Troubleshooting & Fault-Finding Closed Loop

CP0539 & CP6773

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INTRODUCTION

This Teacher's Notes document supports the delivery of both **CP0539 – Industrial Maintenance of Closed Loop Systems** and **CP6773 – Troubleshooting & Fault-Finding Closed Loop Systems**. These programmes are designed to develop practical skills and theoretical understanding in maintaining and diagnosing faults within industrial closed-loop control systems.

Each system replicates real-world automation environments, using industrial-grade PLCs, HMIs, sensors, and actuators to simulate flow-based control processes. Learners gain hands-on experience with fault scenarios, safety systems, and system behaviour under varying conditions.

This document provides structured guidance for instructors, including mapped learning objectives, teaching strategies, pacing, safety instructions, and worksheet answers. It supports flexible delivery approaches whether guided, fault-led, or scenario-based and aligns with national qualifications such as T Levels and EAL units in industrial maintenance and control.

Whether your learners are new to automation or developing existing knowledge, this curriculum promotes diagnostic thinking, confidence with test equipment, and real-world readiness.

INSTRUCTOR GUIDE

TEACHING STRATEGY

You are free to use this system as you wish but there are three ways we recommend.

1. Working through the Worksheets
2. Working through the Scenarios
3. Teacher-led fault insertion via removal of wires

The worksheets are great as an introduction to the kit, even if someone is experienced in Industrial Automation or Maintenance.

The scenarios replicate real life in that the Fault screen and Alarm screen are disabled, and as such the student must think about the overall function of the kit before being able to diagnose the problem.

They need not “fix” anything, as all the faults are software based.

You can however introduce hardware faults by removing certain wires, outlined later in this section. This will then induce real hardware faults that students can use a multimeter or other test equipment to diagnose the faults.

Use “Random Fault” for varied difficulty.

Suggested Delivery & Pacing

SUGGESTED DELIVERY & PACING

This 10-week schedule provides a structured path through the course content. Learners begin with guided exploration of the system, then move into hands-on tasks that involve discovery, fault-finding, and scenario-based diagnostics.

Each week introduces new components and system behaviours, allowing students to gradually build confidence and competence. A mix of teaching methods is used to reinforce both theory and practice. The course ends with a review and assessment to consolidate learning.

Week	Topics / Worksheets	Focus	Mode
1	Intro, Worksheets 1–2	Closed-loop flow, E-Stop	Guided
2	Worksheets 3–5	Status LEDs, PLC IO, HMI	Discovery
3	Worksheets 6–7	Pump & Valve behaviour	Guided then fault-led
4	Worksheets 8–9	Float and Proximity sensors	Fault-led
5	Worksheets 10–11	Flow and Temperature sensors	Discovery
6	Worksheets 12–13	Digital vs Analogue sensors	Guided
7	Random Faults	Fault-finding via IO screen	Fault-led
8	Scenarios 1–4	Realistic simulation	Scenario-based
9	Scenarios 5–8	Realistic simulation	Scenario-based
10	Review & Assessments	Practical & written	Mixed

SAFETY BRIEFING

Before any practical work begins, instructors should review the following key safety points with learners:

1. **Isolation Procedure**
   Always isolate power using the circuit breaker (MCB1) before adjusting or removing any hardware wiring. No wire changes should be made while the system is powered.

2. **Low-Voltage Electrical Awareness**
   The system runs on 24V DC. While considered safe, shorting terminals can still cause sparks or damage components. Treat all wiring with care and avoid live probing unless supervised.

3. **Emergency Stop Disclaimer**
   The system includes a physical E-Stop button that simulates a dual-channel safety circuit. This is for training purposes only and does **not** meet industrial safety standards. The system is only fully safe when power is off at the MCB.

4. **Pump Protection and Dry Running**
   The system includes float switches to prevent dry running. While the installed pump is rated to run dry for up to two hours, dry operation should still be avoided unless instructed during specific test procedures.

5. **Temperature Warning**
   During extended operation, the tank temperature may exceed 40°C. The system includes a software cutout at this point. Learners should be aware that components may become warm to the touch.

6. **Simulated Hardware Faults Only**
   Hardware faults should only be simulated as instructed (e.g. removing specific signal wires). Learners must not tamper with or modify any other wiring or components.

7. **Water Spills and Leaks**
   If a leak occurs, immediately stop the system by switching off the MCB or pressing the E-Stop. The pump can empty the tank in under one minute—do not leave the system unattended while running.

Standard Fault List

STANDARD FAULT LIST

The system has 7 faults that cannot be bypassed in software, these will trigger regardless to how you use the kit.

1. Emergency Stop
2. PID Setpoint Not Reachable
3. Low Tank Level
4. High Tank Level
5. High Tank Temp
6. Low Tank Temp
7. Tank Lid

Here's a simple breakdown of each fault:

1. **Emergency Stop** – If the emergency stop button is pressed, the system shuts down immediately for safety. No way to override it in software. Likewise, if there is a break in either of the two channels, the system will error out.
2. **PID Setpoint Not Reachable** – The system tries to reach a target value (flow, pressure, temperature, etc.), but it can't. Could be a blocked valve, closed hand valve, failed pump, or sensor issue.
3. **Low Tank Level** – The tank's liquid level drops too low. The system has two float switches, one low and one high. If the low-level sensor does not detect liquid, it will prevent the system from running.
4. **High Tank Level** – The tank is too full, risking overflow and potential damage or mess. This is triggered via the tanks high level float switch.
5. **High Tank Temp** – The temperature inside the tank gets too high, which could cause overheating or damage to components.
6. **Low Tank Temp** – The temperature drops too low, meaning the process might not work as expected.
7. **Tank Lid** – If the tank lid is open when it should be closed, the system stops. There is a proximity switch that detects the metal on the lid.

These faults ensure safety and prevent damage, and they always trigger when detected.

RANDOM FAULT EXPLANATION

A simulated fault can occur via the “Random Fault” button, or if a Fault Scenario is activated.

Both the Fault Scenarios and the Random Fault button use the same 8 faults.

The faults here differ from the original faults list;

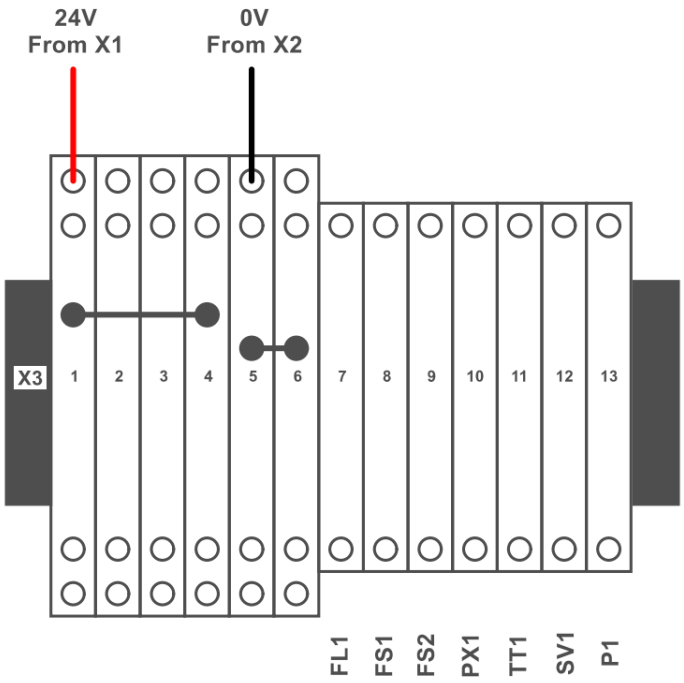
1. High Temperature
2. Tank Lid Error
3. Bad Flow
4. Low Temp
5. High Float Switch
6. Estop Channel 1 Failure
7. Incorrect Temperature Scalar in Analogue Setup
8. PID Error

Please see our external document titled; “CP6773 - Troubleshooting & Fault-Finding Closed Loop Systems – Answers”

This document gives you solutions to the scenarios as well as further explanations to help you with explaining the scenarios to your students.

ADDITIONAL HARDWARE FAULTS

It is possible to induce further faults into the system by removing certain wires. We recommend only removing wires from the Field Terminals that are on the front of the training rig, between the PLC and HMI.



You can remove one of the below wires and then ask your students to attempt to diagnose the faulty component.

Fault	Wire Number	Description
Flow Sensor	X3-7	The output wire of the flow sensor, which provides a pulse to the PLC. This will prevent the flow sensor from reading anything.
Tank High Float Switch	X3-8	Removes the signal to the PLC for the tank high float switch.
Tank Low Float Switch	X3-9	Removes the signal to the PLC for the tank low float switch.

Additional Hardware Faults

Tank Lid Proxy	X3-10	Removes the signal to the PLC for the proximity sensor.
Temperature Sensor	X3-11	Removes the analogue input from the Temperature Sensor.
Valve	X3-12	Removes the negative supply to the valve, preventing the valve from running.
Pump	X3-13	Removes the negative supply to the pump, preventing the pump from running.

VERSION CONTROL

15 05 25	First Revision Created

