

Imported Butane Vapour Recovery Unit PLC Upgrade at Pembroke Refinery



Tom Roch

BEng Electrical and Electronic Engineering

Project Aim –

- To upgrade the aging relay logic controlling the butane vapour recovery unit (VRU) at Pembroke Oil Refinery
- Upgrade the dated pneumatic oil temperature control
- Establish a communication link between this new equipment and the current main DCS (distributed control system).

Introduction

In the petrochemical industry, butane, along with other light hydrocarbons can be used for the production of Naphtha, a feedstock used for the production of gasoline. Although some butane can be extracted from crude oil distillation at Pembroke refinery, extra butane is imported using gas tankers via the jetty.

The pressure and temperature of butane held in storage tanks at the refinery needs to be controlled.



Figure 1 - Screw type compressors

Four screw type compressors (figure 1) draw gas from the top of the tanks and compress it, then cool it using 'fin fans' (large fans blowing over radiators). The reduction in thermal energy means when it is returned to the storage tank at a low pressure, it returns to a liquid state (similar to how a household fridge works). These compressors start and stop automatically and are controlled by very old relay logic, based on the tank pressure. A PLC program was written to take the place of this system along with new control system graphics and controller tags for oil temperature control. These were tested on the refinery's control system test rig. All other hardware was selected and costed ready for installation.

Method and Design

The Piping and Instrument diagram (figure 3) was used to understand the instrumentation associated with the compressor. Using this along with relay logic drawings, a system flow chart for the start and stop sequence of each compressor could be generated (figure 2).

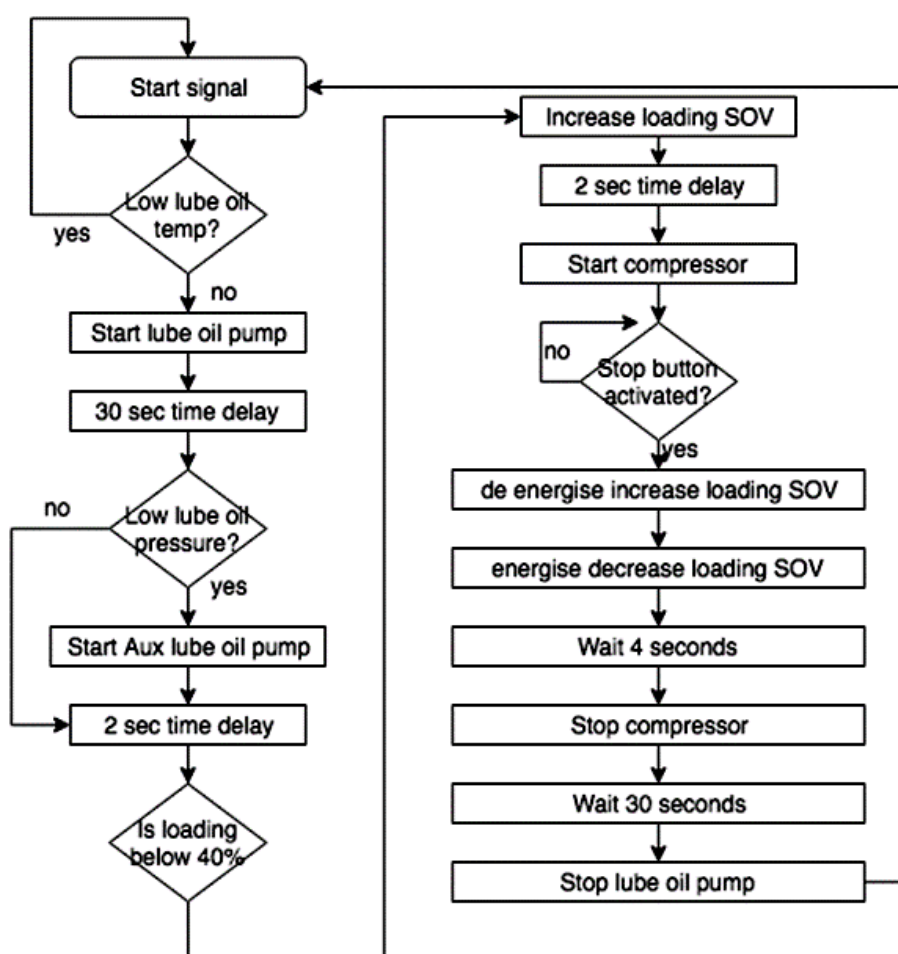


Figure 2 - PLC program flow chart

The relay logic is represented in the P&ID (figure 3) by a diamond shaped icon with "note 3" along side it. All instrumentation linked to the relay logic would need to be included in the new PLC program. The P&ID also shows the pneumatic temperature controller (bottom left) which would be upgraded to modern electrical system driven from the control room.

This new controller was initially going to be controlled by the PLC, which would have involved running new cables to the instrument enclosure. It was discovered however that there were spare cores on cables running straight back to the control room, so these were made use of instead, and a new tag was created within the refinery's main control system.

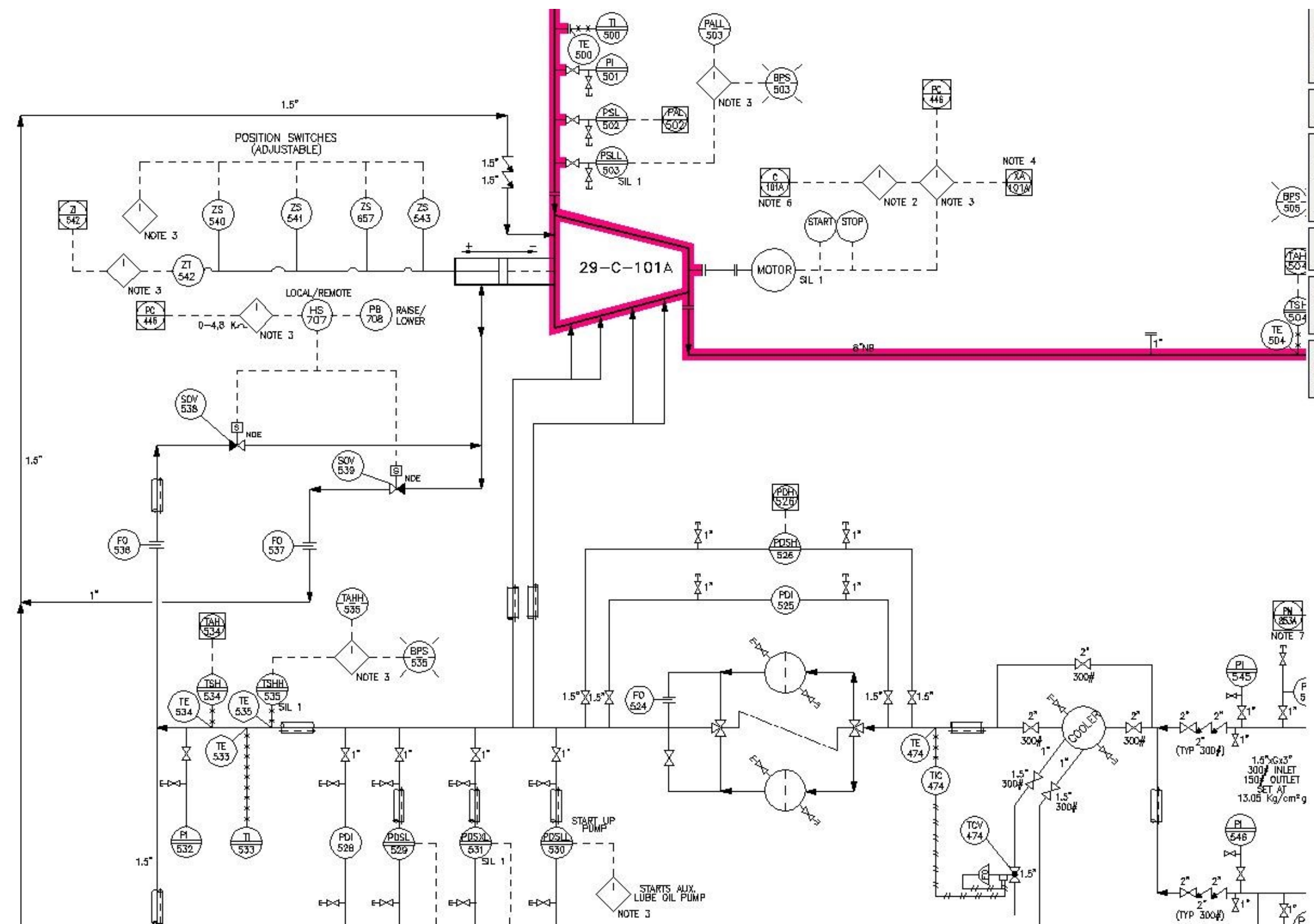


Figure 3 - Compressor P&ID, each compressor has the same instrumentation.

Figure 4 shows the new equipment that will be installed (shown in blue). The new PLC will be installed next to the relay logic panel. When the compressor is available to be taken off line, the field cables will be simply connected to the PLC input and output cards.

The serial card and configuration that was tested in the control system test rig will be transferred to the online system.

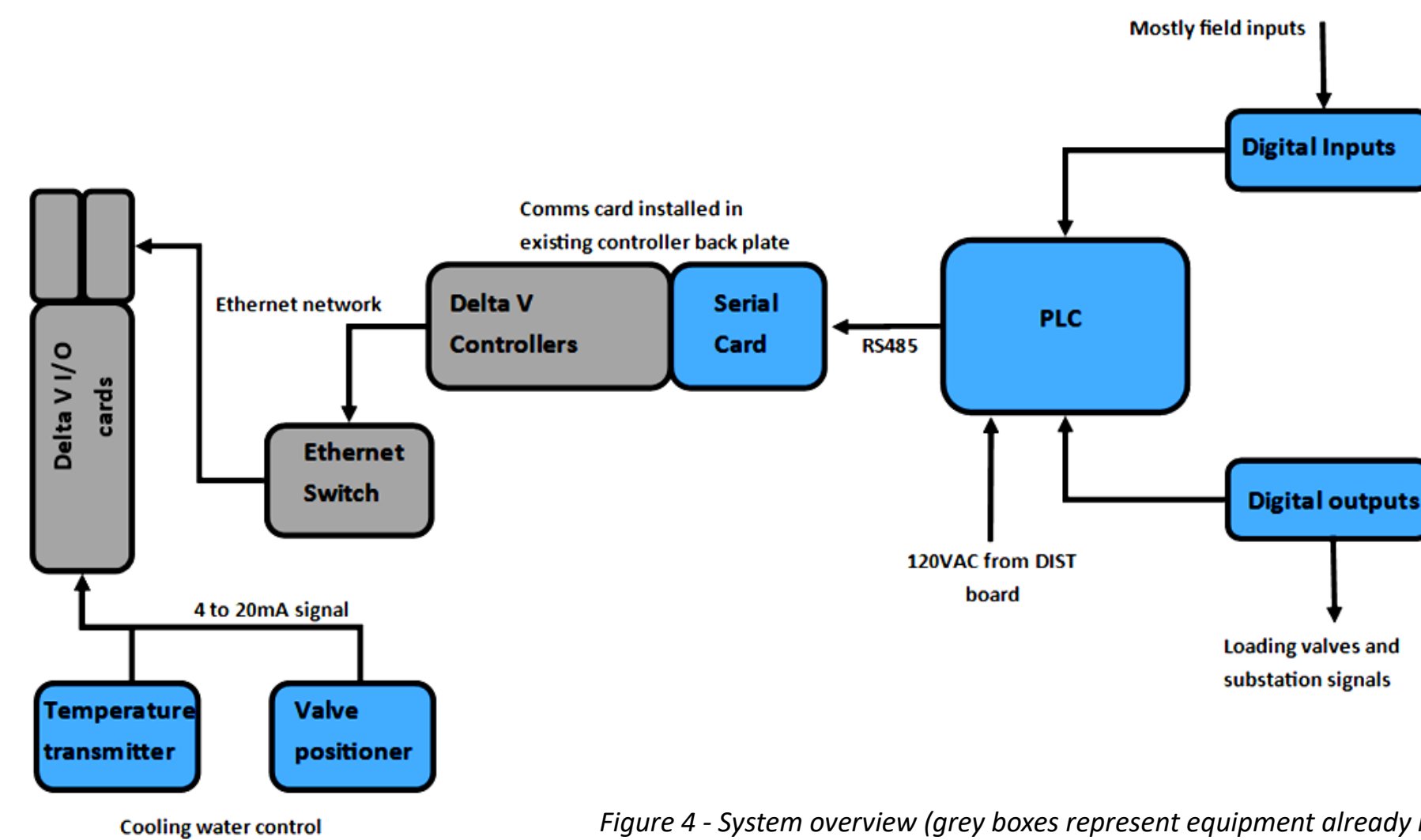


Figure 4 - System overview (grey boxes represent equipment already installed)

Testing

A new graphic from which to control the compressor was designed and tested (figure 5). This was then used to transmit and receive data along the serial link between the control system test rig and the PLC. The PLC program was fully tested by forcing inputs using a laptop. The graphic was used to start and stop the program and the flow chart to the right of the screen used to ensure the PLC stepped through the correct sequence.

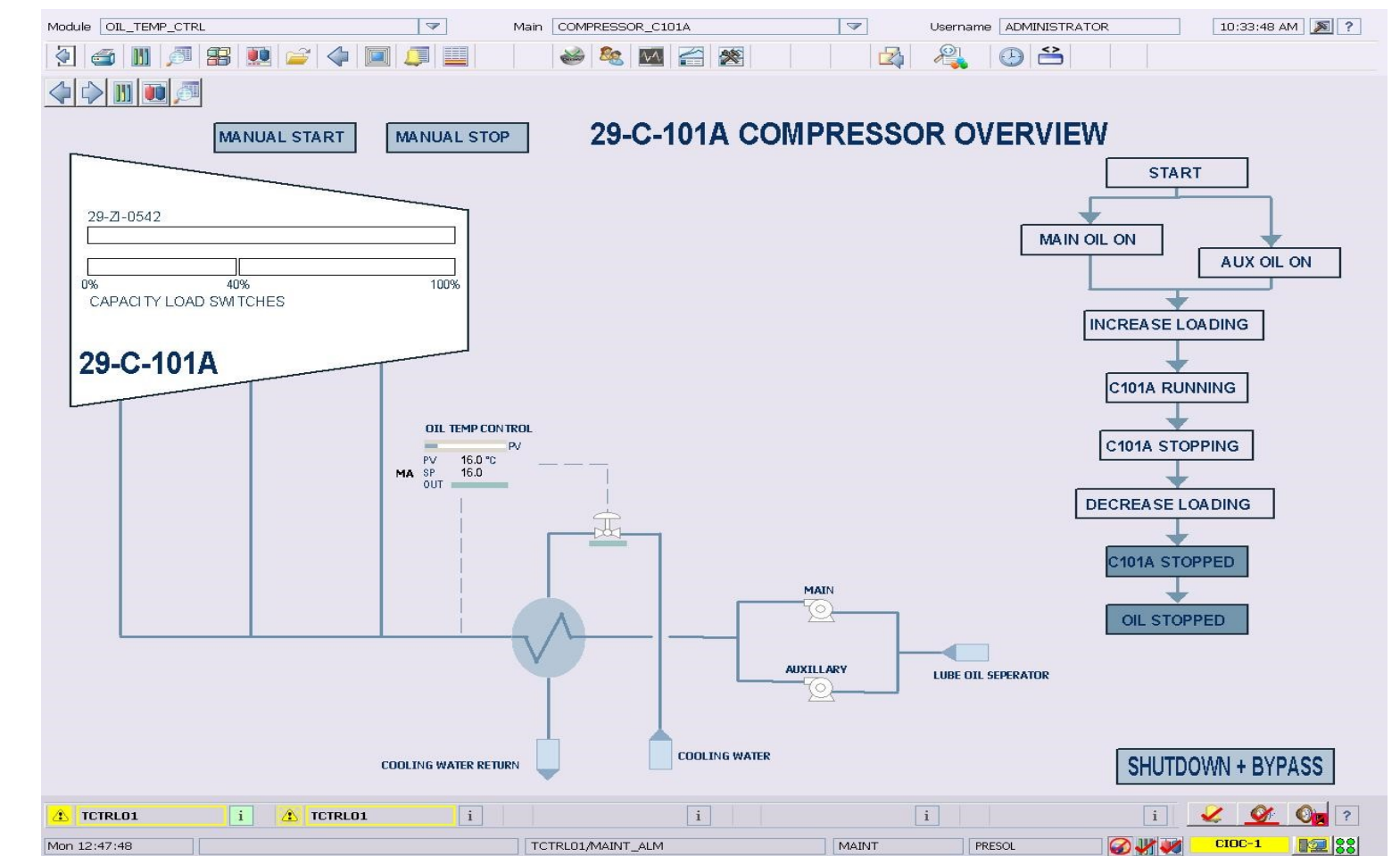


Figure 5 - Main control graphic



Figure 6 - Controller testing

The temperature controller tag was created and checked by injecting a mA signal into an input CHARM, then measuring the controller output (figure 6).

This new tag, along with serial link configurations and the new graphics are now saved on a memory stick, ready to be downloaded onto the online control system.

Conclusion

The new PLC program, serial link and graphics all functioned as intended. Substantial research was carried out into the design of the control system graphics as operators will look at this system for a 12 hour shift. It must be easy to decipher and not cause eye strain.

Several operators were asked to review the graphics. All praised the new flow chart since only a compressor run light was available to them previously, however some mentioned it would have been better to have it on a separate page.

Future recommendations include -

- Extra graphic page to demonstrate flow chart.
- Timers within the flow chart to show how far into each step the program has gone.
- New analogue pressure readings instead of pressure switches. This would involve installing new transmitters in the field, and displaying the signals on the control panel via the serial link.