



Project Case Study

Public Transport Authority of Western Australia (PTA) Tunnel Control System SCADA

Background

The Public Transport Authority of Western Australia (“the PTA”) underground railway tunnel and stations operations in Perth commenced passenger operations in December 2007.

The Tunnel Control System SCADA (TCS SCADA) comprises a Citect SCADA front end, monitoring & controlling over 9000 I/O points through duplicated Allen-Bradley PLCs, a variety of RTUs, Variable Frequency Drives, Fire panels, etc.

In all there were three distinct phases of testing and remediation of the TCS SCADA over the following three years.

Phase 1 (2007)

The PTA had concerns about the readiness of the TCS SCADA and, in particular, the life safety systems and engaged ARCS to prove they were fit for purpose. Over the following three years ARCS were engaged to undertake reviews and testing of the TCS SCADA and its sub-systems.

Problem

A review of ITPs, drawings and HMI functionality created considerable doubt as to the thoroughness of the commissioning process and the actual SCADA arrangements differed considerably from the documented arrangements. The HMI displayed a range of inconsistent and occasionally misleading equipment operational states along with a range of unusual choices in what was monitored and controlled e.g. operators could monitor the state of a range of minor GPOs used for kettles and vacuum cleaners but not the state of the main LV Air Circuit Breakers.

Solution

ARCS proposed and undertook representative sample testing of the Fire Detection, Tunnel Ventilation and Stairwell pressurisation systems across the tunnels complex and demonstrated that while there were clearly significant problems, the life safety systems had demonstrated a level of operational readiness sufficient to permit underground operations to commence.

Phase 2 (2008)

Immediately after the commencement of passenger operations, the PTA engaged ARCS to undertake a much wider review of the TCS SCADA. This testing was commenced in 2008 and included Station Hydraulics (Sumps & Pumps) Variable Frequency Drives (VFD), main Distribution Boards (DB), room entry switches, and more extensive testing of the Tunnel Ventilation System (TVS).

Problem

The TCS PLC code was reviewed using the RSLogix5000 software suite and the following issues and problems identified:

- Code recycled largely unaltered from previous projects
- Code was only available from the PLC and had no useful embedded programming comments
- Several thousand lines of redundant and irrelevant code addressing active I/O tags but which had been
- Active code outputting to tags not mapped to the HMI and similar code elsewhere in the programme which was mapped to the HMI
- Code blocks mapped to field I/O with outputs to inactive code elsewhere in the programme

No programming documentation was available for the PLC and programmable RTUs.

Some 5800 tests were planned but the extent of faults detected was so great that testing ceased after only 11% of tests had been conducted. Of these nearly 60% were determined to be Citect SCADA faults, 30% PLC code faults and 7% field wiring and equipment faults with a small percentage undetermined.

Of greatest concern was the TVS, in which it was discovered that a single point of failure – e.g. a faulty limit switch – would prevent the TVS from achieving the required ventilation state. Other significant faults discovered included incorrect mapping of Fire Zones to the HMI, unmonitored Emergency Stops, unmonitored 3-phase drives and a large number of PLC code and tag mapping problems.

Solution

Following this testing, the PTA engaged ARCS to work with the subcontractor to assist in remedial works and to conduct a repeat testing exercise when these were complete. ARCS put in place an extensive recommissioning programme which comprised point-to-point and end-to-end testing of the main TCS subsystems to determine system component behaviour. The PLC and RTU reprogramming works were undertaken by the contractor under the supervision of ARCS.

Phase 3 (2009/10)

ARCS commenced the third round of testing in 2009. As this was to prove that the remediation process had addressed most of the major concerns, the first stage of this testing was a repeat of the previous 2008 testing process.

The second stage of this testing was 100% through-testing of all major subsystems.

Problem

The first stage of testing concluded that specific items identified for remediation had been addressed but also revealed that there were a broad range of issues in previously untested areas. A large number of items tested and passed in the second round of testing failed in the third round. Further investigation concluded that the contractor had not updated the Citect tags database to align with the remedial programming works and that these were the likely source of the problem.

Solution

ARCS undertook a SCADA tag audit which disclosed substantial mapping discrepancies in several areas. These were rectified and resolved close to 100% of Citect HMI issues.

Additional TCS SCADA Works

The testing revealed that the LV ACBs and 11kV transformers were incorrectly indicated on the HMI. ARCS were engaged to provide extension of comms to the Micrologix PLCs controlling the ACBs and to deliver TCS PLC and Citect programming changes required to animate these items correctly on the Citect HMI.