



High integrity digital to analog converter recovery program

Summary

High integrity digital to analogue converters (HIDAC) were a key component within the safety systems at a customer's nuclear power plant. They had been in service for more than 25 years and were no longer supported by the original equipment manufacturer. Increasing failure rates in recent years had caused concern to be raised over their continued safe and reliable operation. The investigation and recovery program implemented improved equipment reliability and projected end of life by more than 10 years.

Scope of work

Curtiss-Wright undertook a multiphase program of work that provided investigative engineering recovery and refurbishment works across the complete HIDAC unit. Investigations centered on the sub assembly within the chassis, including the 11 analogue data acquisition boards, a high integrity processor board, IEEE interface board, motherboard and two power supplies.

Systems outline

The HIDAC converts analogue thermocouple signals into a digitized representation that is used to trigger a shutdown of the reactor in the case of a temperature transient. The equipment functions are implemented in transistor-transistor logic (TTL) and using programmable logic (PLD and PLA) in MIL-STD-883 CERDIP packages with embedded firmware.

Initial investigations

We assessed the condition and supportability of the HIDAC equipment, by testing and fault-finding on a typical failed unit to identify the root cause of the

failures and the impacts of aging on components. Review was also undertaken on the available spares, parts obsolescence and quality, and completeness of test equipment, manuals and specifications.

Key findings of the investigation:

- Product support data was incomplete
- Firmware was not available
- Factory automated test system was not available
- Data acquisition cards had faults due to semiconductor aging
- Programmable logic devices in use are obsolete
- Connectors and cables had become brittle
- Dry joints on circuit boards were apparent throughout
- Significant noise was being generated by the power supply units due to aging electrolytic capacitors

Recovery actions schedule

The recovery actions implemented focused on making the units reliable and supportable for longer than 10 years. Initial work focused on establishing the definitive equipment design and configuration using customer available information supplemented with reverse engineering and research. The work culminated in the development of parts and component lists, circuit diagrams, as used configuration details, history files, repair and diagnostics test specifications, calibration procedures, and periodic maintenance procedures.

Firmware functionality information for the EPROMs, 5 different PAL and three different field devices were derived from available HIDAC units by functional testing and supported by data mining.

A custom computer based automated functional and soak test system was developed that operates on Shell core test software driving a GPIB unit to control test instrumentation and data recorders.

Twelve component alternatives were considered where form, fit and function, equivalence analysis and availability were used for a replacement power supply. The assessments considered functional performance, environmental, qualification and regulatory constraints to ensure the change would have no detrimental effect on safety or performance.

Refurbishment

A refurbishment programme was developed to replace components and remake dry joints.

Twenty HIDACs were refurbished within a specifically developed process and programme that included point to point shipping on dedicated transport, receipt, inspection and documentation of condition, diagnostic testing, repair and refurbishment, test, soak test and history file completion. The works included replacement of power supplies, connectors, electrolytic capacitors, wiring, fans, EPROMs and mains filter. Improving the general condition through tin whisker remediation, cleaning and replacement of missing or broken fasteners.

United States of America

707 Jeffrey Way
Round Rock
Texas 78665-2408
USA

Tel: +1 512-434-2800

United Kingdom

Innovation House
Lancaster Road
Ferndown Industrial Estate
Wimborne
Dorset BH21 7SQ
UK

Tel: +44 (0) 1202 850 450

For more information

Web: cwic.curtisswright.com

Email: sales@nspi.curtisswright.com

About Curtiss-Wright

Curtiss-Wright Round Rock and Wimborne have worked with nuclear and industrial customers for over 60 years. We support customers across the world from facilities located in the US and UK. Our solutions are embedded in strategic national infrastructure and our people are active partners in customer programs that are focused on delivering advanced future nuclear and industrial capabilities.

Curtiss-Wright Corporation (NYSE: CW) is a global integrated business that provides highly engineered products, solutions and services mainly to Aerospace & Defense markets, as well as critical technologies in demanding commercial power, process and industrial markets. We leverage a workforce of approximately 8,600 highly skilled employees who develop, design and build what we believe are the best engineered solutions to the markets we serve. Building on the heritage of Glenn Curtiss and the Wright brothers, Curtiss-Wright has a long tradition of providing innovative solutions through trusted customer relationships.