Westinghouse Nuclear Automation

Ovation™-based Rod Control Logic Cabinet
Background

The Westinghouse solid state rod control system has been in operation at many plants for over 30 years. The original system has demonstrated its reliability but lacks built-in redundancies and has limited diagnostics. One of the complex elements in the system is the logic cabinet that originates all the system modes, rod group selections, bank overlaps and system sequential timing. The logic cabinet comprises of 73 printed circuit board logic cards for a four-loop plant that consists of 23 board types with numerous single-point vulnerabilities (SPVs). Maintaining this system has become more challenging when the logic cabinet SPVs, an aging work force and diminished experience in the plants is considered.

System Description

Westinghouse has developed a cost-effective retrofit solution to upgrade the rod control system in a phased manner where the Logic Cabinet is replaced and interfaces with the existing Power Cabinets, or the Logic Cabinet and the Power Cabinets are upgraded simultaneously. For the rod control logic cabinet upgrade, the existing cabinet electronics are replaced with an Ovation™ redundant controller panel assembly. This modification is straightforward and does not interfere with or disturb the existing system signal cable interfaces. The logic cabinet upgrade is implemented by removing the existing electronic assemblies and installing a new panel containing the Ovation upgrade equipment. The new panel, as shown in the Figure 1 front view, contains: a redundant controller, two branches of input/output (I/O), termination modules, network interfaces, temperature/humidity sensor, bus bar and line filter assemblies. The panel rear view in Figure 2 contains redundant power supplies for 24-VDC internal and field powering, two branches of I/O, termination modules, bus bar and AC line filter assemblies.

With this upgrade, the Ovation I/O layout is designed to interface seamlessly with the existing field and power cabinet signals as shown in Figure 8. Pre-manufactured cable assemblies will be provided to wire the Ovation I/O modules to the existing cabinet terminal blocks. Existing logic cabinet to power cabinet wiring and field signal wiring to the logic cabinet will not be disturbed.

Logic cabinet configuration controls such as the bank overlap thumbwheel switches, and reset and master cycler pushbuttons, are replaced with adjustable software based set-points or controls. Additionally, Manual Control Bank speed, Shutdown Bank speed, Bank D full out position and Bank D Withdrawal Limit (C11 Permissive) are provided as soft control adjustable set-points. Implementing the manual speeds as set-points eliminates the need for NRS card in the 7300 process control system. With this upgrade, the P/A converter function and related hardware will be eliminated and replaced with Ovation analog output signals from the logic cabinet.

Optionally, hardwired pulsed bank demand positions (contact outputs) to the plant computer can be replaced with process points on the Ovation highway transmitted to the plant computer.

Main Control Room

A new LCD touch screen or mouse-driven display will be provided and located appropriately in the main control room (MCR). Soft control application and monitoring graphic displays (Figures 4 through 7) will be provided as a backup indication to the Main Control Board (MCB) hard controls and counters. The new application display information and Ovation alarm system information make the status and health of the rod control system readily available to the operator. With this upgrade, diagnosis of system problems becomes straightforward and minimizes troubleshooting and maintenance efforts.

The existing MCB mechanical step counters will be replaced with the digital step counters (Figure 3), that include audible clicking for each pulse up- or down-count. There is one step counter for each of the rod groups. The group rod step counters are mounted in the existing step counter housings on the MCB. The replacement step counters in the control room are powered by redundant 24 VDC – the standard interface voltage for the Ovation I/O modules.

The existing (100 VDC) rod-in and rod-out lamps will be replaced with 24 VDC LED units. The MCB speed indicator is driven by the rod control system over the existing field cables.
Figure 1: Front view, Rod Control Logic Cabinet up-graded with Ovation controller panel assembly

Figure 2: Rear view, Rod Control Logic Cabinet up-graded with Ovation controller panel assembly
Figure 3: Replacement Rod step counter

Step counter display

Figure 4: Rod Control overview monitoring and status display
Figure 5: Rod Control alarm status with soft reset pushbutton

Figure 6: Rod Control maintenance display with soft set point adjustment interfaces
Figure 7: Startup and group counter adjustment soft controls

Figure 8: Ovation I/O interfaces to field and power cabinets
Ovation Logic Cabinet Upgrade: Base System

When an existing Ovation infrastructure is already installed in the plant, the Westinghouse base scope logic cabinet upgrade consists of one new redundant Ovation controller panel assembly, redundant power supplies and sufficient I/O to address the existing field interfaces and number of power cabinets. In addition, mounting hardware, interface cables and new group rod step counters are provided. Typical documentation included are as follows:

- System Design Specification
- Standard Factory Acceptance Procedure
- Standard Site Acceptance Procedure
- Electromagnetic Interference/Radio-frequency Interference Test Report
- Failure Modes and Effects Analysis or Reliability Analysis
- Software Hazards Analysis
- Technical Manual
  - Technical description and operation of the system
  - Control logic sheets
  - Graphics displays
  - Site acceptance tests
  - Installation instructions
- System Drawings that identify:
  - Field interfaces
  - Interconnections to power cabinets
  - System power
  - Annunciators

Ovation Logic Cabinet Upgrade: Optional Scope

The following items are customer dependent and provided as optional scope:

1. LCD display for control room interface
2. Infrastructure cabinet (if first Ovation System)
3. Westinghouse site advisory support
4. Site demolition and installation
5. Design change (modification) package implementation or support
6. Licensing support – 50.59 creation
7. Training for operators, technicians or system engineers
8. Updates to existing rod control technical manuals and drawings
9. Cyber security assessments/remediation
10. Simulator Update – displays, step counters and control logic

Benefits Summary

The Westinghouse Ovation-based logic cabinet upgrade offers these benefits:

- Standardized solution for two-, three- and four-loop Westinghouse PWRs
- Multiple SPVs are reduced/eliminated
- Controller panel fits inside the same existing logic cabinet footprint
- Original rod control logic functionality reproduced on highly reliable Ovation redundant controller (reliability greater than 99.9 percent)
- The system includes a standard interface to the plant data network (Ovation) system
- Minimal demolition and installation time (approximately three days)
- Reuse of existing MCB switches and indicators with a soft display indication backup
- Lamp indicators replaced with LEDs
- I/O that is hot swappable and requires no calibration
- Hot swappable power supplies that are monitored
- Temperature and humidity monitoring
Benefits Summary (cont.)

- New maintenance health and status features available on soft displays and advanced diagnostics enable low-level fault detection and reporting
- Manual rod speeds and control bank overlaps are software based set-points and easily adjustable
- Elimination of P/A converter hardware with Ovation I/O replacement
- Shared inventory with other Ovation systems
- Elimination of spare parts inventory associated with the 23 unique printed circuit card types needed for the original solid state logic cabinet
- Elimination of aging mechanical devices
- Reduced surveillance testing required (functions are implemented in software)
  — Eliminates the need for coil current profile timing checks currently being performed each outage in response to the Salem event
  — Eliminates Bank Overlap checks

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