Ovation Upgrade to the 7300 Systems at Braidwood
Lessons Learned
Scope of the upgrade

The project was done as two major, independent phases:

- **N-1 phase**
  - Updated a Unix based Ovation main turbine control to Windows based Ovation
  - Updated all of the Rod control logic cabinets to Digital Ovation logic
    - First time US upgrade of this type for rod control.
    - Second plant world wide for this upgrade.
      - The other plant was 3 loop vice our 4 loop

- **N phase**
  - Updates to the following control systems:
    - Reactor Temperature and Pressure control
    - Pressurizer level control (charging controls)
    - Makeup and VCT level control
    - Turbine driven feed pump speed control
    - SGWLCS
    - Steam Dump controls
    - Letdown pressure and Temperature controls
    - Turbine gas cooling control
    - Component Cooling system non-emergency level and makeup control
    - Residual heat removal system Temperature and flow controls.
    - Added auto-start of the motor driven main feed pump
Scope of the project Hardware:

The Main Control Board Changes:

• N-1 phase
  – Updated two existing Ovation drops from a Unix workstation to a Thin Client workstation
  – Removed several peripherals form the MCB including keyboards and a trackball
  – Rod control required new step counters that installed in existing mounts
  – All new hardware installed in existing slots/locations

• N phase
  – Added dual monitor Thin Client workstation to 1PM05J (Main board) and moved two existing monitors.
  – Added single monitor Thin Client workstation to 1PM04J (Feedwater panel)
  – Replaced 2 unitized feed pump control panels with a touch screen Thin Client drops 1PM04J
  – Rearranged or removed 16 control board meters
  – Removed 9 control selector switches for controlling channels
  – Replaced 28 Manual/Auto control stations with Ovation SLIM (small loop interface module) HMI controls. (Contractually required to fit into existing slots with no cutting or grinding.)
  – Added a desk top Thin Client at the NSO/operator’s desk
  – Removed 6 Yokagowa paperless recorders
Before and after
Controller changes
Scope of the project Simulation:

The simulator changes:

- **N-1 phase**
  - Removed 4 Unix based desktop workstations from computer room
  - Removed network connections for old UNIX based Ovation
  - Step counters went from 4 wire harness to 3 wire harness
  - Installed first server and network switch for windows based Ovation

- **N phase**
  - Second server installed
  - Second “development” network switch installed (unplanned addition)
  - KVMs installed for Thin Client work stations for testing
  - Test carts built
    - 2 roll around desks with KVM for access to Ovation drops
    - 1 roll around desk with 2 touch screens for feed water pump control
    - 2 server cabinets with modified side panels
      - One panel had 15 SLIMs and the other had 13 SLIMs
      - Each had a dedicated power supply (24 volt DC), network switch, and media converter
      - We used server cabinets so they could be used after the project as a cabinet refresh for our existing server cabinets (mid 90s vintage)
Test panels
The project was really two projects schedule wise:

- **N-1 phase**
  - FAT Jan 2016
  - SAT April/May through year end
  - Physical install scheduled to coincide with load acceptance for Cycle 4. Taken before cycle 5, 2016
  - Plant installation was October 2016 outage

- **N phase**
  - SAT scheduled to start Mar 2017, Actual June 30th, 2017
  - SAT scheduled to be completed Thanksgiving week Nov 2017. First full load of Feedwater Turbine control logic received Dec 8th, 2017
  - Scheduled start to physical installation Dec 12th 2017, Completed on time
  - Final acceptance of SAT completion and training load to meet RFT date of Jan 2nd was on DEC 28th 2017.
  - Load taken with open items that required 3 further patches/updates during Jan/Feb of 2018.
  - Additional significant patches taken in March 2018
  - Installation in plant during April 2018
  - Final “as built” training load taken July 2018
The testing represented a significant amount of manpower:
- Total sim hours by testing schedule was 1016 hours
- That represents at least 3000 man hours as scheduled.
- We ran over at least 30% for the entire test plan.
- Hardware install was 6 workers and 360 Man-hours
Some lessons learned from training side

Contractor use for testing and material generation:

1. Contractor 1 Tester/NRC exam writer assistance: Former simulator coordinator at Braidwood. 30 years of training/OPS experience, with over a decade as sim coordinator.

2. Contractor 2 Tester/Training material developer: Former Shift manager at Braidwood. 30 years experience in operations and training.

3. Contractor 3 Limited testing help/training materials generation: 25 years as an operator, Licensed RO, SRO certified in training for 5 years prior to retirement.

4. Contractor 4 Limited testing assistance/procedure writing: 25+ years experience as a licensed RO.

5. Instructor #1 Limited testing assistance/Materials generation for LORT only.

6. NSO 1 and 2 assigned to testing: Both have >25 years as licensed RO’s. Worked 8 hrs each over weekends to assist in testing and coordinating simulator design work with procedure writers and engineering. (They were temporarily assigned to Engineering and Procedure group for project) One of them was the OPS representative to the plant FAT and plant project group.

Sounds like an awesome group right?
Lesson learned:

Contractors are contractors:
Contractor 1 and 2 finished the contract for the project right at installation. They then left for 6 months to reset contractor clock.
Contractor 3 left at the end of the project and may or may not return. Had said that that may be his last contract stint, going to really retire this time.
Contractor 4 moved on to another plant’s project when this project completed and has not returned to Braidwood.
Instructor 1 took an offer to attend ILT at another utility and is no longer at the station.
NSO 1 and NSO 2 both retire this year.

To sum up, we had really great people on the project that tested the system, helped with the development of some of the engineering issue solutions during design, and generated some very good training materials. They REALLY had intimate knowledge of the system.

And then they all left. We did not make it a point to involve younger, long term instructors. So when we started the actual crew and ILT training, the instructors had little experience and knowledge, but good materials. We should have used the contractors to do day to day stuff and had instructors doing the Ovation upgrade work to get the knowledge.
Lesson learned:

How do you eat an elephant? One bite at a time. Just don’t try to eat the whole elephant at one sitting.

We did the following during the Ovation project upgrade:

- Added FLEX systems to the model
- Refreshed I/O from SCSII to TCP/IP
- Refreshed the training server and changed architecture for the sim back end from one server with two computers to run the simulation to two identical servers that run copies of the simulation
- Replaced the Radiation Monitoring System with a new windows based system
- Refreshed the simulator instructor interface graphics program and P&IDS with Jade software
- In conjunction with the Jade refresh we also did a V Panel project while we were doing the SAT for N phase
- Re-carpeted the simulator floor
- Completed change out of overhead lighting out from 8 ft fluorescent to 4 foot LED
- Replaced analog/digital mixed CCV recording and audio system in the sim to HD cameras and digital recording to a server vice DVD
- Replaced the computer room HVAC system
The elephant continued:

In the training world we had multiple overlapping ILT classes going during the project

1. One class had the N-1 installed during the class and had to be trained on the changes just before the NRC exam (Licensed both units)

2. Second class received half the simulator phase training on the legacy system and then the second half of the sim was on three different versions of Ovation with the NRC exam on the as built load. (received a single unit license for Unit 1, waiting on unit 2 license waiver)

3. Third class started training and were not taught anything about legacy Pre-Ovation. Unit 2 was delayed and so this class may also get a single unit license until Unit 2 is completed.

In addition to the ILT classes we ran an instructor SRO certification class in parallel overlapping the ILT Class 1 and Class 2 above.

We also ran an ANSI SRO certification course for corporate managers during the summer of the SAT for the N phase.

During most of the 2016 through 2018 time frame the simulator was in use:

Tues – Fri 0700 to 1500 reserved for LORT
Mon – Fri 1500 to 2300 reserved for ILT

Nights Mon-Friday 2300 to 0500 were for anyone else doing training, Inst Cert, engineering training, ANSI Cert, etc.

Weekend from Sat 0500 until Sunday night at 2300 and Mon from 0500 until 1500 was Ovation testing.
The only panel mod was moving a recorder.
Schedule issues

Simulator project started with the plant engineering behind schedule. There were some design items that were 4 months behind. The feed pump controls were the major system that lagged behind. The first cut of that logic was delivered on the week the Original schedule had us final accepting the load for training.

Some issues this lead to:
1. Simulator FAT was 2 full months prior to plant system FAT.
2. It was the norm to receive changes to the logic that were not tested yet.
3. Changes came out and we would have no idea what was in the change package.
4. Many times the testers had no idea how it was supposed to work......
5. The test schedule became rapidly useless.

Design issues plagued the project. We were still doing logic sheet changes in the control system up to the day of installation.

Is that how it’s supposed to work? Was a common refrain. There were a lot of weekends with Westinghouse engineers on site at the simulator making logic changes to the plant design and beta testing it in the simulator before going back to fix the plant design.
Post Outage: The trip

Braidwood has the ability to test the main feed pump trip circuits at power.

The system works by introducing a resistance in the trip circuit to lower the voltage to a low enough voltage to light a small indicator light, but it is low enough to not actuate the trip relay. Since the light is down stream of the relay, if it lights up during the test, you have verified continuity to the relay in the trip circuit.

Impedance in the old relay was not the same as impedance in the new Ovation trip relay. The ovation relay had a much lower threshold voltage where it would actuate the relay than the old relay had.

To compound the transient, the B loop feed line had a check valve that was restricting flow.

The end result was a completely preventable reactor trip due to the modification.
Questions??