2017 Plant Simulation Conference
San Diego

NextEra Energy Seabrook
Nuclear Full Scope Simulator
NextEra Energy Seabrook is a 1300MW Nuclear PWR located on the New Hampshire coastline.

Seabrook station operates a complete Full-Scope simulator that includes a fully operational copy of their control board.
Driving Forces to Upgrade

• Inability to maintain core.
• Custom core tuning software, person retired.
• S/G tuning, person retired.
• New RELAP 2015, integration concerns.
• 1992- Adcore 2000 core model.
• Custom core tuning software, person retired.
• No updates to executive platform since 2007.
• Each cycle IC took 6 to 8 weeks to develop, for each of five core states, could not model coast down.
• Still using Python for balance of plant. Some systems upgraded to FlowLite.
Budgeting & Justifying the Project

• Point Beach got into regulatory space with poor performing simulator, required significant investment to recover.
• New Training manager at SBK from Point Beach.
• PTN/PSL required significant updates, heavy simulator use and declining reliability.
• Presentations at Plant Training Advisory Board and Plant Health Committee.
• Met with multiple vendors obtained cost comparisons.
• Developed a multi year strategic upgrade plan, benchmarked fleet industry.
• Resolution of two three year old fidelity issues with s/g level and pressure response. New RELAP in 2015. Identified that the old core model which had customized tuning software would need to be updated.
Staffing the Project & Time Commitments

• Simulator staff-three people
  – Programmer, hardware tech, supervisor-Ex SRO performance testing.
  – LOIT instructors, drive the plant, support FAT testing, and certification testing.
  – Time line:
    • Obtain approval April 2015-December 2016 (with October outage)
    • Project plan approved Jan 4, funding delay, new project plan approved March 25.
    • New model development complete April 8.
    • Software integration May 20 (RELAP, S3R, FLOW BASE, ELEC MODEL)
    • FAT-June 1-Aug 12
    • Aug 22nd-Sept 15th.
    • Certification testing in progress, annual exams, LOIT, SRO cert, simulator now running 22 hours per day. Project completed on 11/7/2016.
Management & Corporate Support

- Management support outstanding; Training manager, PGM, Site VP.
- Corporate purchasing- biggest challenge.
- Fleet peer group-core models, vendor information and recent upgrades.
- Fuels Group Juno beach.
Upgrade Project Goals

• Upgrade core neutronics model to Studsvik S3R

• Create GUI for Relap models

• Retire old FORTRAN models, including Containment, and re-make them with 3KM tools

• Update “Franken-Simulator” secondary-side and auxiliary systems under only the latest version of Flowbase
Updated Modeling Techniques

Previous Modeling Tools

- Core
  - Westinghouse Adcore 2000 Neutronics
- Primary Side
  - 3KeyMaster Relap5
- Secondary Side
  - Python
  - FlowLite
  - Flowbase (2006)
- Containment
  - Fortran

New Modeling Tools

- Core
  - Studsvik S3R Neutronics
- Primary Side
  - 3KeyMaster Relap5
  - 3KM Relap GUI
- Secondary Side
  - Flowbase
- Containment
  - Flowbase
Fewer Tasks – Greater Functionality

Previous Simulator

Updated Simulator

• 30 tasks replaced or removed

• 18 Header files removed

• Functionality of 15 of the removed tasks now handled by updated Flowbase Tool alone
RELAP Graphical User Interface
Python to Flowbase Conversion

- Python is incompatible with the latest version of Flowbase
- All models previously in Python were entirely remade with the latest tool.
Containment Model Upgrade

- Previous containment model a “black box” Fortran code
- Drastically improved fidelity using first principle modeling with Flowbase
New Simulator Features – SBT Tool

- Built in ability to automatically run transients while gathering data
- Data can be exported into a .csv format, editable with Excel
New Simulator Features – V&V Trending

– Ability to trend live or exported data against a sample in the 3KM environment

– Facilitates tuning, and easy verification of repeatability
New Simulator Features – V&V Reports

- Automatically generate reports, easily identifying all out-of-range parameters
New Simulator Features – Fast Time Xenon & Samarium

- Xenon is a neutron poison created as a byproduct of nuclear fission with a half-life of about 9.2 hours.
- Each reactor load has its own equilibrium value for Xenon and Samarium, where creation rate matches decay rate.
- Previous simulator required 9-10 hours of runtime to achieve a completely stable condition with poisons in equilibrium.

- With new fast timing of poisons, equilibrium can be reached and a new IC snapped in a matter of minutes.
Challenges Faced

• Have sufficient time to allow testing and troubleshooting following identification.

• Compressed schedule as a result of simulator usage demands and fleet contract approvals.

• Consider manipulating every component on the board twice.

• Be prepared for plant/training demands, JITT etc. to impact schedule.

• Schedule the Certification testing outside the SAT window.
What Went Well

- FAT/SAT—Ability to make corrections on spot, retest and move on.
- FAT/SAT-Test plan that included; typical certification testing, instructor station functions, malfunctions, JPM’s, and surveillance procedures.
- WSC support FAT/SAT working w/Site SME.
- Use of glass panel simulator during FAT.
- Fast time Xe/Sm. Amazing!
- Develop one IC and copy to any core life. Time savings 6 weeks!
- SBT-software that has the IC, scenario file, and trends comparison to baseline, and previous simulator trends.
- Having the previous legacy load to compare settings functions.
Along with updates to all of the models, four Glasstop displays were part of the upgrade.

- Each Glasstop is capable of running the entire simulator standalone
- Glasstops were used extensively during FAT, in lieu of the Full Scope hard panel
Thank You

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