Advanced Instrumentation, Information, and Control Systems Technologies

Nuclear Power Plant
Control Room Modernization

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October 13, 2016

Light Water Reactor Sustainability R&D Program

Control Room Modernization - Objectives

- Address obsolescence and reliability issues of legacy analog control rooms (potential nuclear plant life-limiting issue)
- Enhance operator performance with new digital technologies
- Improve operational support functions with a seamless digital environment

Resulting in

- Increased capacity factors
- Reduced O&M costs
- Enhanced nuclear safety
- Improved workforce job satisfaction and retention

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Control Room Modernization R&D

- Utility Partners
  - Southern California Edison
  - Duke Energy Corporation
  - Arizona Public Service Company
  - Southern Company
  - Exelon Nuclear Corporation
- Research Collaborators
  - IFE Halden Reactor Project
  - Electric Power Research Institute
  - Vanderbilt University
  - Korea Atomic Energy Research Institute
  - Engineering and Human Factors Consultants

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Human System Simulation Laboratory (HSSL)

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Partnership with Arizona Public Service

- APS is undertaking significant upgrades of important control systems under their Strategic Modernization Program at their Palo Verde Nuclear Generating Station.
- They have partnered with the LWRS Program in control room modernization as part of these upgrades.
- This project will extend over 10 years in 5 major phases.
- This represents the first major control room modernization in the current operating fleet.

Three Dimensional Modeling

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Feedwater and Turbine Systems
Original Analog Control Board

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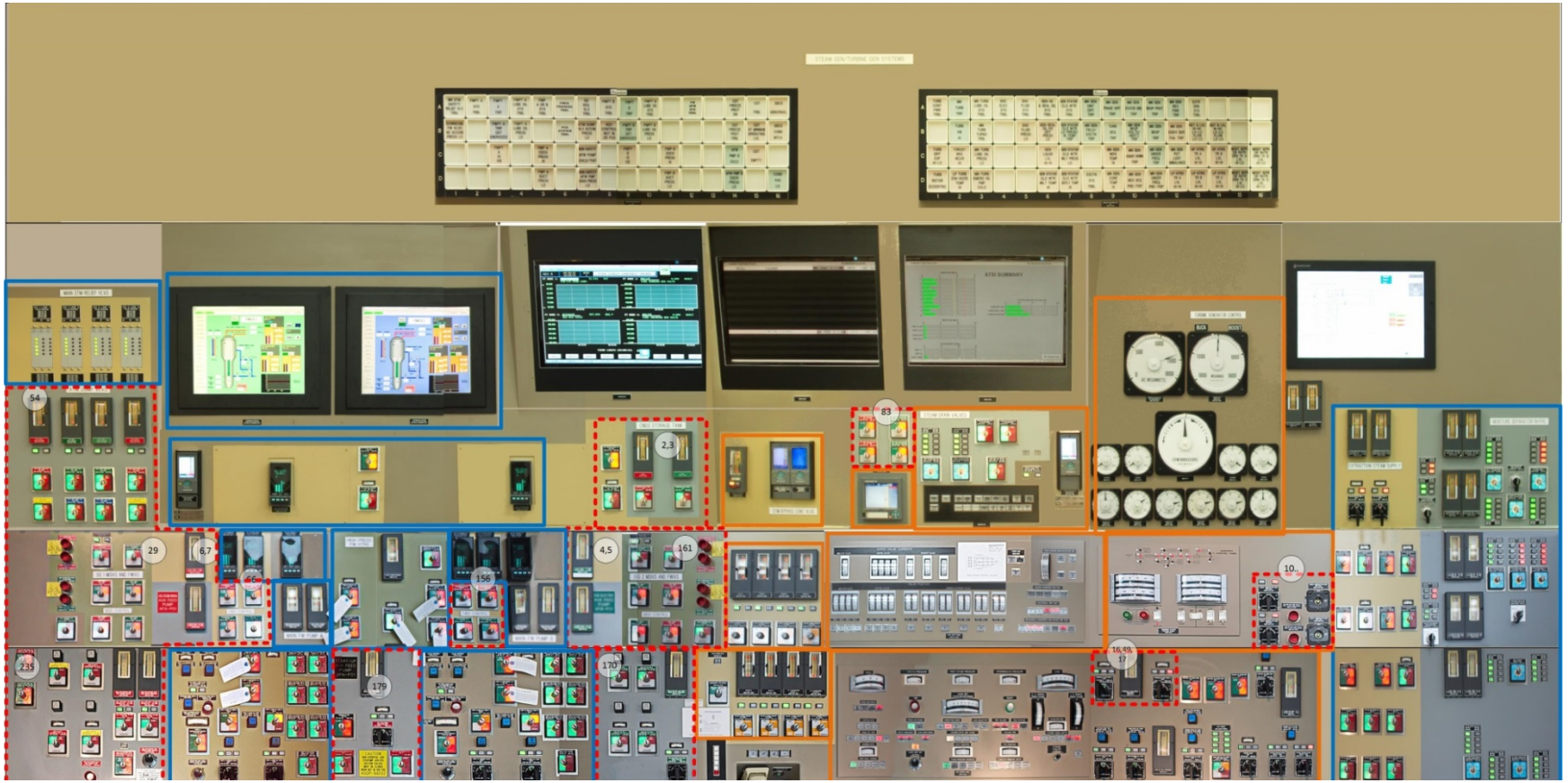
Step 1 – Model Existing CB



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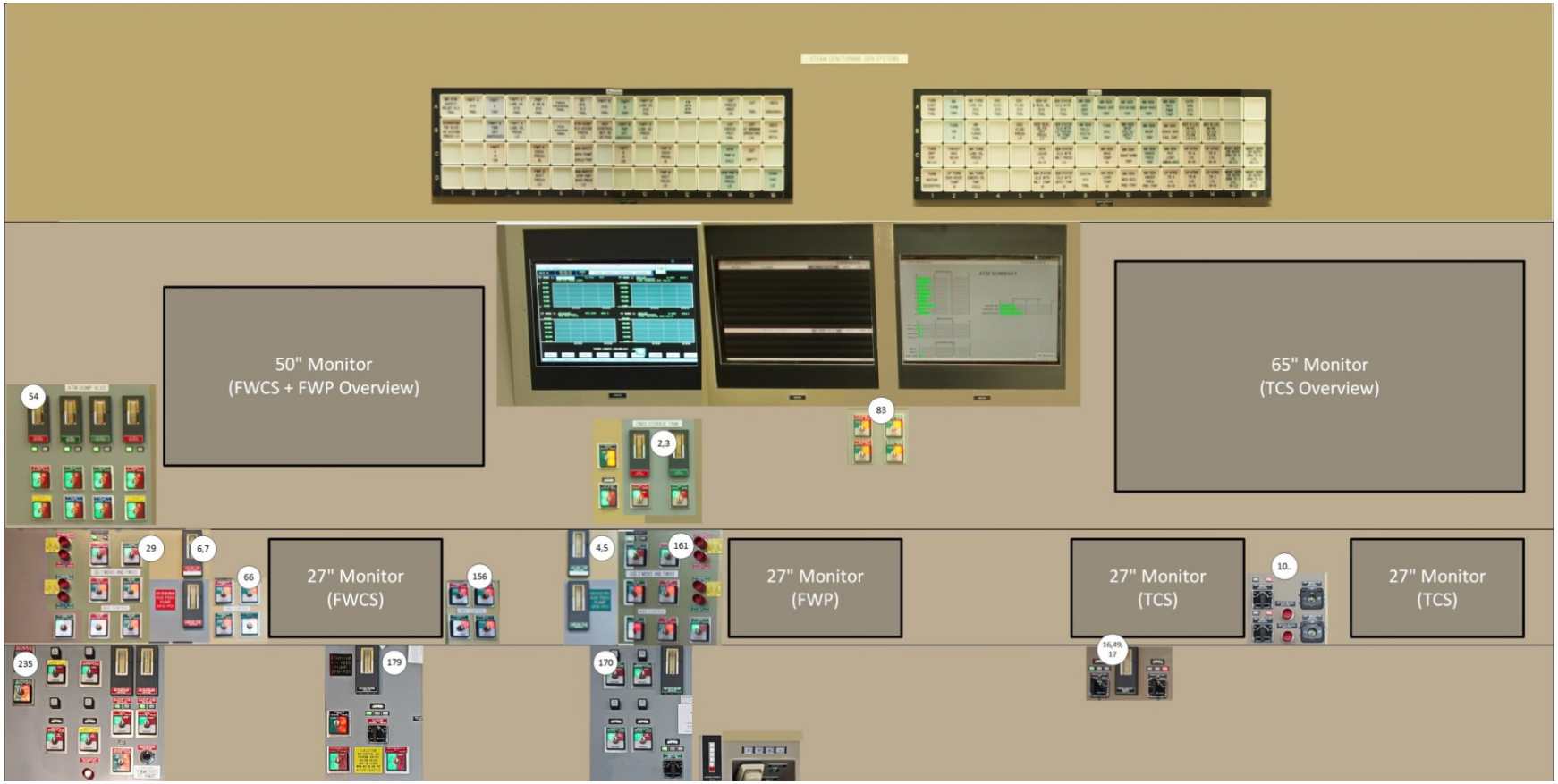
Step 2 – Delete Devices Being Replaced and Model New HMI



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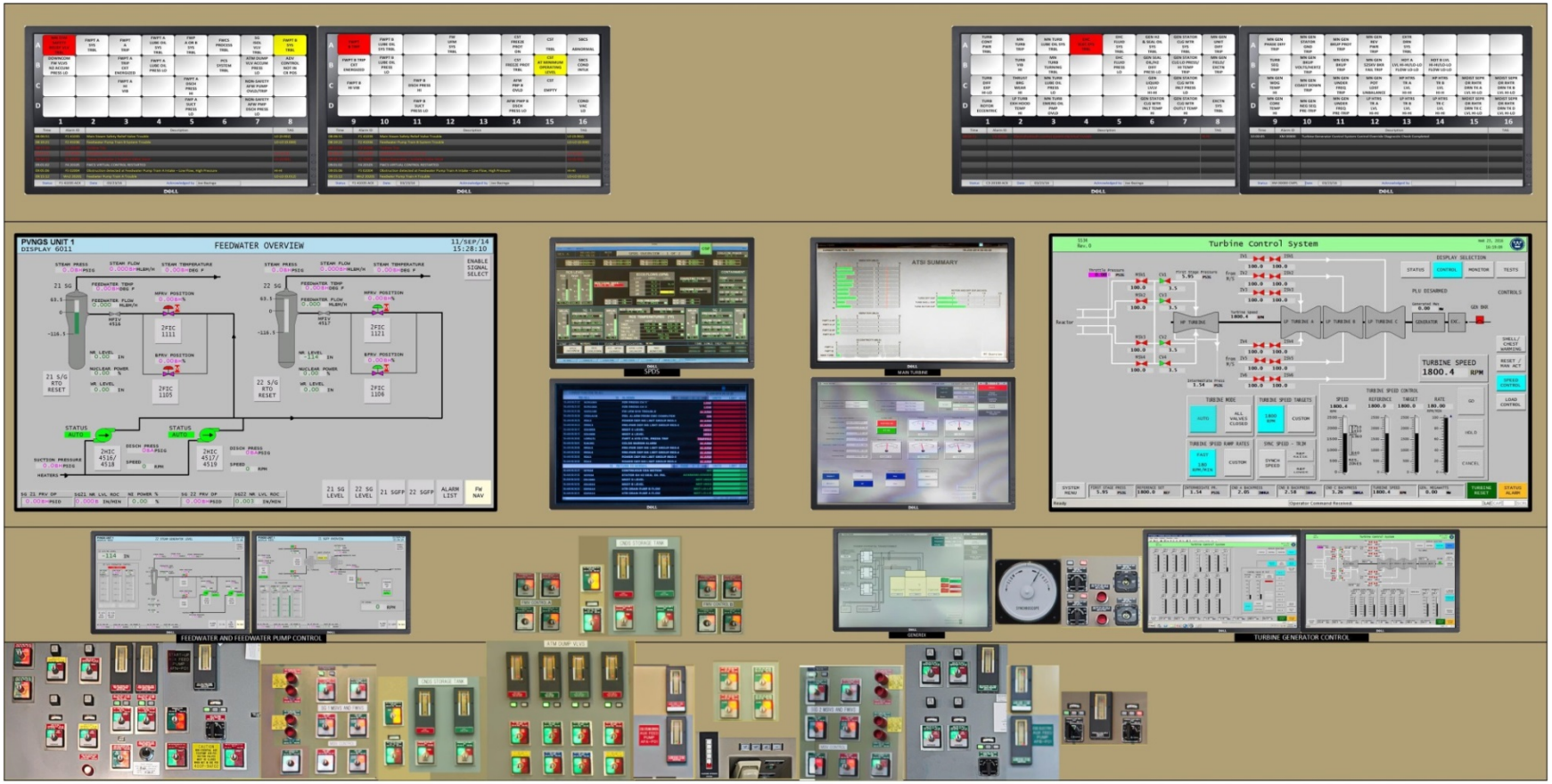
Step 3 – Rearrange Remaining Devices and HMI for Improved Human Factors



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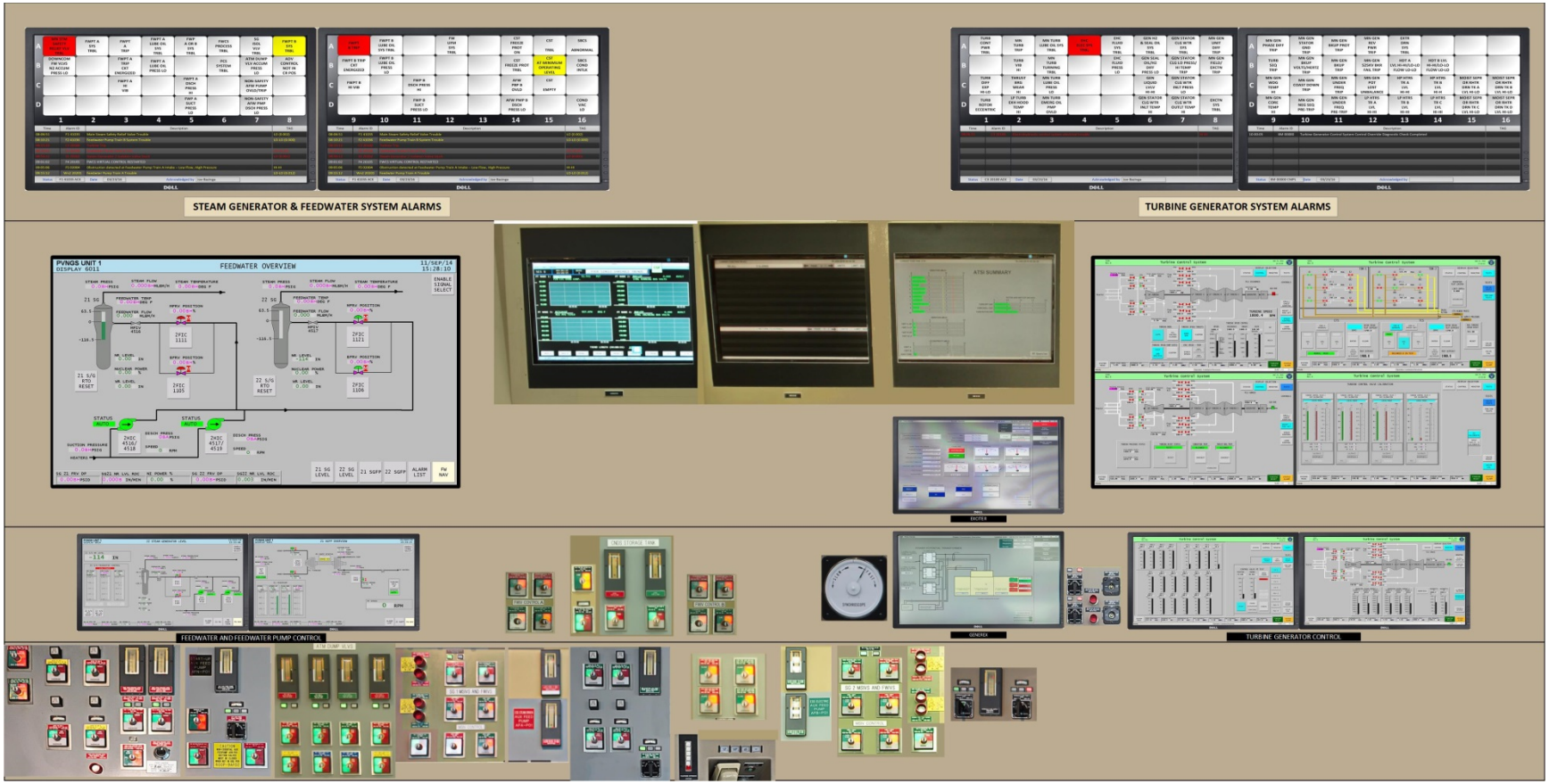
Step 4 – Optimize Human Factors and Practical Considerations



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Human Factors Verifications

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Feedwater and Turbine Systems Control Board Final Concept

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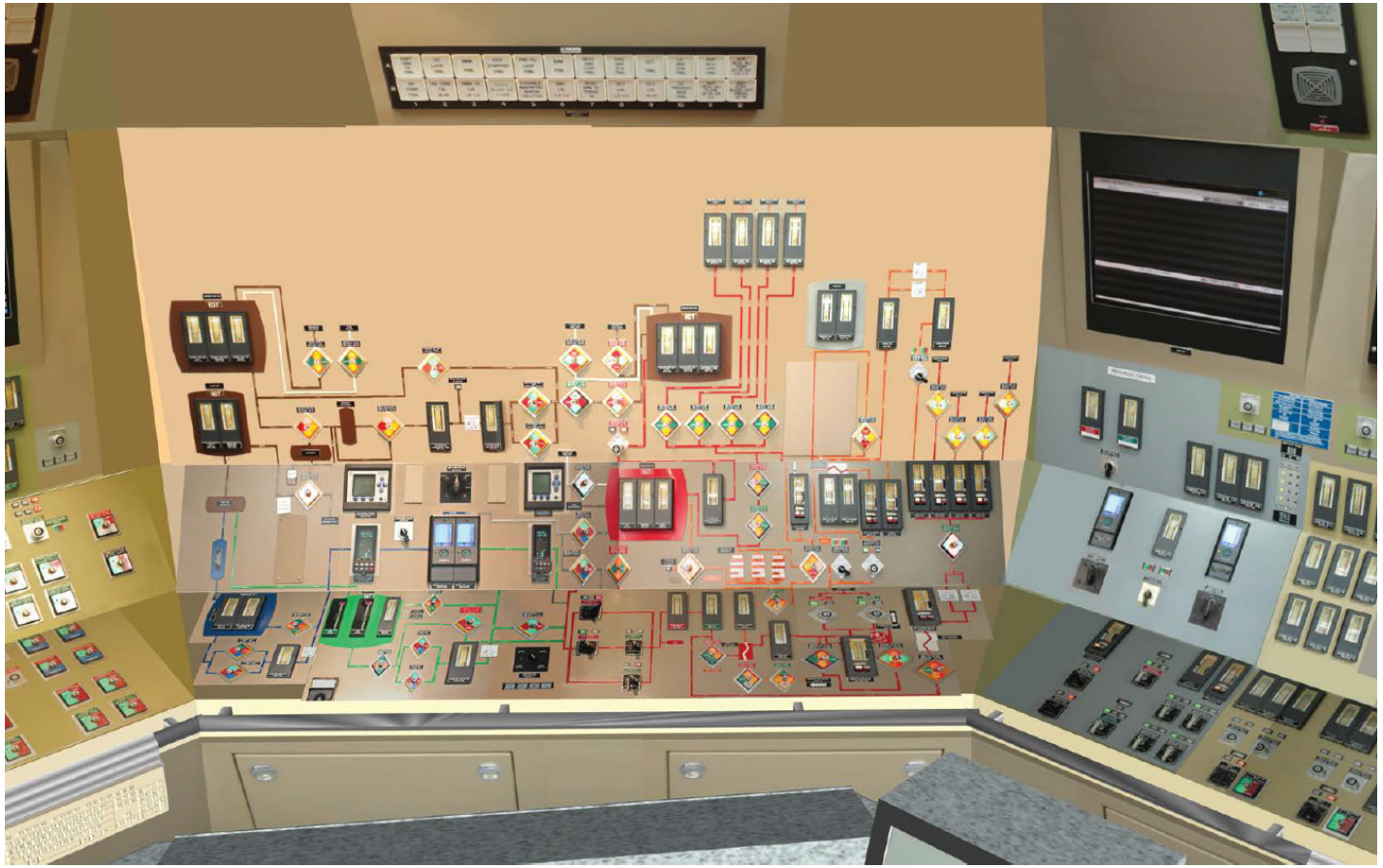
Reactor Coolant System Control Board



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Reactor Coolant System Control Board Final Concept

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Hybrid Control Room End-State Concept

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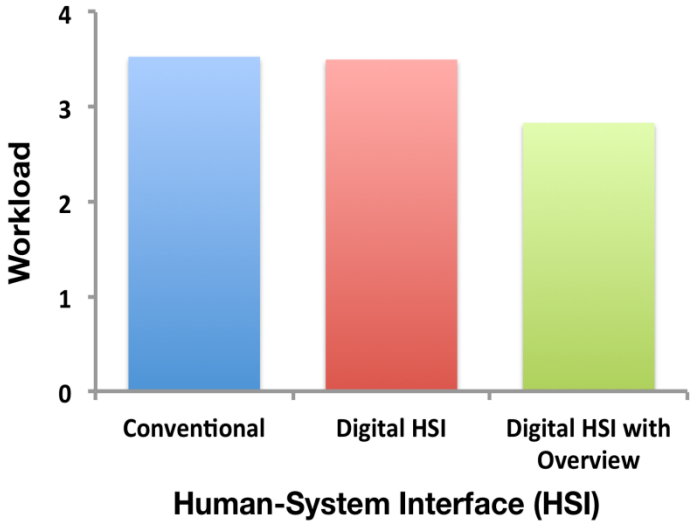
Operator Studies in HSSL

- Utility partner brings operator teams to participate in structured studies in the HSSL to validate control room designs, uncover human error traps, and improve usability.
- Studies use a variety of objective and subjective measures to confirm effects on workload, situational awareness, etc.



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Computer Assisted Virtual Environment

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Fully-Integrated Control Room

- Conceptual design of a compact control room similar to what is now provided in new nuclear builds (e.g. AP-1000)
- All control actions are from operator consoles in front of large overview displays for plant-level functional status.
- Have defined a migration path from conventional control rooms to compact design.
- Cost benefit is higher due to substantial elimination of analog control devices.

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Questions?