



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Light Water Reactor Sustainability (LWRS) FY 2017 CINR Webinar: NEUP RC-8 & 9

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Light Water Reactor Sustainability (LWRS) Program

■ LWRS Program Goal

- Develop fundamental scientific basis to allow continued long-term safe operation of existing LWRs (beyond 60 years) and their long-term economic viability

■ LWRS program is developing technologies and other solutions to

- Enable long term operation of the existing nuclear power plants
- Improve reliability
- Sustain safety

■ LWRS focus areas

- Materials Aging and Degradation
- Advanced Instrumentation and Controls
- Risk-Informed Safety Margin Characterization
- Reactor Safety Technologies



Nine Mile Point ~ Courtesy Constellation Energy



Technical Focus Areas Summary

Nuclear Energy

■ Nuclear Materials Aging and Degradation

- Understand and predict long-term environmental degradation behavior of materials in nuclear power plants, including detecting and characterizing aging degradation

■ Advanced Instrumentation, Information, and Control Systems Technologies

- Address long-term aging and obsolescence of existing instrumentation and control technologies through a strategy for long-term modernization

■ Risk-Informed Safety Margin Characterization

- Develop significantly improved safety analysis tools (computer codes called RELAP-7 and Grizzly) and apply these tools to analyze the safety margin of aging plants

■ Systems Analysis and Emerging Issues

- Address high impact emerging issues such as flexible operations and water usage issues (the potential backfit of cooling towers)

■ Reactor Safety Technology

- Address emerging safety concerns in response to the Fukushima accident
- Develop technologies to enhance the accident tolerance of current and future reactors



Risk-Informed Safety Margin Characterization (RISMC)

■ Margins Analysis Techniques

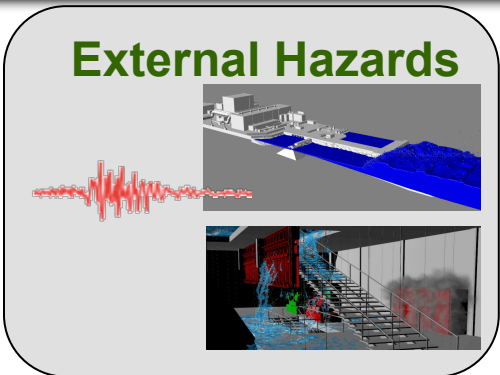
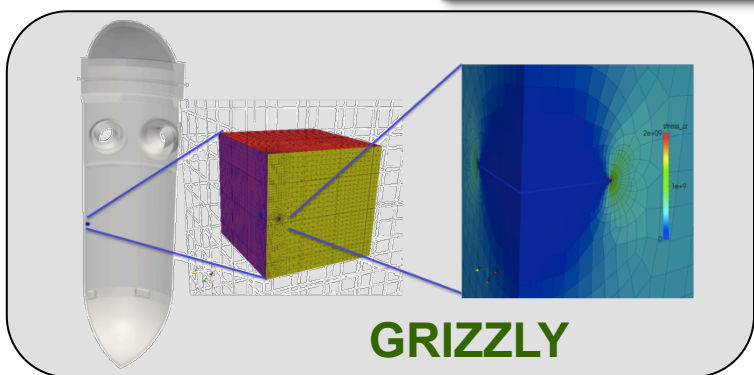
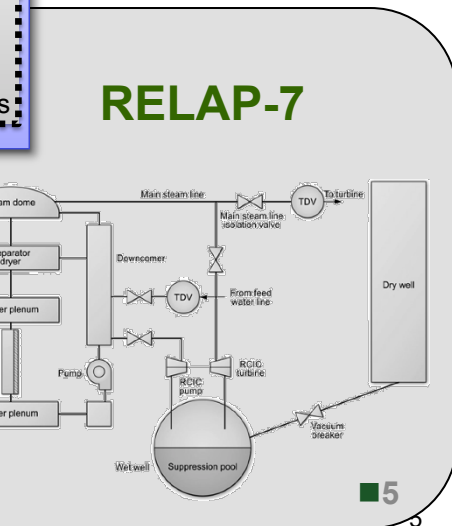
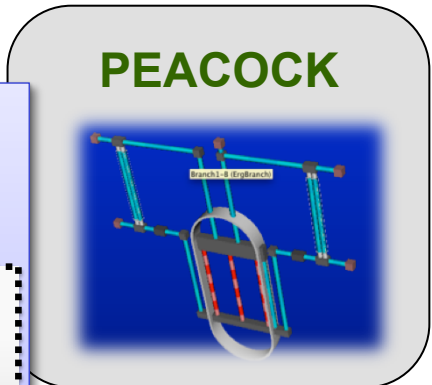
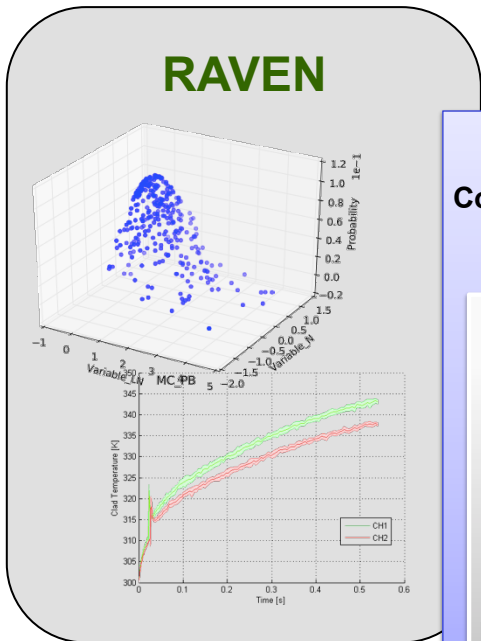
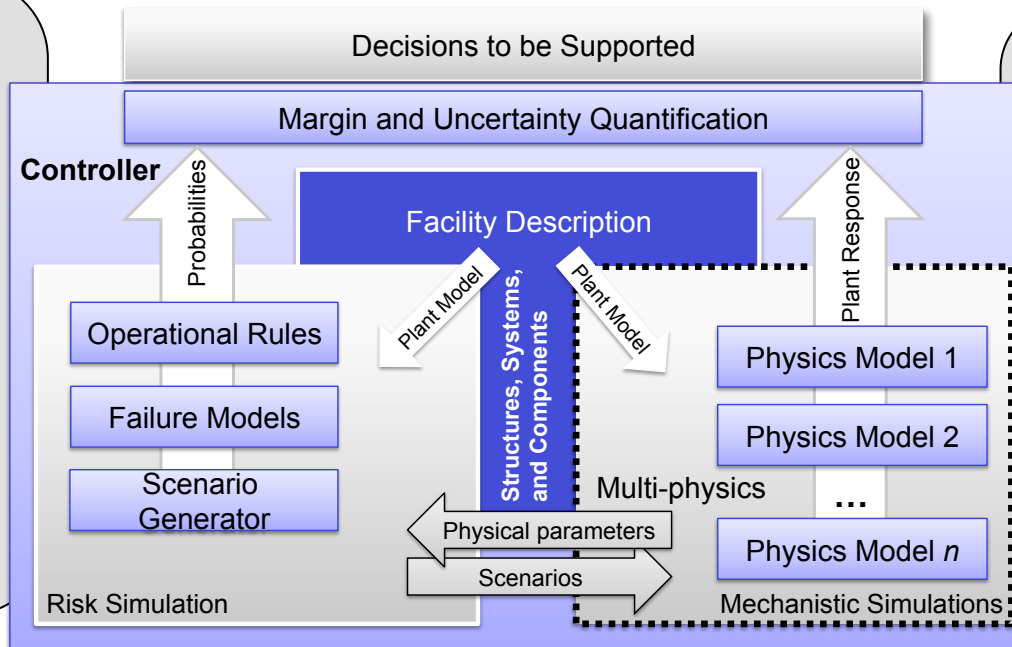
- Develop techniques to conduct margins analysis, including methodology for carrying out simulation-based studies of safety margin
- Use advanced probabilistic risk assessment (PRA) to optimize plant safety and performance via highly-integrated simulation

■ Simulation components of the RISMC Toolkit

- RELAP-7 Thermal-hydraulics
 - Thermal-hydraulics systems code that simulates plant-level fluid behavior
- RAVEN (Risk Analysis Virtual Environment)
 - Risk analysis and scenario generator
 - Provides probabilistic input on plant state to RELAP-7 (including operator actions, component states, etc.)
 - Integrates output from RELAP-7 with other considerations (e.g., probabilistic and procedures information) to determine component states
- Grizzly Aging Simulation (Grizzly)
 - Component aging and damage evolution will be modeled in separate modules that will couple to RELAP-7 and RAVEN
- External hazards (flooding and seismic)



Integrated RISMC Toolkit



RC-8 RISMC: Leveraging Static PRA Information into RISMC Simulation Methods

■ Traditional static PRA models provides useful info of general plant behavior & probabilities

- How can we best leverage this existing information for application in advanced simulation approaches?

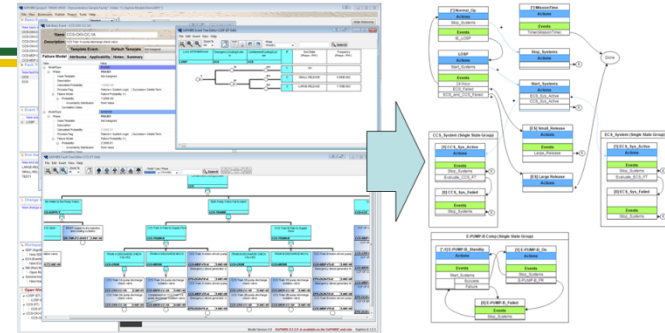
■ Simulation-based risk analysis can provide additional information

- How can we use this information to assist in decision making?

■ Proposals are encourage that will use the RISMC Toolkit to

- Develop ways to use the existing investment in NPP static PRA models (seamless hybrid PRA → static parts + dynamic parts)
 1. Determine what should be translated from static to dynamic PRAs (and why)
 2. Determine how to translate this information, including automation (if possible)
 3. Determine how to ensure accuracy/validity of the hybrid model
- Extend hybrid models to evaluate a range of metrics including economic impacts

■ A desirable outcome will be a hybrid "generic" PWR or BWR model for use by the U.S. nuclear power industry



RC-9 RISMC: Light Water Reactor Sustainability Enterprise Risk Management

- **Recent nuclear power risks → economics & safety**
 - Risks to safety and plant assets need to be managed in a cost-effective fashion for continued industry viability
- **Proposed research to enhance how nuclear industry manages these risks → Enterprise Risk Management (ERM)**
- **Targeting ERM approaches to improve sustainability of current fleet**
- **Provide innovative ideas that can leverage RISMC predictive models**
 - Understand key enterprise risk drivers
 - Sustainability models and metrics focusing on ERM that will help to ensure safety and enhanced performance of the nuclear fleet
 - Quantitative models to focus operational safety/economics over near- and long-term
 - ERM strategies that correlate to opportunities to increase efficiencies
 - Pilot study demonstrating the benefits of the LWRS-based ERM approach by teaming with a candidate nuclear power facility
 - Address some of the initiatives and approaches raised by the Nuclear Energy Institute as part of the Nuclear Promise

