

# A Probabilistic Risk Assessment Resource to the U.S. Nuclear Regulatory Commission

In the early 1990s, Pacific Northwest National Laboratory (PNNL) conducted a probabilistic risk assessment (PRA) of the Hanford N Reactor. That PRA remains the only NUREG-1150-style reactor PRA other than NUREG-1150 itself. Since then, PNNL has remained engaged in PRA projects across multiple domains—from nuclear power plant design and operations (through other energy sectors) to matters of national security.

PNNL has been supporting the U.S. Nuclear Regulatory Commission (NRC) for over 40 years in a wide range of topic areas. For more than a decade, a cornerstone of PNNL's work for the NRC has been PRA. PNNL is the principal PRA resource for the NRC's Office of Nuclear Reactor Regulation (NRR) for both performing technical evaluations of license amendment requests for risk-informed programs and serving the NRC's Office of Nuclear Regulatory Research (RES) in advancing PRA methods and applications.

Along with its support for the NRC's PRA programs, PNNL has shown a commitment to improving PRA state of the art internationally with a focus on the next generation of reactors. For example, PNNL is part of the ASME/ANSI committee writing the *PRA Standard for Advanced Non-LWR Nuclear Power Plants* (ASME/ANS RA-S-1.4). Further, PNNL's focus on advanced reactors is grounded in its growing engagement in advanced reactor technology development for the DOE Office of Nuclear Energy, advanced reactor technology selection for the Province of Alberta, and the NRC's program for developing advanced reactor licensing infrastructure.



Diablo Canyon Power Plant, operated by PG&E near San Luis Obispo in California, is licensed to operate into 2025. (Photo: NRC.gov)

## OFFICE OF NUCLEAR REACTOR REGULATION

PNNL is the NRR Division of Risk Assessment's go-to laboratory for supporting implementation of risk-informed regulatory programs. This support includes contributing to the development of risk-informed regulatory infrastructure and conducting technical evaluations of risk-informed license amendment requests. Risk-informed activities PNNL has supported—and continues to support—include the following:

- the transition of fire protection programs to National Fire Protection Association (NFPA) Standard 805
- risk-informed technical specifications initiatives 4b, "Risk-Informed Completion Times," and 5b, "Relocate Surveillance Frequencies to Licensee Control"
- risk-informed categorization and treatment of structures, systems, and components in accordance with Title 10 of the Code of Federal Regulations (CFR) 50.69

- implementation of lessons learned from the Fukushima Dai-ichi Nuclear Plant accident in Japan, specifically Recommendation 2.1 on re-evaluating seismic and flooding hazards using risk information
  - evaluation of severe accident mitigation alternatives in support of license renewal
  - use of PRA information to assess the risk of non-compliances with tornado missile requirements
- implementation of the performance-based Option B of 10 CFR 50 Appendix J for extending containment leakage testing intervals.

## OFFICE OF NUCLEAR REGULATORY RESEARCH

PNNL has supported RES across a diverse range of topical PRA areas. Some examples include the following:

- drawing on a combination of expertise in materials corrosion sciences and PRA to develop the report, *Methodology for Estimating Failure Rates of Degraded Passive Components for Application to the Significance Determination Process*.
- drawing on material sciences expertise to develop methods to risk-inform the impact of various passive component degradation mechanisms under the NRC's Extended Materials Degradation Program.
- development and implementation of elicitation methodology to support the Full-Scope Site Level-3 PRA, which was applied to the following:
  - risk evaluation of reactor primary system bypass sequences.
  - risk-informed prioritization of reactor states associated with low power and shut down operations.
- development of, and methodology for, characterization of the quantitative hazard associated with flooding of nuclear power plants due to external flooding sources, and modeling of operator performance in extreme environments associated with external hazards.
- development of a cybersecurity risk-assessment method (i.e., Nuclear Security and Incident Response) for nuclear power plants based on pilot inspections of four plants that provided a holistic tool for identifying vulnerabilities.



Missouri River floodwaters surround Nebraska's Fort Calhoun Station power reactor, June 2011 (photo: New York Times)

## OTHER SPONSORS

In addition to support of NRC PRA projects, PNNL provides PRA expertise to other sponsors. Those activities, some of which focus on advanced reactors, enrich the base of experience PNNL brings to the NRC. Some examples include the following:

- assistance to foreign regulators (e.g., the Canadian Nuclear Safety Commission) in technical evaluation of risk-informed licensing applications
- development of risk-informed reactor monitoring concepts under the DOE Office of Nuclear Energy's (NE's) Advanced Reactor Technology program
- development of a means of incorporating passive components into next-generation PRA methodologies under DOE NE's Light Water Reactor Sustainability Program's Risk-Informed Safety Margin Characterization pathway
- development of a comprehensive risk-assessment methodology supporting a risk-informed strategic plan for decommissioning the Fukushima Dai-ichi Nuclear Plant for Japan's Nuclear Damage Compensation and Decommission Facilitation Corporation.

### For more information, contact

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