Risk and Decision Analysis

A Probabilistic Risk Assessment Resource for the Nuclear Energy Enterprise

Pacific Northwest
NATIONAL LABORATORY

U.S. DEPARTMENT OF
ENERGY

Pacific Northwest National Laboratory (PNNL) staff members are experts in the development and application of probabilistic risk assessment (PRA). This expertise dates to the 1980s with the development of the NUREG-1150 and Hanford N Reactor PRAs. Since then, PNNL has remained engaged in PRA projects across multiple domains—from current and next-generation nuclear power plant design and operations to matters of national security and defense.

PNNL is committed to advancing state-of-the-art probabilistic risk assessment for both existing and next-generation advanced reactors.

PNNL has supported 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 performing technical evaluations of license amendment requests for risk-informed programs. PNNL also supports 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 advancing state-of-the-art PRA internationally with a focus on the next generation of reactors. For example, PNNL is part of the American Nuclear Society (ANS)/American National Standards Institute (ANSI) committee that wrote the *PRA Standard for Advanced Non-LWR Nuclear Power Plants* (American Society of Mechanical Engineers [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 Department of Energy (DOE) Office of Nuclear Energy (NE), Department of Defense, advanced reactor technology selection for the Province of Alberta, and the NRC's program for developing advanced reactor licensing infrastructure.

Office of Nuclear Reactor Regulation

PNNL is the NRR Division of Risk Assessment's principal contractor for supporting implementation of risk-informed regulatory initiatives. This includes contributing to the development of regulatory infrastructure and conducting technical evaluations of license amendment requests. Risk-informed

(photo courtesy of: New York Times)

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

- evaluation of severe accident mitigation alternatives in support of license renewal

- implementation of lessons learned from the Fukushima Daiichi Nuclear Plant accident in Japan, specifically Recommendation 2.1 on re-evaluating seismic and flooding hazards using risk information

- use of PRA information to assess the risk of non-compliances with tornado missile requirements.

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
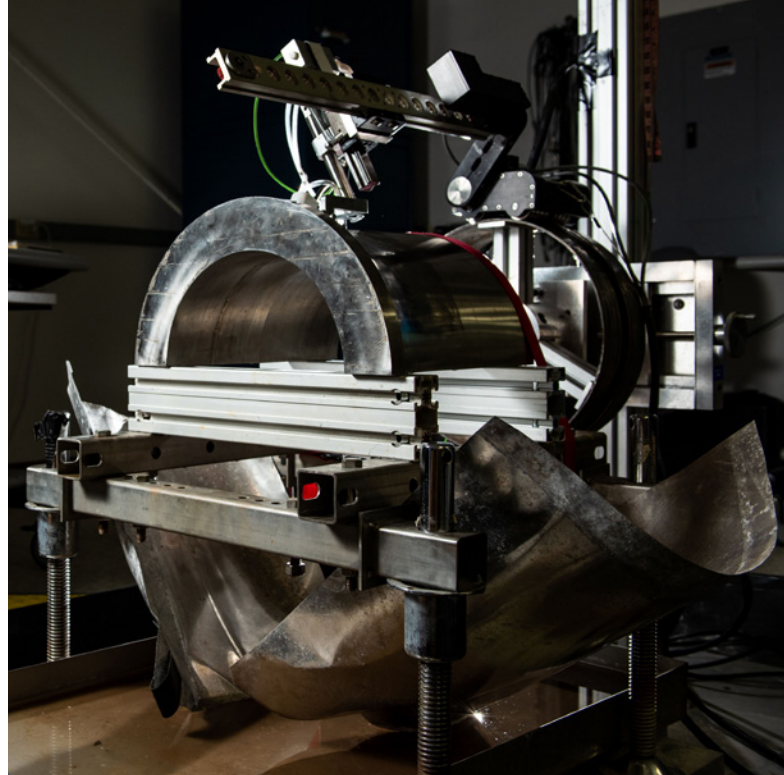
- conducting expert elicitations to support the NRC Full-Scope Site Level-3 PRA, including:
  - risk evaluation of reactor primary system bypass sequences
  - risk-informed prioritization of reactor low power and shutdown operating states

- development of and methodology for characterization of the quantitative hazard to 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

- development of regulatory infrastructure documents and tools in support of reactor risk-informed decision-making

- assessment of state-of-art uncertainty analysis methodologies for application in PRAs for advanced non-light water reactors.

Other Sponsors

In addition, PNNL provides PRA and safety risk-assessment expertise to other sponsors. Those activities 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 NE's Advanced Reactor Technology program
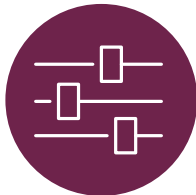
Development of a means of incorporating passive components into next-generation PRAs under DOE NE's Light Water Reactor Sustainability Program
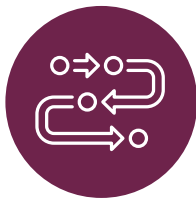
Development of a comprehensive risk-assessment methodology supporting a risk-informed strategic plan for decommissioning the Fukushima Daiichi Nuclear Plant for Japan's Nuclear Damage Compensation and Decommission Facilitation Corporation

Development and application of a risk-informed regulatory framework for surface transportation of mobile reactors for the DOE National Reactor Innovation Center and the Department of Defense.

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