**17th International Conference on Probabilistic Safety Assessment and Management &
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Topical (Panel) Session

Emerging PSA Needs with respect to Advanced Reactor Technologies

Organizer
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Panelists
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Extended Abstract: There is significant activity associated with the development of new and advanced nuclear power plant designs and operating concepts. New and advanced designs are expected to include simplified high-reliability safety systems, reduced reliance on operator actions, and enhanced margins for safety [1]. However, there is more limited experience in performing probabilistic safety assessment (PSA) and management activities for new and advanced reactor designs compared to the currently operating large light water reactor fleet [2]. For example, new fuel designs and coolants may necessitate new analysis methods, risk metrics, mission time considerations, accident sequence identification, and end-state definitions. Some design and operating concepts may introduce new policy considerations, such as siting in or near populated areas or in locations exposed to more diverse hazards (including hazards that may evolve as a result of a changing climate); transportation of fueled modules; remote or autonomous operations; and multi-module and multi-unit risk. Furthermore, new component types needed to support non-light water reactor coolants or to support certain passive system designs and increased reliance on passive safety features may highlight additional data needs. The limited operating experience and performance data for some advanced reactor design concepts exacerbates these data needs, particularly when considering new failure modes or latent conditions.

Specific challenges for the deployment of new and advanced reactors include:

- How can the use of PSA technology be leveraged and enhanced to ensure nuclear plant safety while supporting efficient licensing and certification reviews?

- Are new PSA analysis and modeling techniques needed to address new concepts of operations such as remote or autonomous plant operation?

- How does the potential for new siting considerations or the use of reactors for process heat generation (e.g., closer to populated areas, collocated with industrial facilities, or exposure to new hazards) impact PSA modeling needs?

- What needs to be done to ensure that the next-generation workforce is prepared to support a more risk-informed, performance-based regulatory framework?

- Is there a role for non-event tree/fault tree risk assessment methods in the assessment of new and advanced reactors?

- How do we ensure an adequate level of PSA technical acceptability and quality with a limited number of experts able to perform peer review activities?

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- How can PSA techniques support the design and pre-operational phase, including early resolution of potential vulnerabilities and accommodating an evolving PSA within the regulatory framework?

This panel is intended to introduce and discuss some of these challenges. The outcome of this panel session will be the identification of specific risk assessment needs and potential future risk method and tool development activities to address these needs. The panelists represent diverse perspectives from regulatory authorities, research organizations, and industry, and the panel format encourages questions and discussion from session attendees. The panel will include the following experts:

- Dr. Kevin Coyne, organizer, is a Senior Level Advisor for Probabilistic Risk Assessment at United States Nuclear Regulatory Commission (NRC). He has experience in reactor plant design, operations, maintenance, and inspection. His research interests include dynamic PSA, common cause failure modeling, probabilistic event and condition assessment, risk informed regulatory policy, and regulatory application of PSA technology.

- Dr. Michelle (Shelby) Bensi, panelist, is an Associate Professor and the Deborah J. Goodings Professor in Engineering for Global Sustainability in the Department of Civil and Environmental Engineering at the University of Maryland (UMD). Her research interests include probabilistic assessment of natural and human-induced hazards, risk-informed applications, applications of machine and statistical learning methods, and the use of Bayesian networks.

- Professor Seung Jun Lee, panelist, is an Associate Professor in the Department of Nuclear Engineering at Ulsan National Institute of Science and Technology (UNIST). He is the Director of the Nuclear Safety Assessment and HMI Evolution (NuSHAPE) Research Laboratory at UNIST and the Chairman of the Small Modular Reactor Special Committee of the Korean Association of Nuclear Risk Research. His research interests include digital instrumentation and control probabilistic safety assessment, human reliability analysis, dynamic PSA, and risk-informed applications.

- Dr. Zahra Mohaghegh, panelist, is an Associate Professor and Donald Biggar Willett Faculty Scholar in the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois Urbana-Champaign (UIUC). She is the Director of the Socio-Technical Risk Analysis (SoTeRiA) Research Laboratory at UIUC, advancing risk science and applications for the safety and economic viability of complex technological systems such as commercial nuclear power plants and advanced reactors.

- Eric Thornsbury, panelist, is a Principal Technical Leader at the Electric Power Research Institute (EPRI). His primary responsibility is leading technical research projects for the Advanced Nuclear Technology (ANT) Program on the use of PSA in advanced nuclear plant design, licensing, and operation. He is also leading work for the Risk and Safety Management (RSM) Program on new methods for modeling dependencies in human reliability analysis.

Acknowledgements

References

[1]   Nuclear Regulatory Commission, "Policy Statement on the Regulation of Advanced Reactors," 73 *Federal Register* 60612; October 14, 2008 (https://www.nrc.gov/reading-rm/doc-collections/commission/policy/73fr60612.pdf).

[2]   Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) Committee on the Safety of Nuclear Installations. A Joint Report on PSA for New and Advanced Reactors, NEA/CSNI/R(2012)17, 2013 (https://www.oecd-nea.org/jcms/pl_19234).