U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Advanced BWR Source Term Characterization and Regulatory Approval Pathway Establishment to Support a Right-Sized Emergency Planning Zone

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Abstract

This proposal is being submitted for consideration through Nuclear Energy Advanced Modeling and Simulation (NEAMS) and Nuclear Energy Enabling Technologies.
The study outcomes will be generally applicable to advanced reactors, however, the GE-Hitachi BWRX-300 reactor is being used as a test case to describe expected benefits.

Current fission product transport and deposition safety analysis codes, which have been benchmarked against data from Large Light Water Reactors (LLWRs), may not be applicable for the safety analysis of advanced reactors. The current codes have limited resolution to adequately characterize salient features of advanced reactors that may contribute to improved fission product deposition. This is because the critical parameters that influence fission product transport and deposition such as geometry, thermal hydraulics and aerosol characteristics are significantly different from those of large light water reactors. Furthermore, these parameters enable SMRs and advanced reactors to take advantage of passive fission product deposition phenomena (such as sedimentation, thermophoresis and diffusiophoresis) for post-accident decontamination. Hence, by improving modeling and simulation capabilities, the fission product decontamination factor, which is a critical parameter used in safety analysis, can be more accurately estimated for advanced reactors.
The specific application of this study will improve the characterization of post-accident fission product transport and deposition. The outcomes of the study will support the establishment of a regulatory pathway to right-size emergency planning zones for advanced reactors.
The objectives of this project are as follows:

1. To support mechanistic and risk-informed safety analysis by enhancing capabilities associated with existing DOE-NE advanced modeling and simulation codes such as RAVEN, RELAP5 and SASS4A/SASSY-1.
2. To utilize the iPWR V&V code as a test-bed to implement, verify and validate applicable theoretical constructs, thermal hydraulic models and fission product transport models.
3. To develop a set of methods and models that can be used to improve current safety analysis codes such as RAVEN, RELAP5 and SASS4A/SASSY-1.
4. Develop and submit a topical report to the NRC for review and commentary.

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