UNITED STATES
NUCLEAR REGULATORY COMMISSION
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Grant # 31310021M0007
Grantee: University of Maryland
Title of Grant: Application of Advanced and Hybrid Risk Tools in External Hazard PRA: Challenges and Opportunities
Period of Performance: 11/30/2020-11/29/2023 (FY2020 Notice of Funding Opportunity NOFO)

Executive Summary

This research project will identify and assess the potential of the latest probabilistic risk assessment (PRA) technologies to inform and support NRC's transformation into a modern, risk-informed regulator. These technologies will be assessed from the perspective of external hazard PRA and their potential to: (1) support and inform NRC's risk-informed regulatory processes and transformation efforts, (2) address technical gaps, uncertainties, and limitations in current technologies supporting risk-informed decision-making (RIDM), and (3) offer opportunities to leverage more advanced technologies to bolster technical bases or improve efficiency in RIDM. Projects activities include a survey and assessment of novel PRA tools, exploration of opportunities to develop hybrid PRA tools that merge existing and new PRA technologies, identify potential impacts of new tools on RIDM and regulatory processes, and synthesize knowledge to summarize challenges & opportunities in the use of modern and hybrid PRA tools. Using external hazard PRA as a research boundary object, this project will identify how modern PRA tools can expand risk assessment capabilities and support more robust and effective RIDM while continuing to leverage extensive investments in existing PRA technologies.

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Presentations and Publications

The list of publications was submitted with the final report after grant expiration.

2021

1. [paper] Shen, J., M. Bensi, M. Modarres (2021), "Review of Operating Experience and Fragility Development During Flooding Incidents at Nuclear Power Stations," at International Topical Meeting on Probabilistic Safety Assessment and Analysis Conference (PSA 2021), Virtual.
2. [presentation] Shen, J.*, M. Bensi, M. Modarres (2021), "Review of Operating Experience and Fragility Development During Flooding Incidents at Nuclear Power Stations," at International

Topical Meeting on Probabilistic Safety Assessment and Analysis Conference (PSA 2021), Virtual.

2022

3. [poster] Shen, J.*, M. Bensi, M. Modarres (2022), “Flood Fragility Function Methodology for a Conceptual Nuclear Power Plant,” at the 7th Annual Probabilistic Flood Hazard Assessment Research Workshop (PFHA), Virtual.
4. [paper] Shen, J., M. Bensi, M. Modarres (2022), “Identification and Assessment of Current and Developing PRA Technologies for Risk-Informed-Decision-Making (RIDM),” at Probabilistic Safety Assessment and Management Conference (PSAM 16), Honolulu, Hawaii.
5. [presentation] Shen, J.*, M. Bensi, M. Modarres (2022), “Synthesis of Questionnaire Insights Regarding Current PRA and Additional Tools,” presentation at Probabilistic Safety Assessment and Management Conference (PSAM 16), Honolulu, Hawaii.
6. [presentation] Shen, J.*, M. Bensi, M. Modarres (2022), “External Flood Fragility Development and Integrating Novel Tools to the XFPRA framework,” presentation at Probabilistic Safety Assessment and Management Conference (PSAM 16), Honolulu, Hawaii.

2023

7. [presentation] J. Shen*, M. Bensi*, M. Modarres (2023), “A Hybrid Bayesian Approach to Augment External Flooding Probabilistic Risk Assessments of Nuclear Power Plants,” presentation at Regulatory Information Conference (RIC 2023), Rockville, Maryland.
8. [poster] J. Shen*, M. Bensi, M. Modarres (2023), “A Hybrid PRA Approach for External Flood Probabilistic Risk Assessments at Nuclear Power Plants Leveraging Conventional and Novel PRA Tools,” presentation at Probabilistic Flood Hazard Assessment Research Workshop (PFHA), Rockville, Maryland.
9. [poster] J. Shen*, M. Bensi, M. Modarres (2023), “A Hybrid Approach to External Flood Probabilistic Risk Assessments at Nuclear Power Plants,” poster at Civil and Environmental Engineering Alumni Day, College Park, Maryland.
10. [paper] Shen, J. Shen, M. Bensi, M. Modarres, C. Frantzis, S. Marandi, O. Patsy (2023), “A Hybrid, Bayesian Network-Based PRA Methodology for External Flood Probabilistic Risk Assessments at Nuclear Power Plants,” at International Topical Meeting on Probabilistic Safety Assessment and Analysis Conference (PSA 2023), Knoxville, Tennessee.
11. [presentation] J. Shen*, M. Bensi, M. Modarres, C. Frantzis, S. Marandi, O. Patsy (2023), “A Hybrid, Bayesian Network-Based PRA Methodology for External Flood Probabilistic Risk Assessments at Nuclear Power Plants,” presentation at International Topical Meeting on Probabilistic Safety Assessment and Analysis Conference (PSA 2023), Knoxville, Tennessee.
12. [paper] Shen, J., M. Bensi, M. Modarres (2023), “Synthesis of Insights Regarding Current PRA Technologies for Risk-Informed Decision Making,” at International Topical Meeting on Probabilistic Safety Assessment and Analysis Conference (PSA 2023), Knoxville, Tennessee.
13. [presentation] J. Shen*, M. Bensi, M. Modarres (2023), “Synthesis of Insights Regarding Current PRA Technologies for Risk-Informed Decision Making,” presentation at Probabilistic Flood Hazard Assessment Research Workshop, Rockville, Maryland.

2024

14. [paper] Shen, J. *, M. Bensi, M. Modarres (2024), "Bayesian Network and Monte Carlo Simulation Augmented External Flood PRA for NPPs," at the 27th International Conference on Structural Mechanics in Reactor Technology (SMiRT27), Yokohama, Japan.
15. [presentation] J. Shen*, M. Bensi, M. Modarres (2024), "Bayesian Network and Monte Carlo Simulation Augmented External Flood PRA for NPPs," presentation at the 27th International Conference on Structural Mechanics in Reactor Technology (SMiRT27), Yokohama, Japan.

In Preparation

- [journal article] J. Shen, M. Bensi, M. Modarres (2024), "A Monte Carlo Augmented Bayesian Network Approach for External Flood Probabilistic Risk Assessments," submission planned to the Nuclear Engineering and Design Journal.
- [journal article] J. Shen, M. Bensi, M. Modarres (2024), "A Hybrid External Flood Probabilistic Risk Assessment Framework Leveraging a Monte Carlo Augmented Bayesian Network," submission planned to the Nuclear Science and Engineering Journal.

Patents

N/A