



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**
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Grant # 31310020M0002

Grantee: University of Maryland

Title of Grant: Improving Foundational Knowledge of Dependency in Human Reliability Analysis

Period of Performance: 9/5/2020-9/24/2023 (FY2020 Notice of Funding Opportunity NOFO)

Executive Summary

The objective of this project is to perform application-driven fundamental research to enhance the technical basis of Human Reliability Analysis (HRA) by developing the theoretical and mathematical foundations necessary to more consistently and accurately model HRA dependency. The proposed project will 1) clearly define HRA dependency constructs, 2) develop a mathematical framework for modeling HRA dependency relationships and 3) develop a mathematical framework to quantify dependency using HRA data. The approach will draw on novel data analysis, causal models, and artificial intelligence techniques and will connect those to existing and emerging HRA methods and HRA data used throughout the NRC's regulatory activities. The outcome of the work will be enhanced foundational knowledge which will be directly fill known gaps in the HRA methods used within NRC's risk-informed decision-making capabilities.

Principal Investigator: Dr. Katrina M. Groth, kgroth@umd.edu

Presentations and Publications

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

1. Conference paper & presentation: V. P. Paglioni and K. M. Groth, "Defining Dependency in HRA," Proceedings of the 2021 International Topical Meeting on Probabilistic Safety Assessment and Analysis (PSA 2021). Nov 2021.
2. Conference presentation: V. P. Paglioni, "Improving the foundational knowledge of dependency in Human Reliability Analysis." Presentation to Graduate Student Lightning Round at the 2021 International Topical Meeting on Probabilistic Safety Assessment and Analysis (PSA 2021). Nov 2021.
3. Presentation: V. P. Paglioni, C. S. Levine and K. M. Groth "UMD progress in Human Reliability Analysis." Virtual presentation to Sandia National Laboratories. February 2, 2022.
4. Presentation: K. M. Groth, C. S. Levine and V. P. Paglioni "UMD Systems Risk and Reliability Analysis (SyRRA) Lab: HRA Research. Presentation to Sandia National Laboratories, Albuquerque, NM, March 23, 2022.

5. Journal paper: V. P. Paglioni and K. M. Groth, "Dependency definitions for quantitative human reliability analysis," Reliability Engineering & System Safety, vol. 220, Apr. 2022, <https://doi.org/10.1016/j.ress.2021.108274>.
6. Conference paper and presentation: V. P. Paglioni, T. Mortenson and K. M. Groth "The Human Failure Event: What is it and what should it be?" Proceedings of the 16th Probabilistic Safety Assessment & Management Conference (PSAM16), June 2022.
7. Journal paper: V. P. Paglioni and K. M. Groth "Dependency Idioms for Quantitative Human Reliability Analysis," accepted in Nuclear Science & Engineering in August 2023, vol TBD, accepted version is on journal website at [doi: 10.1080/00295639.2023.2250159](https://doi.org/10.1080/00295639.2023.2250159)
8. Ph.D. Dissertation, April 2023: Vincent P. Paglioni, Improving the foundational knowledge of dependency in Human Reliability Analysis. University of Maryland, College Park, MD, 2023-04.
9. Plenary Presentation: K. M. Groth, "PSA's Future: People, Technology, and Impact," 18th International Probabilistic Safety Assessment and Analysis Conference (PSA 2023), July 17-20, 2023, Knoxville, TN.
10. Conference paper and presentation: Paglioni, V. P., Camille Levine, Ahmad Al-Douri, and Katrina M. Groth. "Why do Human-Machine Teams Fail: Investigating Failure Mechanisms in HRA." 13th Nuclear Plant Instrumentation, Control & Human-Machine Interface Technologies Conference (NPIC&HMIT 2023) July 17-20, 2023, Knoxville, TN.
11. Conference paper and presentation: V. P. Paglioni and K. M. Groth. "Bridging the Data – Model Gap for HRA: Creating Bayesian Networks from HRA Data." 13th Nuclear Plant Instrumentation, Control & Human-Machine Interface Technologies Conference (NPIC&HMIT 2023) July 17-20, 2023, Knoxville, TN.
12. Journal paper to be submitted: V. P. Paglioni and K. M. Groth "Creating Formative Dependency Models Using HRA Dependency Idioms, Bayesian Networks, and HRA Data, Part I: Model Construction," will be submitted to Reliability Engineering & System Safety around November.
13. Journal paper to be submitted: V. P. Paglioni and K. M. Groth "Creating Formative Dependency Models Using HRA Dependency Idioms, Bayesian Networks, and HRA Data, Part II: Model Quantification," will be submitted to Reliability Engineering & System Safety around November.
14. Conference paper: J. O'Leary, Y. Zhao, K. Groth "A Survey of Parameterization Techniques for Bayesian Network Models for Human Reliability Analysis," Probabilistic Safety Assessment and Management (PSAM) 2023 Topical Meeting, Virtual, October 23-25, 2023.

Patents

N/A