

**M. D. Muhlheim**  
**Oak Ridge National Laboratory**  
**Oak Ridge, TN 37831**

**Education**

- B.S., in nuclear engineering at the University of Tennessee
- M.S. in nuclear engineering at the University of Tennessee, emphasis in reliability and risk assessment, J. B. Fussell advisor
- Ph.D. in nuclear engineering at the University of Tennessee, emphasis in radiation shielding, P. N. Stevens advisor

**Research and Professional Experience**

*Oak Ridge National Laboratory (1991-present)*

Dr. Michael D. Muhlheim is a research and development staff member in the Modern Nuclear I&C Group, in the Advanced Reactor Engineering and Development Section, at the Oak Ridge National Laboratory (ORNL). Through experience and training, Dr. Muhlheim is well versed in performing qualitative and quantitative safety assessments on currently operating and advanced nuclear power plant (NPP) designs, evaluating the instrumentation and control (I&C) systems for NPPs and research reactors, and developing new tools and metrics for evaluating those systems.

Dr. Muhlheim has been involved in performing the technical evaluations of the I&C systems for the US-APWR, ESBWR, APR1400, ACR-1000, Doosan, and GE-H for input into the U.S. Nuclear Regulatory Commission (NRC) safety evaluations. Other NRC related work included evaluating the systems interactions at NPPs (NUREG/CR-3922), serving as project manager for the Accident Sequence Precursor program to provide estimates of the significance of operating events (NUREG/CR-4674, Vols. 23, 25-27), developing a set of guidelines for evaluating the adequacy of the design of highly integrated control room communications (NUREG/CR-6991), evaluating the emerging technologies in the I&C at NPPs (NUREG/CR-6992), investigating diversity attributes for safety-related digital systems (NUREG/CR-7007), providing a technical basis for the use and evaluation of embedded digital devices (NUREG/CR-7372), and the primary author of the Interim Staff Guidance for the format and content of I&C applications for nuclear power utilization facilities and the reviewer guidance for those applications.

Dr. Muhlheim has also been involved in the design of research reactors and advanced nuclear power plants (e.g., Transformational Challenge Reactor, Advanced Neutron Source, IRIS, BWRX-300), and space craft (e.g., JIMO). Dr. Muhlheim was the Project Manager for developing a prototype computer code called risk-based design optimization tool (RBOT) that allows designers to examine the reliability characteristics of design alternatives and observe how design changes affect the plant's ability to respond to different internally and externally initiated events. The RBOT prototype was successfully used by Westinghouse to lower the initial estimated core damage frequency (CDF) for its IRIS reactor by almost 2 orders of magnitude. Westinghouse then applied the lessons learned from the evaluation of IRIS to make design changes to its AP-1000 reactor during the last year of its design certification review by the NRC. Advancements in this work led to the development of a supervisory control system for the PRISM reactor and the Operational Performance Risk Assessment applied to the BWRX-300.

Dr. Muhlheim has been involved in the early design stages of several large projects including identifying and evaluating the risks associated with launching a space reactor, determining top-level reliability and safety requirements for a space reactor on a lunar or Martian surface, evaluating the reliability characteristics of different I&C systems including autonomous control for deep space applications, managing the development of a probabilistic risk assessment (PRA) tool to perform concept-level predictions of system safety and reliability for GEN IV nuclear power plants, and acting as the task

manager of the Conceptual Safety Analysis Report for the Advanced Neutron Source (ANS). In addition, as part of the Plant Design Requirements Working Group for the ANS, he was involved in specifying the design requirements and safety and licensing criteria for the facility, and the identification of safety classifications for structures, systems, and components for both reactor and nonreactor safety classes.

#### *H&R Technical Associates (1990-1991)*

Performed criticality safety, transportation, and reliability risk assessments of several DOE facilities. Performed source term, shielding, and criticality analyses for the *Safety Analysis Report for Packaging (SARP): Multi-hundred Watt Isotope Heat Source Shipping Container*.

#### *JBF Associates (1980-1990)*

Performed reliability, risk assessment, criticality calculations, and process hazards analyses. Used all of the hazard analysis tools and all of the risk metrics. In addition, performed reviews of operating experience of nuclear power plants, both foreign and domestic.

#### **Synergistic Activities**

- General Chair of the International Probabilistic Safety Assessment 2023 conference
- Current Chair of the ANS standards working group (WG) 3.15, *Risk-Informed Selection of Critical Digital Assets (CDAs) for Nuclear Power Systems*
- Authored or co-authored over 150 journal articles and reports
- Recipient of the American Nuclear Society's Mark Mills award (1996)

#### **Selected Publications**

1. M. D. Muhlheim, P. Ramuhalli, A. Huning, A. Guler, R. Wood, and A. Saxena, *Status Report on Regulatory Criteria Applicable to the Use of Digital Twins*, ORNL/SPR-2022/2493, June 2022.
2. Muhlheim, M. D., Belles, and R. J., Hardin, L. A., *Criteria for Determining the Safety of Wireless Technologies at Nuclear Power Plants*, ORNL/SPR-2022/2534, August 2022.
3. Muhlheim, M. D., Poore, W. P., Nack, A. M., Wood, R. T., Melin, A. M., Bull Ezell, N. D., Hale, R. E., Holcomb, D. E., Huning, A. J., and Halverson, D. S., *Developing a Technical Basis for Embedded Digital Devices and Emerging Technologies*, NUREG/CR-7273, March 2021.
4. S. Bhatt, S. M. Cetiner, E. Fountain, S. Hilmes, M. D. Muhlheim, C. M. Petrie, M. Russell, V. Varma, and A. Wysocki, *Transformational Challenge Reactor Instrumentation and Control System Conceptual Design Report*, ORNL/SPR-2020/1547, May 29, 2020.
5. M. D. Muhlheim, G. F. Flanagan, W. P. Poore, III, and R. J. Belles, *Assessment of Applicability of Standards Endorsed by Regulatory Guides to Sodium Fast Reactors*, ORNL/SR-2017/520, September 2017.
6. Sacit M. Cetiner, Michael D. Muhlheim, Askin Guler-Yigitoglu, Randall J. Belles, Scott M. Greenwood, T. Jay Harrison, Richard S. Denning, Christopher A. Bonebrake, Gerges Dib, David Grabaskas, and Acacia J. Brunett, *Supervisory Control System for Multi-Modular Advanced Reactors*, ORNL/TM-2016/693, November 2016.
7. NRC Interim Staff Guidance Augmenting NUREG-1537, Part 1, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content, for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors*, October 17, 2012.
8. NRC Interim Staff Guidance Augmenting NUREG-1537, Part 2, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria, for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors*, October 17, 2012.
9. R.T. Wood, R. J. Belles, M.S. Cetiner, D.E. Holcomb, K. Korsah, A.S. Loebel, G.T. Mays, M.D. Muhlheim, J.A. Mullens, W.P. Poore, III, A.L. Quails, and T.L. Wilson, Jr., and M.E. Waterman,

*Diversity Strategies for Nuclear Power Plant Instrumentation and Control Systems*, NUREG/CR-7007, February 2010.

10. M. D. Muhlheim, J. W. Cletcher, II, S. Flanagan, J. L. Hynek, and R. Stack, "Selected Examples of Design Optimization Using RBOT and FaultTree+," International Safety System Conference, August 2005, San Diego, CA.
11. M. D. Muhlheim and J. W. Cletcher, "Use of PRA Techniques to Optimize the Design of the IRIS Nuclear Power Plant," GENES4/ANP2003, Sep. 15-19, 2003, Kyoto, JAPAN.
12. M. D. Muhlheim, Richard T. Wood, William L. Bryan, Thomas L. Wilson, Jr., David E. Holcomb, Kofi Korsah, and Usha Jagadish, "Evaluation of I&C Architecture Alternatives Required For The Jupiter Icy Moons Orbiter (JIMO) Reactor," 5th ANS International Topical Meeting on Nuclear Plant Instrumentation, Control and Human Machine Interface Technologies, November 12-16, 2006, Albuquerque, NM.