CALVIN M. HOPPER
NUCLEAR CRITICALITY SAFETY SPECIALIST
28 November 2023

SUMMARY OF EXPERIENCE AND QUALIFICATIONS [1968 – 2023]

After forty years of full-time employment in the field of nuclear safety (i.e., health physics and nuclear criticality safety) at commercial and government facilities, Calvin Mitchell Hopper retired from the Oak Ridge National Laboratory (ORNL) in 2008 as a Senior Development and Design Engineer in the Radiation Transport and Criticality Group within the Nuclear Science and Technology Division. Subsequent to retirement from ORNL, Mr. Hopper provided programmatic and technical consulting services in nuclear criticality safety (NCS) to ORNL, the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Energy (DOE), the Missouri University Research Reactor program, the U.S. Defense Nuclear Facility Safety Board, the Four Rivers Nuclear Partnership, Paducah, KY, D&D Project, the Fluor-BWXT Portsmouth LLC Portsmouth D&D Project and the Ohio State Department of Health. Also, he provided NCS leadership of both the governance and the standards activities within the American Nuclear Society, Nuclear Criticality Safety Division and the International Organization for Standardization Technical Committee 85, Subcommittee 5, Working Group 8 on Nuclear Criticality Safety.
Throughout his career, he provided both training and NCS analyses/evaluations and consulting services to industries in the US (i.e., GE Hitachi Nuclear Energy, Westinghouse Energy Columbia, SC) and Canada (i.e., Cameco Corp., Bruce Power LP). Additionally, he provided NCS educational services through the University of Tennessee – Nuclear Engineering Department graduate classes, the Tennessee Industries Week programs and lectured for the US DOE Prevention of Significant Nuclear Events and Potential Safety Impacts of New Technologies on the Operation of DOE Nuclear Facilities. He contributed and reviewed evaluated criticality experiment benchmarks for the international OECD (Organization for Economic and Cooperative Development) International Criticality Safety Benchmark Evaluation Project handbook.

SECURITY CLEARANCE

US DOE Q – Active

EMPLOYMENT HISTORY

NUCLEAR CRITICALITY SAFETY SPECIALIST

Fulltime Nuclear Criticality Safety Specialist Employment [1968 – 2008]

Oak Ridge National Laboratory, Oak Ridge, TN
Senior Development and Design Engineer
1984 – 2008

- [2002 – 2008] Planned, coordinated and contributed administrative and technical support for various research projects (see PUBLICATIONS).
- [2002 – 2005] Planned and coordinated the research design of needed structural materials critical experiments for the US DOE/NASA Jupiter Icy Moons Orbiter (JIMO) power reactor, Prometheus, using the ORNL SCALE TSUNAMI (Tools for Sensitivity and Uncertainty Analysis Methodology Implementation) sequence.

- [2002] Contributed to the ORNL report that was responsible for subsequently altering IAEA standards regarding nuclear material accountability at the purified natural uranium product stage, U_3O_8, as opposed to the previous accountability stage for purified UO_2 – a significant alteration for international nuclear materials safeguards.
- [2001] Provided technical support to PNNL development of safety evaluations for the US DOE Pit Disassembly and Conversion Facility.
- [1999 – 2006] Coordinated the development and transition of the US NRC and US DOE sponsored GLLSM (Generalized Linear Least Squares Method) sensitivity and uncertainty (S/U) software application to the US DOE Nuclear Criticality Safety Program sponsored TSUNAMI sequence within the ORNL SCALE system that subsequently was applied internationally to nuclear engineering applications and nuclear criticality safety computational validations and evaluations.
- [1997 -1998] Coordinated and contributed to the US NRC sponsored revision and upgrade of his 1974 seminal "Nuclear Criticality Accident Slide Rule" that is internationally recognized as a useful emergency training and response tool.
- [1997 – 2008] Assisted the US DOE in the 1997 development and establishment of the US DOE Nuclear Criticality Safety Program including its Criticality Safety Support Group (CSSG) as a Charter Member, Deputy Chair, and Chair (see https://ncsp.llnl.gov/cssg.php) and addressing numerous CSSG Taskings during his 16-year membership (see https://ncsp.llnl.gov/cssg_tasking.php). He transitioned to the CSSG Emeritus Member status in 2013.
- [1996 – 1999] Coordinated the development of the US NRC sponsored ORNL nuclear criticality GLLSM (Generalized Linear Least Squares Method) sensitivity and uncertainty (S/U) computer software project and acquiring and using Former Soviet Union critical experiment data for the GLLSM S/U proof of principal.
- [1994 – 1997] Coordinated and contributed to US NRC supported nuclear criticality safety study regarding low-level fissile radioactive waste disposal at the Barnwell, SC and Clive, UT facilities.
- [1991] Prepared ORNL's SARP (Safety Analysis Report for Packaging) Chapter 6 for the licensing of the USA/5797/B(U)F for HFIR (High Flux Irradiation Reactor) fresh fuels – inner and outer fuel elements.
- [1990 – 1994] Developed and staffed the ORNL Nuclear Criticality Safety Section/Group, serving as interim Section/Group Head.
- [1990 – 1991] Contributed to the seminal development and reviews of the International Handbook of Evaluated Criticality Safety Benchmark Experiments.
- [1984 – 1990] Appointed to the position of the first ORNL Nuclear Criticality Safety Officer role responsible for preparing all fissionable material operations' safety analyses/evaluations, training and maintaining the active ORNL NCS corporate knowledge.
- [1984 – 1990] Assisted ORNL's Joseph T. Thomas in the development and management of the US DOE sponsored Nuclear Criticality Technology and Safety Program (NCT&SP) that was dissolved in 1990.

Y-12 Plant, Oak Ridge, TN

NCS Department Head
1982 – 1984

- [1981 – 1984] Headed the Oak Ridge Y-12 Plant Nuclear Criticality Safety Department responsible for management of safety analyses/evaluations, training and research for all Plant fissionable material processes, operations, storage, and transportation.
- [1981 – 1984] Served on the US DOE Albuquerque Weapons Criticality Safety Committee that focused on the transportation and storage of weapons and weapon components and identified issues resulting in a US DOE-wide special safety program.

Y-12 Plant, Oak Ridge, TN
HP Technical Department Head
1980 – 1982

- [1980- 1982] Headed the Y-12 Plant Health Physics Technical Department for all internal and external radiation monitoring analyses and the deployment/analyses of the US DOE Mobile Whole Body *In Vivo* Monitoring services to US DOE facilities east of the Mississippi.

Texas Instruments, Inc., HFIR Project
Head of U.S. NRC License No. SNM-23, Nuclear Safety and Nuclear Materials Accountability
1978 – 1980

- Administered the programmatic and technical oversight of the Nuclear Safety (i.e., Criticality Safety and Health Physics), and Nuclear Materials Accountability programs at the Texas Instruments, Inc., HFIR Project in Attleboro, Massachusetts.
- Prepared and submitted the first general license submittal to the US NRC for the HFIR Project thereby replacing the 13-year-old US NRC specific license and strings of license amendments.

Y-12 Plant, Oak Ridge, TN
Nuclear Criticality Safety Engineer
1970 – 1978

- Performed NCS analyses and evaluations for the Y-12 Plant Development Division, Metal Preparation Division and Assembly Division.
- Developed safety evaluation reports for the packaging of weapons components and materials.
- Co-authored first nationally released nuclear criticality safety computer code validation report as a “stalking horse” for the development of ANSI N16.9/ANS-8.11-1975 (W1983), “Validation of Calculational Methods for Nuclear Criticality Safety.”
- Served two separate 6-month personnel rotations to the Oak Ridge Gaseous Diffusion Plant to provide NCS support for the evolving gas centrifuge enrichment project.
- Developed the 1974 seminal Nuclear Criticality Accident Slide Rule for the Y-12 Plant.

Oak Ridge Critical Experiments Facility Radiation Protection Officer
1968 – 1970

- Provided independent personnel and environmental radiation protection and monitoring services for the Oak Ridge Critical Experiments Facility (ORCEF).

- Developed the first "ORCEF Radiation Protection and Monitoring Program Manual".

Technical and Programmatic Assistance Consultancies [1974 – 2023]

Boston Government Services, LLC, Oak Ridge,
- [2021 – Present] Support for assessing safety, operations, and licensing needs for a new fuel fabrication facility.

CS Engineering, Inc., Knoxville, TN
- [2020 - Present] Conducted the nuclear criticality safety Assessment Report about the Portsmouth Gaseous Diffusion Plant X-780 On Site Waste Disposal Facility Hazard Analysis for the State of Ohio, Department of Health, Columbus, OH.

Fluor-BWXT Portsmouth LLC, Portsmouth, OH
- [2019] Assessed the Fluor-BWXT Portsmouth LLC, Nuclear Criticality Safety Program.

Spectra Tech, Inc., Oak Ridge, TN
- [2018 – 2019] Reviewed the Four Rivers Nuclear Partnership, LLC Paducah Deactivation Project NCS Evaluations.

University of Missouri, Columbia, MO
- [2017 – 2018] Provided draft nuclear criticality safety program outline and content for the Missouri University Research Reactor (MURR) intended modification of their US NRC reactor operating license for the purpose of molybdenum production.

CS Engineering, Inc., Knoxville, TN
- [2014 – 2017] Provided intermittent NCS Expert input for the 2014, 2015, 2016 and 2017 ORNL Uranium Processing Facility "Red Team Review" regarding recommendations to the Secretary of the US DOE for NCS in the design and approval of construction of the US DOE Uranium Processing Facility (UPF).

CS Engineering, Inc., Knoxville, TN
- [2013 – present] Supported the US DOE Nuclear Criticality Safety Program, as an Emeritus Member of the Criticality Safety Support Group.
- [2013 – 2020] Provided Intermittent reviews of Oak Ridge National Laboratory US DOE NCSP and ORNL NCS evaluations regarding special actinide criticality safety.

US Defense Nuclear Facility Safety Board, Washington, DC
- [2013 – 2016] Assisted the development of a staff NCS training program and reviews of US DOE Contractor NCS program applications.

AECL, Chalk River, Ontario, CA
- [2012] Consulted with staff regarding nuclear criticality safety of their selected transportation mode for repatriating US enriched uranium reactor target residue material solutions from Chalk River National Research Universal and National Research Experimental research reactors.

CS Engineering, Inc., Knoxville, TN

- [2010 – 2013] Headed the project coordination for the planning, development and deployment of the US DOE Nuclear Criticality Safety Program "Hands-On Subcritical and Critical Experiments Training and Education Project".
- [2008 – 2011] Performed final NCS Evaluation Reviews for the Oak Ridge Uranium Processing Facility, and the Oak Ridge Y-12 National Security Complex.

University of Tennessee, Knoxville, TN

- [1994 – 2008] Prepared and conducted intermittent nuclear criticality safety general employee and engineer training courses for the US DOE Rocky Flats Plant, CAMECO Port Hope Conversion and Fuel Manufacturing Facilities, Tennessee Industries Week, and University of Tennessee undergraduate and graduate nuclear engineering courses.

Bruce Power, Tiverton, Ontario, Canada

- [2001 -2002] Provided guidance for the validation of nuclear criticality codes in anticipation for the use of slightly enriched (0.7 – 1.0) uranium fuel processing, fabrication, handling and storage.

US Nuclear, Inc. facility in Oak Ridge, TN

- [1974 – 1978] Provided independent NCS consulting services to the US Nuclear, Inc. research reactor fuel fabrication facility licensed by the US NRC.

PROFESSIONAL ACTIVITIES, ACCOMPLISHMENTS, RECOGNITIONS

- [2013] US DOE National Nuclear Security Administration Distinguished Career Service Award.
- [2013] American Nuclear Society Nuclear Criticality Safety Division Technical Achievement Award.
- [2009] ANS Standards Service Award.
- [2008] American Nuclear Society Nuclear Criticality Safety Division Distinguished Service Award.
- [2005, 2009] Consultant to the International Atomic Energy Agency Nuclear Safety and Security in the topical areas of emergency management and nuclear safety guides.
- [2005] General Chair of the ANS NCSD 2005 Topical Meeting.
- [2003] Honorable Scott McInnis US House of Representatives Tribute to Calvin Hopper's distinguished professional achievements and community commitments.
- [2003] Outstanding Achievement Award from Colorado State University – Pueblo.
- [2002] National Nuclear Security Administration Certificate of Appreciation for the TRUPACT-II and HalfPACT systems criticality safety package analysis.
- [2001] Fellow Member in the American Nuclear Society.
- [2000 – 2018] Past Convener (Chair) [2000 – 2013] and continuing Expert [2013- - 2023] of Working Group 8 on Nuclear Criticality Safety within Subcommittee 5 and Technical Committee 85 for ISO.
- [2000 – 2013] Over-all Advisor to ANSI for ISO (International Organization for Standardization) Technical Committee 85 (Nuclear energy, nuclear technologies, and radiological protection) / Subcommittee 5 (Nuclear fuel cycle).

- [1998 – 2011] Member and recent past Chair of the ANSI/ANS N16 (now identified as the NCSCC – Nuclear Criticality Safety Consensus Committee).
- [1994] US DOE Under Secretary of ES&H citation for successfully managing the *US DOE Plutonium ES&H Vulnerability Assessment* for the US DOE Oak Ridge Operations Assessment and Team Report.
- [1987 – 2007] Member of ANSI/ANS standards working groups
  - ANSI/ANS-8.1-1983. – 1998
  - ANSI/ANS-8.7 - 2021
  - ANSI/ANS-8.19-1996, - 2005
  - ANSI/ANS-8.20-1991
  - ANSI/ANS-8.23-1997, - 2007
  - ANSI/ANS-8.26-2007
- [1984 – 1997] Past Chair of ANSI/ANS-8.7-1998.
- [1970 – to present] Member and past Program Chair, Secretary, Vice-Chair and Chair of the ANSI/ANS Nuclear Criticality Safety Division (NCSD).

PUBLICATIONS AND REPORTS

- Nuclear Science and Engineering
  - [2017] “Calculation of the Minimum Critical Mass of Fissile Nuclides”.
  - [2004] “Sensitivity- and Uncertainty-Based Criticality Safety Validation Techniques”.
- [2013] “Domestic and International Nuclear Energy Voluntary Consensus Standard’s Needs”.
- [2011] “US DOE Nuclear Criticality Safety Program Hands-On Subcritical and Critical Experiments Training and Education Course”.
- [2011] “US DOE NCSP Training and Education Program Plan”.
- [2011] “The Language of the Process Analysis Requirement and the Double Contingency Principle”.
- [2011] “DOE/EM Criticality Safety Needs Assessment”.
- [2010] “Nuclear Computational Science, a Century in Review.”
- [2008] “Analysis of Legacy LEU Critical Experiments with ENDF/B-VII”.
- [2007] “Validation of Accuracy of Criticality Calculations of Damp Mixed Oxide Powders”.
- [2006] “Application of the Pitzer Method for Modeling Densities of Actinide Solutions in the SCALE Code System”.
- Nuclear Technology
  - [2006] “Application of the Pitzer Method for Modeling Densities of Actinide Solutions in the SCALE Code System”.
  - [1995] “Improved Dose Estimates for Nuclear Criticality Accidents”.
- [2005] “History of the Oak Ridge Critical Experiments Program”.
- [2005] “Determination of Consistent Benchmarks Used for Nuclear Criticality Safety Analysis Applications”.
- [2005] “Critical Mass Experiment with Niobium - 1 wt.% Zirconium Fueled with Highly Enriched Uranium in Support of Project Prometheus”.
  - [2004] “Sensitivity- and Uncertainty-Based Criticality Safety Validation Techniques”.
- [2004] “Sensitivity Analysis Applied to the Validation of the ^{10}B Capture Reaction in Nuclear Fuel Casks”.
- [2004] “Impact of Benchmarks on Potential MOX Throughput”.
- [2004] “Guide for Nuclear Criticality Safety in the Storage of Fissile Materials”.

- [2003] “Nuclear Criticality Safety of the DOT 9975 Container for $^{237}NpO_2$ Storage, Handling, and Transportation.
- [2003] “Assessment of Degree of Applicability of Benchmarks for Gadolinium Using KENO V.A and the 238-Group Neutron Cross Sections”.
- [2002] “Design Parameters for a Natural Uranium UO_3 or U_3O_8 Fueled Nuclear Reactor”.
- [1999] “The Potential for Criticality Following Disposal of Uranium at Low-Level-Waste Facilities, Containerized Disposal”.
- [1999] “Slide Rule for Rapid Response Estimation of Radiological Dose from Criticality Accidents” – Volumes 1 & 2.
- [1999] “Sensitivity and Uncertainty Analyses Applied to Criticality Safety Validation, Volume 2: Illustrative Applications and Initial Guidance”.
- [1999] “Sensitivity and Uncertainty Analyses Applied to Criticality Safety Validation, Volume 1: Methods”.
- [1999] “Proposed Methodology for Establishing Area of Applicability”.
- [1999] “Bounding Values for Low-Level-Waste Transport Exemptions and Disposal”.
- [1999] “Application of Covariance Data to Criticality Safety Data Validation”.
- [1998] “Definition of Weapons-Usable Uranium-233”.
- [1998] “Assessment and recommendations for fissile-material packaging exemptions and general licenses within 10 CFR Part 71”.
- [1997] “The Potential for Criticality Following Disposal of Uranium at Low-Level Waste Facilities”
- [1997] “Isotopic dilution requirements for ^{233}U criticality safety in processing and disposal facility”.
- [1997] “Dose Consequences from a Postulated Criticality Occurring in a Low-Level Waste Disposal Facility”
- [1996] “Criticality Safety Study of the MSRE Auxiliary Charcoal Bed”.
  - [1995] “Improved Dose Estimates for Nuclear Criticality Accidents”.
- [1995] “Criticality Safety Criteria for License Review of Low-Level Waste Facilities”.
- [1994] “Criticality Safety Study of the MSRE Fuel Drain Tank Cell in Building 7503”.
- [1992] “Criticality Safety Studies for The Storage of Waste from Nuclear Fuel Service in Intercell Storage Wells 2 and 3 of Building 3019”.
- [1988] “Oak Ridge National Laboratory health and safety long-range plan, Fiscal years 1988-94”.