Dr. Steven L. Krahn, BCEE
Professor of the Practice of
Nuclear Environmental Engineering
Vanderbilt University

Education

Doctorate, Public Administration, University of Southern California, 2001.

M.S., Materials Science, University of Virginia, 1994.

B.S., Metallurgical Engineering, University of Wisconsin, 1978.

Certificate (MS Equivalent), Nuclear Engineering, Bettis Reactor Engineering School, U.S. Department of Energy, 1980.

Certificate, Management and Leadership, The Sloan School, Massachusetts Institute of Technology, 2009

Research Interests

Nuclear technology and the nuclear fuel cycle, including the potential uses for Thorium-based systems; risk assessment and risk management; operational readiness and technology insertion in nuclear facilities. Dr Krahn is Principal Investigator (PI) or Co-PI on a portfolio of research projects involving qualitative and quantitative analysis of present and future nuclear fuel cycle options; clients include the U.S. Department of Energy (DOE, Office of Nuclear Energy and Office of Environmental Management) and Electric Power Research Institute (EPRI). Dr Krahn is PI on an analysis of fuel cycle options incorporating Thorium into thermal reactor-based systems for DOE. He also provides engineering and nuclear safety consulting to the U. S. nuclear industry. Dr Krahn was selected to the American Academy of Environmental Engineers & Scientists in 2013, is a Board Certified Environmental Engineer, and was elected to the Executive Committee of the Fuel Cycle and Waste Management Division (FCWMD) of the American Nuclear Society in 2015.

Brief Biography

Dr Krahn is Professor of the Practice of Nuclear Environmental Engineering in the Department of Civil and Environmental Engineering at Vanderbilt University, where he teaches courses in nuclear environmental engineering and performs research in nuclear fuel cycle risk assessment and the insertion of technology in nuclear facility applications. Immediately prior to coming to Vanderbilt, he served in DOE as the Deputy Assistant Secretary for Safety & Security in the Office of Environmental Management.

Dr Krahn brings to Vanderbilt more than 35 years of technical and project management experience in positions of increasing responsibility in government, private industry and the military. His technical highlights have included: providing leadership to the nation-wide safety program of a $9 billion/year nuclear program at DOE; providing technical direction and leadership for a major DOE engineering program; managing a federal agency providing safety oversight to the nuclear weapons complex; directing a $25 million division in an engineering

services company; leading the technical review of numerous technical and systems issues at nuclear facilities; he has led a number of technical symposium sessions and reviews associated with the Thorium Fuel Cycle and he is senior engineering consultant nuclear industry. His project management highlights include: management of the $140 million complex overhaul of a nuclear submarine; management of the $30 million nuclear work package for two submarines; technical direction of the R&D program for a DOE program offices; and the direction of the design and construction of two major safety upgrades at DOE nuclear facilities.

He has led or participated in technical reviews on nuclear fuel cycle technologies for DOE and commercial nuclear clients, across the U.S.

Chronological Work History

Vanderbilt University, Professor of the Practice of Nuclear Environmental Engineering, Department of Civil & Environmental Engineering (Present)

Dr. Krahn teaches and performs research in the field of nuclear environmental engineering. He leads research in the technologies associated with the materials processing and risk assessment associated with the nuclear fuel cycle. Over the past three years he has organized and/or chaired nine sessions at national and international technical meetings on the Thorium Fuel Cycle and published 14 peer-reviewed journal articles and symposia papers on the subject. He actively participates in the Consortium for Risk Evaluation and Stakeholder Participation (CRESP), an engineering research center within Vanderbilt that works to advance cost-effective cleanup of the nation's nuclear weapons production waste sites and R&D facilities. In addition, Dr. Krahn provides nuclear engineering and nuclear safety consulting to the nuclear industry.

United States (U. S.) Department of Energy, Deputy Assistant Secretary for Safety & Security, Office of Environmental Management (June 2009 – November 2010)

Dr. Krahn led the Safety and Security Program for DOE's Office of Environmental Management (EM), the largest nuclear program in the U.S.; as such, he was the primary technical, safety and regulatory interface for this $9B/year program on matters associated with nuclear/worker safety, occupational health, quality assurance, and security matters. The overall mission of the Safety and Security Program is to manage EM-wide safety management system implementation and associated oversight activities; manage the interface with DOE's nuclear safety regulator, the Defense Nuclear Facilities Safety Board (DNFSB, see also below); direct EM's operational safety and security programs in the Field, lead the headquarters implementation of nuclear (regulator-mandated) and non-nuclear quality assurance programs; and direct EM line management assessments of Field performance in the aforementioned areas. His responsibilities included serving as the focal point for providing day-to-day technical, operational safety, health and quality assurance oversight, feedback, interface, and assistance to the EM field offices. He was selected by the Under Secretary as a member of the Department's Risk Assessment Working Group, a top-level, technical advisory panel setup to oversee DOE's implementation of DNFSB Recommendation 2009-1, *Quantitative Risk Assessment*. Further, Dr. Krahn chaired the EM Technical Authority Board (TAB); the TAB was the top-level, line management panel for evaluating technical issues of fundamental importance to the EM program—as TAB Chairman, Dr. Krahn reported directly to the Assistant Secretary and often briefed the Under Secretary and Deputy Secretary on technical issues. Dr. Krahn also served as the Deputy Chair of the DOE Nuclear Safety Research and Development Committee, which provides overall direction to safety-related research performed by the Department's contractors, national laboratories and academia.

U. S. Department of Energy, Director, Office of Waste Processing Engineering and Technology (August 2007 – June 2009)

Dr. Krahn directed the Office of Waste Processing, whose mission was to target engineering and technology investments to identify, advance, develop, and implement engineering concepts, technologies, and practices that improved the performance of DOE cleanup projects over their entire life cycle from planning to disposal; and also to provide the highest level of interdisciplinary engineering consultation, guidance, expertise, and continuity in the organization. The office, led by Dr. Krahn, worked to reduce total cleanup costs by promoting cross-site integration and standardizing best technical practices, solutions, and processes. He recruited and maintained a cadre of subject matter experts that worked to reduce planning, design, construction, maintenance and operation costs; provide transition to state-of-the-art, beneficial research and technology development and deployment, and to leverage lessons learned and feedback. Dr. Krahn acted as the primary technical interface with EM's national laboratory, the Savannah River National Laboratory, providing technical and programmatic direction, evaluation of planning and review of laboratory-directed research and development. During his tenure, he performed technical/engineering reviews of a broad spectrum of facilities, including: the Waste Treatment Plant at Hanford, the Salt Waste Processing Facility at Savannah River, the Plutonium Preparation/Pit Disassembly and Conversion Facility "Combo" Project at Savannah River, the Sludge Treatment System at Hanford, and the U-233 processing at Oak Ridge, among others. His technical leadership was recognized by the Department with a Special Act Award in July 2008 for developing and implementing a Technology Readiness Assessment process that implemented industry best practices into the EM technology development program.

Perot Systems Government Services (PSGS), Chief Scientist, also Senior Vice President and Senior Consultant (April 2000 – August 2007)

Dr. Krahn directed and provided management and technical consulting services to DOE and National Aeronautics and Space Administration (NASA) market clients in the areas of nuclear and worker safety and quality engineering, risk management, project management, performance measurement and other technical management issues. He has provided management systems re-engineering consulting to DOE's Y-12 National Security Complex in Oak Ridge, TN; technical work management and nuclear safety advice to the Nuclear Materials Technology Division at the Los Alamos National Laboratory; safety management system re-engineering and risk management consulting for NASA's Office of Safety & Mission Assurance after the loss of the space shuttle *Columbia*; nuclear/worker safety, quality assurance and technical consulting support to the High-Level Waste (HLW) Tank Farms on DOE's Hanford Reservation; nuclear reactor safety and systems engineering support to one of the teams competing to design the next generation of space nuclear reactors for NASA; engineering and nuclear safety management consulting to a nuclear fuel fabrication plant, regulated by the U. S. Nuclear Regulatory Commission; and engineering, nuclear safety and quality assurance consulting to the Gaseous Diffusion Plant Decontamination & Decommissioning (D&D) Project in Oak Ridge, TN.

During the above engagements, he played pivotal roles in several major technical evaluations. These included the independent regulatory investigation of a major fire in a plutonium fabrication facility at DOE's Rocky Flats Environmental Technology Site in 2005. Dr. Krahn also had leadership roles in the startup assessments (known as Operational Readiness Reviews, ORRs) for the Spent Nuclear Fuel Project and Hanford, D&D of the K-29 Gaseous Diffusion Plant D&D and the start- up of a major nuclear test reactor at DOE's Sandia National Laboratory.

During the above time period, in addition to the consulting services discussed above, Dr. Krahn chaired the Senior Safety Review Board (SSRB), providing independent technical, nuclear safety

and quality assurance oversight for the HLW Tank Farms at the Hanford Site from 2001 - 2006; he also chaired the independent nuclear Criticality Safety Committee (CSC) advising BNFL Inc at Oak Ridge from December 2002 to June 2005; finally, he was named to chaired the Independent Review Board (an regulator-mandated independent review committee) for the Metropolis Technical Works, an NRC-regulated fuel fabrication facility from 2005 to 2007.

Also over the time period covered above, Dr. Krahn provided leadership and management to a division which grew to comprise 100 personnel in offices across the country. He had marketing, execution and profit and loss responsibility for annual revenues of approximately $25M.

PricewaterhouseCoopers LLP (PwC), Principal Consultant (September 1998 to March 2000)

During his work with PwC, Dr. Krahn provided engineering, nuclear safety and quality assurance consulting services and project management support to DOE Management & Operating contractors (similar to those described above). During this time period his clients included the contractors for the Mound Environmental Management Project in Miamisburg, OH; Hanford HLW Tank Farms; and Rocky Flats Environmental Technology Site. In addition, he provided process re-engineering consulting to a national intelligence agency involved in revamping the manner in which it provided communications services to its clients world-wide. He led a team of 10 -15 professionals and was responsible for annual revenue of about $3M.

U. S. Defense Nuclear Facilities Safety Board (DNFSB) Deputy Technical Director & Chief Operating Officer (March 1997 to September 1998)

Dr. Krahn led the development of the first-ever strategic plan for the DNFSB—an independent regulatory agency in the Executive Office of the President with responsibility for nuclear safety oversight of the U. S. Nuclear Weapons Complex and associated environmental restoration. This involved interpreting guidance from the President's Office of Management and Budget (OMB), which seemed to change daily, at times; mapping the work of the DNFSB into coherent strategic areas that clearly matched the mission statement for the agency; close coordination of this effort with five Presidential appointees; and defending the plan in front of OMB and congressional staff. The resultant strategic plan was praised by OMB as "the best in the Energy and Defense sector" and was provided to other agencies as an exemplar. He subsequently led the updating of the plan, focusing the strategy into detailed, measurable action plans.

Also during this time period, Dr. Krahn led the regulatory review of DOE's storage of a highly hazardous isotope of uranium (U-233). This review determined that the DOE approach to maintenance and storage of this material was not consistent with the unique hazards it presented and associated nuclear safety requirements. Through a cooperative systems planning effort with DOE and its contractors, a revised approach was developed which provided an integrated approach to: assessing the risks present at various storage sites, evaluating the stability of various chemical and physical configurations of U-233, systematically reviewing the potential uses for the isotope, and providing an engineered set of solutions based on the overall risk presented by the material, its potential utility, its storage configuration—bringing all of these into conformance with nuclear safety expectations. During this time period Dr. Krahn also led several high-priority reviews of weapons-related issues.

DNFSB, Assistant Technical Director for Weapons Programs (October 1992 to March 1997); also Assistant Technical Director for Operational Safety ("dual hatted," January 1995 -March 1997)

Dr. Krahn led a team that identified fundamental problems with DOE's process for certifying that facilities were ready for operation—know as Operational Readiness Reviews (ORRs). Working closely with two Presidential Appointees, he developed detailed regulatory recommendations that provided a comprehensive approach to address the problem. Subsequently, Dr. Krahn worked closely with DOE for three years to implement a standards-based program to put in place a consistent, technically defensible process. This set of recommendations and corrective actions are generally considered one of the most important joint efforts of the DNFSB and the DOE. He also worked closely with a Presidential Appointee in drafting regulatory recommendations designed to revolutionize the manner in which DOE dealt with nuclear/worker safety regulatory and management issues; the recommendations came to be known as the Integrated Safety Management program (ISM); ISM is now the official policy of the DOE—it ensures that all safety functional areas: nuclear, occupational, chemical, etc., are taken into account in the planning for hazardous work. Further, ISM provides means for risk-informed grading of the level of safety precautions required for various activities, based on the hazards that they present. Numerous DOE officials have testified to the fact that the ISM method has significantly improved safety planning efforts and made work execution more efficient. It has led to DOE having accident and injury rates which average 75% less than comparable private industries.

Dr. Krahn was the lead DNFSB staff member for the implementation of major revisions to DOE'S standards and regulations for assuring the safety of operations involving nuclear explosives. As such, he worked with senior DOE officials over the space of three years to put in place improvements in the safety management system used for assembling, disassembling and testing nuclear explosive devices—these changes, for the first time, brought modern risk management tools, such as risk-informed methods, formality of operations and rigorous hazards assessment into use in the DOE nuclear weapons complex.

He also led a technical review team that identified significantly degraded conditions in the storage of large (up to 14-ton) cylinders containing depleted uranium hexaflouride (which is both radioactive and toxic). The cylinder situation was particularly problematic as there were more than 60,000 such cylinders being stored by the DOE at three different sites. The substandard storage conditions had resulted in a number of the cylinders breaching—with the attendant environmental damage and health risk. Working closely with senior officials of the DOE and its contractors, a systematic approach was used to risk-order rank the cylinders for corrective action and properly tailor corrective actions to the condition of the cylinders.

Dr. Krahn led a team that unearthed nuclear criticality and operational formality issues at the Oak Ridge Y-12 Plant. He drafted a set of technical recommendations for DNFSB review and approval that provided and outline for substantial change in the way in which hazardous operations were controlled at the Y-12 Plant—the set of recommendations were endorsed by the DNFSB and issued in the space of three days (record turnaround). Dr. Krahn also worked closely with senior DOE and contractor officials to develop a corrective actions plan that was fully responsive to the recommended changes, while still supporting the high priority, national defense missions of the plant.

In 1997, Dr. Krahn was named the inaugural winner of the ***John W. Crawford Award*** for Technical Excellence at the DNFSB.

DNFSB, Rocky Flats Program Manager (May 1991 to September 1992)

Dr. Krahn also led the technical and nuclear safety review of operations to support restart of two plutonium processing facilities in support of high-priority missions. He also provided nuclear/worker safety and quality assurance regulatory oversight for the site. Working closely with the General Counsel, Dr. Krahn developed the process by which the Presidential Appointees "deliberate," that is, come to formal technical, action-forcing decisions—especially, those specifically required by the Board's enabling statute. This effort required substantial reorientation of the manner in which the Board normally did business; also, drafting and having the Board approve detailed procedures for technical and legal staff input.

Orion International Technologies, Inc., Support to DOE Office of New Production Reactors, Senior Principal Engineer and Program Manager (July 1990 to May 1991)

Dr. Krahn led the process-based reengineering of the research and development program to support the design and regulatory review of several new reactors for DOE's Office of New Production Reactors. He also acted as the chief of staff for DOE's Chief Engineer. Working closely with Argonne National Laboratory, Sandia National Laboratory, Oak Ridge National Laboratory, and the Pacific Northwest National Laboratory, he assessed the project needs for developmental items and developed a detailed schedule for implementation which would support the high national priority of the New Production Reactor mission. Elimination of unnecessary tasks and redirection of resources enhanced the delivery of a number of technologies and significantly reduced the overall cost of the program.

Integrated Systems Analysts, Inc. (ISA), Navy Maintenance Division, Division Manager, (September 1988 to July 1990)

Dr. Krahn led the reengineering and initial year of operations of the first commercial venture at a company that had formally been solely a defense contractor. This effort involved significant changes to the accounting structure, personnel practices and contracting procedures for this division (when compared to the rest of the firm). It also required the development of new marketing methods and billing practices. He turned this division around, prior to taking over it was described as "a hemorrhage on the firm," when Dr. Krahn left the job the division was profitable.

He also completely revamped the work process flow, inventory management and billing procedures for the firm's computer maintenance depot. He improved product turnaround time by approximately 50 percent; reduced turnaround time for part orders and significantly improved relationships with part vendors; and finally, Dr. Krahn's efforts reduced the average age of accounts receivable by half, while identifying customers with consistent payment problems.

All of the above was completed in parallel with continuing to provide substantial maintenance engineering and program management support to the Navy's major technical command (see below).

Integrated Systems Analysts, Inc. (ISA), Naval Sea Systems Command Maintenance Improvement Program, Program Manager (November 1987 to July 1990)

Dr. Krahn directed the contract support for development of reliability-centered maintenance (RCM) for surface ships in the U.S. Navy. This new process, adapted from best practices in the commercial airline industry, was used to revolutionize the scheduling and performance of maintenance. By clearly tying maintenance tasks to system reliability, as opposed to the uptime of individual components, substantial savings were realized—by reducing the frequency and length of industrial availabilities and then by restructuring maintenance for high cost systems.

U.S. Navy, Various Assignments, Commissioned Naval Officer, December 1978 to November 1987

In Industrial Project Management, Dr. Krahn was a senior project manager for more than four years at a major Navy industrial facility (shipyard). He directed both nuclear and non-nuclear production efforts. This involved planning and scheduling of up to $140 million worth of work; determining testing requirements and coordinating the test program which provided the quality assurance needed for the production work; ensuring nuclear/worker safety and quality assurance for these projects; and managing a workforce that peaked at 650 people. He was awarded the Navy Achievement Medal for meritorious performance during this tour.

As Assistant Engineer on a fleet ballistic missile submarine, Dr. Krahn was responsible for the maintenance of all propulsion, auxiliary and weapons systems and for administering the training and qualification program for a department of eight officers and 80 enlisted personnel.

Previously, Dr. Krahn was selected by Admiral Rickover for duty on his staff as a Nuclear Engineer; in this assignment, he reviewed and approved all modifications and design changes to the reactor plant fluid systems and radiation shielding aboard three classes of submarines and two land-based prototypes. Dr. Krahn also approved all changes to operating and maintenance procedures. He was one of the youngest engineers ever granted "signature authority" by Admiral Rickover.

Publications

Journal Articles and Peer-Reviewed Manuscripts

1. "Comparative Assessment of Thorium Fuel Cycle Radiotoxicity," A. Croff and S. Krahn, accepted for publication in *Journal of Nuclear Technology*, July 2015

2. "Radiological Impacts and Regulation of Rare Earth Elements in Non-Nuclear Energy Production," T. Ault., S. Krahn, and A. Croff, *Energies*, Volume 8, pp 2066-2081 (March 2015)

3. "Assessment of the Potential of By-Product Recovery of Thorium to Satisfy Demands of a Future Thorium Fuel Cycle", T. Ault, S. Krahn, A. Croff, *Journal of Nuclear Technology,* Volume 189, Number 2, pp 152-162 (February 2015)

4. "Estimating Worker collective Doses from a Revised Approach to Managing Commercial Nuclear Fuel," B. Burkhardt, S. Krahn, A. Croff, A. Sowder, *Radwaste Solutions*, Volume 22, No. 1, pp (January/June 2015)

5. "Front End of the Thorium Fuel Cycle: Availability and Recovery," S.Krahn, T. Ault, R. Wymer, A. Croff, in *Introduction of Thorium in the Nuclear Fuel Cycle: Short- to Long-Term Considerations*, NEA/OECD Report No. 7224, pp 33-36, 2015

6. "Thorium Recovery," T. Ault, S. Krahn, A. Croff, R. Wymer, in *Introduction of Thorium in the Nuclear Fuel Cycle: Short- to Long-Term Considerations*, NEA/OECD Report No. 7224, pp 113-122, 2015

7. "Evaluating the Radiological Risk to Workers from the U.S. Once-Through Nuclear Fuel Cycle," S. Krahn, A. Croff, B. Smith, J. Clarke, A. Sowder, A. Machiels, *Journal of Nuclear*

Technology, Volume 185, Number 2, pp 192-207 (February 2014)

8. "System of Systems Engineering—Past Emerging to Evolving?", invited article and special edition editor, *Int. J. System of Systems Engineering*, Vol. 3, Nos. 1&2, 2012, pp 1-2
9. "A Preliminary Assessment of the Influence of Certain Variables on the Implementation of Recommendations from Scientific-Technical Advisory Committees," S. Krahn, dissertation, University of Southern California, 2001
10. "The Demanding Customer and the Hollow Organization: Meeting Today's Contract Management Challenge," J. Crawford and S. Krahn, *Public Productivity and Management Review*, September 1998.
11. "The Naval Nuclear Propulsion Program: A Brief Case Study of Institutional Constancy," J. Crawford and S. Krahn, *Public Administration Review*, March/April 1998.

Conference Papers (with corresponding presentations):

1. "Comparison of Radioactive Waste Volumes from Single Used Nuclear Fuel Recycling and the Once-Through Nuclear Fuel Cycle," B. Smith, S. Krahn, A. Croff, K. Brown, J. Clarke, A. Machiels, A. Sowder, presented at the *International High-Level Radioactive Waste Management Conference*, Charleston, SC, April 12-16, 2015.
2. "Developing and Testing of a Decision Framework for Informing Fuel Cycle Preferences," S. Krahn, A. Gardiner, T. Ault, A. Croff, B. Smith, J. Clarke, A. Machiels, A. Sowder, presented at the *International High-Level Radioactive Waste Management Conference*, Charleston, SC, April 12-16, 2015.
3. "The Context, Structure, and Objectives of the Thorium Fuel Cycle Technical Track," S. Krahn, A. Worrall, A. Croff, B. Smith, presented at the *ANS Winter Meeting 2014*, Anaheim, California, USA. November 9-13, 2014.
4. "Environmental Impacts of Thorium Recovery from Titanium Mining in North America," T. Ault, S. Krahn, A. Croff, R. Wymer, presented at the *ANS Winter Meeting 2014*, Anaheim, California, USA. November 9-13, 2014.
5. "Thorium Recovery from Rare Earth Element Deposits in the U.S.," B. Van Gosen (USGS), S. Krahn, T. Ault, presented at the *ANS Winter Meeting 2014*, Anaheim, California, USA. November 9-13, 2014.
6. "Supporting a Thorium-Fueled Reactor Fleet in the U.S. with Domestic By-Product Thorium," T. Ault, S. Krahn, A. Croff, R. Wymer, presented at the *ANS Winter Meeting 2014*, Anaheim, California, USA. November 9-13, 2014.
7. "Differences in Thorium and Uranium Fuel Reprocessing," R. Wymer, A. Croff, T. Ault, Bethany L. Smith, S. Krahn, presented at the *ANS Winter Meeting 2014*, Anaheim, California, USA. November 9-13, 2014.
8. "Comparative Assessment of Thorium Fuel Cycle Radiotoxicity," A. Croff, S. Krahn, presented at the *ANS Winter Meeting 2014*, Anaheim, California, USA. November 9-13, 2014.

9. "Why Reconsider a Molten Salt Reactor?," S. Krahn, C. W. Forsberg, B. Smith, T. Ault, presented at the *ANS Winter Meeting 2014*, Anaheim, California, USA. November 9-13, 2014.

10. "Estimating Worker Collective Doses from a Revised Approach to Managing Commercial Used Nuclear Fuel," B. Smith, S. Krahn, A. Croff, A. Sowder, presented at the *ANS Winter Meeting 2014*, Anaheim, California, USA. November 9-13, 2014.

11. "An Update on the Attributes and Status of Thorium Fuel Cycles", S. Krahn, A. Croff, T. Ault, Conference Paper, presented at the *19th Pacific Basin Nuclear Conference CNS Conference*, Vancouver, Canada August 24-28, 2014.

12. "Use of Technology Readiness Levels to Facilitate Nuclear Fuel Cycle Research, Development, and Deployment", S. Krahn, A. Croff, T. Ault, presented at the *19th Pacific Basin Nuclear Conference CNS Conference*, Vancouver, Canada, August 24-28, 2014.

13. "An Overview of EPRI's Decision Analysis Tool and the Analytical Hierarchy Process", T. Ault, A. Gardiner, S. Krahn, B. Smith, A. Croff, A. Sowder, presented at *The 3rd Annual EPRI Workshop*, Nashville, TN, USA. 22-23 July 2014.

14. "A Review of the Information Pertaining to the Upcoming Three-Alternative Evaluation", A. Gardiner, T. Ault, S. Krahn, B. Smith, A. Croff, A. Sowder, presented at *The 3rd Annual EPRI Workshop*, Nashville, TN, USA. 22-23 July 2014.

15. "A Review of the Results from the July 22, 2014 Strategic Evaluation of Fuel Cycle Alternatives", S. Krahn, A. Gardiner, T. Ault, B. Smith, A. Croff, A. Sowder presented at *The 3rd Annual 3rd Annual EPRI Workshop*, Nashville, TN, USA. 22-23 July 2014.

16. "Evaluating the Collective Radiation Dose to Workers from the U.S. Once-Through Nuclear Fuel Cycle", S. Krahn, A. Croff, B. Smith, J. Clarke, A. Sowder, A. Machiels, invited presentation, *Health Physics Society Annual Meeting*, Baltimore, MD, USA. 13-17 July 2014.

17. "A Decision Analysis Tool to Support Planning and Decision-Making for Sustainable, Deployment-Oriented Research, Development and Demonstration (RD&D) of Advanced Nuclear Energy Technologies", S. Krahn, T. Ault, A. Gardiner, A. Croff, J. Clarke, A. Machiels, A. Sowder, presented at *International Congress on Advances in Nuclear Power Plants (ICAPP)*, Charlotte, NC, USA April 6-9, 2014.

18. "Highlights and Summary Observations from the Global 2013 Thorium Fuel Cycle Track", S. Krahn, A. Croff, T. Ault, F. Franceschini, presented at *International Congress on Advances in Nuclear Power Plants (ICAPP)*, Charlotte, USA April 6-9, 2014.

19. "Nuclear Fuel Cycle Technology Readiness Metrics Level Determination: The Results of a Focused Expert Review", S. Krahn, A. Sowder, A. Machiels, R. Jubin, A. Croff, T. Ault, presented at *International Congress on Advances in Nuclear Power Plants (ICAPP)*, Charlotte, USA April 6-9, 2014.

20. "Safety Culture Lessons Learned from the U.S. Chemical Safety Board Incident Investigations," L. Fyffe, J. Hutton, J. Goeckner, S. Krahn, *2014 Proceedings of the Waste Management Symposium*, 2014.

21. "The Environmental, Health and Safety Risks of the Transition from the Present U.S. Once-Through to a Modified Open Nuclear Fuel Cycle," B. Smith, S. Krahn, J. Clarke, K. Brown, A. Machiels, A. Sowder, presented at *International Congress on Advances in Nuclear Power Plants (ICAPP)*, Charlotte, USA April 6-9, 2014.

22. "Adapting Technology Readiness Assessment to Evaluation of Nuclear Fuel Cycles," S. Krahn, A. Sowder, A. Machiels, R. Jubin, A. Croff, T. Ault, presented at the *2014 International Congress on the Advances in Nuclear Power Plants (ICAPP 2014)*, Charlotte, NC, April 6 – 9, 2014

23. "Development of a Department of Energy Standard for Probabilistic Risk Assessments at Nuclear Facilities," with J. O'Brien, G. Smith, R. Sastry, K. Fleming, presented at the *ANS Winter Meeting*, Washington, DC, November 10 – 14, 2013

24. "Development of a Dimensionless Number to Assess Risk for LLW Disposal Facilities," J. Rustick, D. Kosson, S. Krahn, M. Ryan, J. Clarke, presented at *Waste Management 2014*, Phoenix, AZ, March 2 – 6, 2014

25. "Why Reconsider the Thorium Fuel Cycle?", with R. Wymer, A. Croff and T. Ault, presented at the *GLOBAL 2013 International Fuel Cycle Conference*, September 29- October 3, 2013, Salt Lake City, UT

26. "Potential Synergy: The Thorium Fuel Cycle and Rare Earths Processing," with T. Ault, R. Wymer, and A. Croff, presented at the *GLOBAL 2013 International Fuel Cycle Conference*, September 29- October 3, 2013, Salt Lake City, UT

27. "Developing Operational Safety Performance Measures For Nuclear Chemical Facilities," with L. Fyffe, J. Hutton, J. Clarke (2013), *Trans. of the American Nuclear Society, 14th International High Level Radioactive Waste Conference*, pgs. 311-315.

28. "An Expert, Top-Level Risk Assessment for Deployment of Future Fuel Cycles," with Vienna, J., Croff, A., Sowder, A. and Machiels, A., presented at the *International High-Level Radioactive Waste Management Conference*, Albuquerque, NM, April 28 – May 2, 2013

29. "Modeling the Environment, Health and Safety Risk of the Present U.S. Nuclear Fuel Cycle," presented at the *International High-Level Radioactive Waste Management Conference*, Albuquerque, NM, April 28 – May 2, 2013

30. "A Role for Nuclear Energy in a Balanced U.S. Energy Portfolio," invited paper, *Inaugural Southeastern Conference Academic Conference*, Atlanta, GA February 10-13, 2013

31. "Risk Management" Chapter 4, *Summary of 2102 EPRI Nuclear Fuel Cycle Assessment Workshop, Program on Technical Innovation*, EPRI December 2012

32. "Assessment of Radiological and Chemical Risks of the Once-Through U-235 Fuel Cycle," B. Smith, J. Clarke, S. Krahn, A. Machiels, A. Sowder, presented at the *2012 Winter Meeting of the American Nuclear Society (ANS)*, San Diego, CA, November 11 – 15, 2012

33. "New Developments in the Technology Readiness Assessment Process in DOE," S. Krahn, H. Sutter, H. Johnson, presented at *Waste Management 2013*, Phoenix, AZ, February 2013

34. "U.S. Chemical Safety Board Reports and Relevant Guidance for Nuclear Chemical Facilities," L. Fyffe, J. Hutton, J. Clarke, S. Krahn, presented at the *2012 Winter Meeting of the American Nuclear Society (ANS)*, San Diego, CA, November 11 – 15, 2012

35. "Building Confidence in LLW Performance Assessment Through Risk Evaluation Analysis," J. Rustic, S. Krahn, J. Clarke, *Trans. of the Amer. Nuc. Soc.*, Vol. 106, p 67

36. "A Comprehensive Radiological and Chemical Risk Assessment of the Open Nuclear Fuel Cycle," with B. Smith and J. Clarke, *Trans. of the Amer. Nuc. Soc.*, Vol. 106, p 147 – 148 (June 2012)

37. "Report on a DOE Nuclear Separations Workshop and the Path Forward," with A. Griffith, *Trans. of the Amer. Nuc. Soc.*, Vol. 106, p 215 – 216 (June 2012)

38. "The Continued Evolution of a Revolutionary Curriculum in Nuclear Environmental Engineering," with J. Clarke and D. Kosson (both Vanderbilt), *Trans. of the Amer. Nuc. Soc.*, Vol. 106, p 125 – 127 (June 2012)

39. "Update on the DOE Nuclear Separations Technology Roadmap," presentation delivered at the 36th Annual Actinide Separations Conference, Chattanooga, TN, May 2012

40. "A Systems Approach to Teaching Radioactive Waste Management," with Kosson, D. and Clarke, J., *Trans. of the Amer. Nuc. Soc.*, Vol. 105, p 177 – 178 (November 2011)

41. "A Revolutionary Master's Degree Program in Nuclear Environmental Engineering," *Trans. of the Amer. Nuc. Soc.*, Vol. 105, p 127 (November 2011)

42. "Executing the Will of Pharaoh: The Roots of Performance Measurement in Ancient Egypt," *The Ostracon*, Volume 20, Fall 2009

43. "DOE Technology Readiness Assessment – Process Guide and Training Plan," presented to the *2008 Technology Maturity Conference*, Virginia Beach, VA, September 9-12, 2008

44. "Technology Readiness Assessment of DOE Nuclear Waste Processing Facilities: Lessons Learned, Next Steps," D. Alexander, K. Gerdes, L. Holton, S. Krahn, H. Sutter, presented at *Waste Management 2008*, Phoenix, AZ, February 2008

45. "The Role of Feedback & Improvement in the Risk Management Process," presentation to the *2005 American Institute of Aeronautics and Astronautics (AIAA) Space Operations Workshop*, May 2005

46. "Safety Management Lessons, Theory and Practice, from the Columbia Accident Investigation Board," presentation to the *Second Annual NASA Program Management Conference*, March 2005

47. "Formality of Operations: A Neglected Parameter in the Nuclear Criticality Equation," with Andrews, W., *Proceedings of the 5th International Conference on Nuclear Criticality Safety*, Albuquerque, NM, September 19, 1995.

48. "The Loss of USS Thresher (SSN593): Lessons for the Development, Implementation, and Use of Standards," Keynote Address at the *3rd DOE Standards Conference*, Washington, DC, November 1993.

Technical Reports:

1. "Program on Technology Innovation: A Comparative Study of the Potential Radiological Risks and Waste Management Impacts of Transitioning to a Modified-Open Fuel Cycle from the Present U.S. Once-Through Fuel Cycle," Electric Power Research Institute (EPRI), Palo Alto, CA. (Winter 2014).

2. "Program on Technology Innovation: Summary of 2014 EPRI Nuclear Fuel Cycle Assessment Workshop (Day 1: Demonstration of the Decision Analysis Tool) - Vanderbilt University, Nashville, Tennessee, July 22 – 23, 2014," Electric Power Research Institute (EPRI) Palo Alto, CA. (Winter 2014).

3. "Program on Technology Innovation: Summary of 2014 EPRI Nuclear Fuel Cycle Assessment Workshop (Day 2: Panel on Challenges in Molten Salt Reactor Development) - Vanderbilt University, Nashville, Tennessee, July 22 – 23, 2014," Electric Power Research Institute (EPRI) Palo Alto, CA. (In Press for Winter 2014).

4. "Program on Technology Innovation: A Quantitative Radiological Risk Analysis of the Once-Through Nuclear Fuel Cycle: Development of a Conceptual Model," Electric Power Research Institute (EPRI) Palo Alto, CA. 3002000807, 2013.

5. "Program on Technology Innovation: Summary of 2013 EPRI Nuclear Fuel Cycle Assessment Workshop - Vanderbilt University, Nashville, Tennessee, July 23 – 24, 2013," Electric Power Research Institute (EPRI) Palo Alto, CA. 3002000364 Co-Principal Investigator with J. Clarke, 2013.

6. "Program on Technology Innovation: Summary of 2012 EPRI Nuclear Fuel Cycle Assessment Workshop Vanderbilt University, Nashville, Tennessee, "Electric Power Research Institute (EPRI) Palo Alto, CA. 1026556. Co-Principal Investigator with J. Clarke, 2012.

7. Comparative Radiological Risk Assessment of Advanced Nuclear Fuel Cycles: Development of a Conceptual Model, Co-Principal Investigator with J. Clarke, Electric Power Research Institute (EPRI), Program on Technical Innovation, 1025207, April 2012.

8. Independent Technical Review of the Calcine Disposition Project, Krahn, S., Gokhale, S. and Matthews, R., CRESP Technical Report, August 2011.

9. External Technical Review of Systems Planning for Low-Activity Waste Treatment at Hanford, Krahn, S., Kosson, D., Gallay, D., Pegg, I., Wymer, R., USDOE Office of Environmental Management, November 2008.

10. External Technical Review of the Plutonium Preparation Project at the Savannah River Site, Krahn, S., Kosson, D., Gallay, D., Mathews, R., Nulton, D., Okafor, K., USDOE Office of Environmental Management,October 2008.

11. Report to Congress Regarding Technology Development and Deployment Activities, USDOE Office of Environmental Management, July 2008.

12. Technology Readiness Assessment (TRA)/Technology Maturation Plan (TMP) Process Guide, USDOE Office of Environmental Management, March 2008.

13. "Report on an Investigation into the Circumstances Surrounding the Fire In Glovebox 8, Building 371 At the Rocky Flats Environmental Technology Site, Krahn, S., Lowe, D. Trujillo, S., and Spears, M., USDOE Office of Environmental Management, June 2005

14. “Operational Formality for the Department of Energy Facilities and Activities,” Krahn, S. and Moury, M., DNFSB Technical Paper # 15, March 1997.

15. Uranium-233 Storage Safety at Department of Energy Facilities, Krahn, S., Andrews, S., Hunt, T. and Sautman, M., DNFSB Technical Paper #13, February 1997.

16. "The Naval Reactors Program: A Potential Model for Improved Personnel Management in the Department of Energy," Appendix B in The DOE Technical Personnel Problem, DNFSB Technical Paper #l0, March 1996.

17. “Integrity of Uranium Hexafluoride Cylinders, DNFSB Technical Paper #4,” Krahn, S., Miller, C., Grover, D., Martin, C., Tontodonato, R. and Yeniscavich, W., May 1995.

Selected Honors & Awards

Elected to the Executive Committee of the Fuel Cycle and Waste Management Division of the American Nuclear Society (2015)

Selected to the American Academy of Environmental Engineers & Scientists (2013)

Career Distinguished Service Award, U. S. Department of Energy (2010)

Meritorious Service Medal, U. S. Navy (2000)

Meritorious Service Award, U. S. Defense Nuclear Facilities Safety Board (1998)

John W. Crawford Award for Outstanding Technical Staff Performance, Inaugural Recipient, U. S. Defense Nuclear Facilities Safety Board (1996)

Navy Commendation Medal, U. S. Navy (1996)

Selected to Senior Executive Service (1993)