

Reset of U.S. Nuclear Waste Management Strategy and Policy Series

Meeting 4: Integration of Storage, Transportation and Disposal of Commercial Spent Nuclear Fuel

May 17-18, 2016

George Washington University
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Prospectus

Spent nuclear fuel must be managed from the time it is removed from the reactor to its eventual reprocessing or permanent disposal in a geologic repository. The present management strategy for commercial spent fuel in the United States is not what was originally envisioned, even as recently as a decade ago.

The inventory of commercial spent nuclear fuel in the U.S. is growing at a rate of ~2,000 metric tons per year, and is projected to be ~140,000 metric tons by mid-century, which is the earliest time that current Administration policy projects the availability of a permanent geologic repository. Without options for off-site storage or disposal and with no prospects for reprocessing, utilities have expanded their capacity to store the growing spent fuel inventory at existing reactor sites, choosing without exception to rely on large dry-storage casks. These casks are characterized as “dual purpose” systems, in that the sealed canisters are designed for both extended on-site storage and, with appropriate over-packs, subsequent transportation. The dual-purpose canisters are not, however, designed for disposal, and they are significantly larger than the disposal canisters planned for all repository concepts currently proposed world-wide.

1) Current Practice and Technical, Operational, and Institutional Concerns

The current practice of loading commercial spent fuel into dry storage systems carries with it an unavoidable commitment to one of three future alternatives:

- a) all spent fuel placed in large dual-purpose canisters will eventually need to be repackaged into purpose-built casks for disposal,*
- b) the nation will need to construct one or more repositories that can directly accommodate large dual-purpose canisters for disposal, or*
- c) spent fuel will remain indefinitely at interim storage facilities and be repackaged as needed, perhaps every century.*

Suboptimal alternatives will lead to increased uncertainties.

All of these options are technically feasible, but none are what was originally planned, and all introduce major new uncertainties regarding the design and operation of future storage and disposal facilities. These uncertainties will impact already large and uncertain future costs: for example, as part of its 2013 assessment of the adequacy of the Nuclear Waste Fee to meet total disposal costs, the DOE estimated a range for \$24 billion to \$81 billion (2012 dollars) for future repository costs, not including costs associated with repackaging spent fuel.

Industry continues to load larger and heavier canisters, which pose logistical challenges.

The dual purpose storage canisters themselves are large: up to 2 meters in diameter and 5 meters in length, and the largest currently in use accommodate up to 37 intact fuel assemblies from pressurized water reactors, which account for about two thirds of the U.S. reactor fleet. A loaded canister may weigh on the order of 70 metric tons, and transportation shielding may increase the weight to 150 metric tons. Because it is economically advantageous for nuclear power plants to load larger canisters, the canister size exceeds sizes and weights that may be optimal for transportation and subsequent disposal. Engineering solutions for hoist, ramp, and transporter operations appear to be feasible, but need to be accounted for in planning.

Although dual purpose canisters are certified by the Nuclear Regulatory Commission for both storage and subsequent transportation, the certificates of compliance set different temperature limits for storage versus transportation. This results in a situation where some canisters may need to cool before they can be transported. This delay may be on the order of decades for some canister designs, and in particular for higher-burnup fuels that generate more heat.

Larger canisters will be hotter for longer and therefore may require a longer time to cool before transportation and subsequent disposal.

With respect to disposal, different geologies impose different temperature constraints on the underground environment. For example, some repository designs have assumed that the maximum temperature in clay backfill must remain below 100°C, while salt may accommodate temperatures up to 200 to 250°C. High thermal loads may be accommodated by cooling canisters above ground for many years, ventilating the repository for many years after waste emplacement, or increasing the spacing between canisters. These choices will affect repository costs.

Consolidated Interim Storage is an option.

Constructing consolidated interim storage facilities has the potential to alleviate storage concerns at reactor sites and may provide a path to resolution of legal issues associated with federal responsibility for spent fuel management. Consolidated storage facilities could also be used to provide flexibility in repackaging options for ultimate disposal. Consolidated storage facilities will introduce additional cost and siting concerns, and technical issues associated with the mechanical effects of repeated transportation and storage will need to be addressed.

Legislative and regulatory issues must be addressed.

All options for the management and disposal of commercial spent nuclear fuel currently under consideration in the U.S. will require legislative and regulatory actions.

Questions to be addressed:

1. What might a better-integrated spent fuel management system for the United States look like?
2. What metrics (e.g., cost, safety, and security) should be used to judge the optimization of the spent fuel management system?
3. What are the barriers to achieving the integration of the spent fuel management system?
4. What are the potential benefits of an integrated spent fuel management system?
5. What actions could be taken now that would have an impact on future spent nuclear fuel management practice?
6. What are the implications of taking no action?

Agenda

Tuesday, May 17th

9:00 am **Welcome – Professor Allison Macfarlane**
Elliot School, George Washington University

Reset Initiative Background & Purpose – Professor Rod Ewing
Stanford University

9:30 am **Setting the Stage (*Moderator Peter Davies, Sandia National Laboratories*)**

- **Tito Bonano**, *Current Status of US Back End of the Nuclear Fuel Cycle*
Sandia National Laboratories
- **Tom Cotton**, *Policy Barriers to Integration*
Complex Systems Group

Short Break

- **Holger Volzke**, *Integration in Other Countries, Germany*
Bundesanstalt für Materialforschung (BAM), Federal Institute for Materials Research and Testing
- **Andrew Orrell**, *Integration in Other Countries, IAEA*
IAEA, Division of Radiation, Transport and Waste Safety

Morning Session Moderated Panel Discussion

12:30 pm **Lunch**

1:30 pm **Key Issues (*Moderator Saida Laârouchi Engström, SKB*)**

- **Tyler Owens**, *Congressional Perspectives on Back End Integration*
Senate Appropriations Subcommittee on Energy and Water Development
- **Rod McCullum**, *Previous Models for Spent Fuel Integration*
Nuclear Energy Institute
- **Sylvia Saltzstein**, *Current Studies of Storage/Transportation Technical Issues*
Sandia National Laboratories

Short Break

- **John Wagner**, *Storage and Canister Concepts for Integrated Spent Fuel Management*
Idaho National Laboratory
- **Allison Macfarlane**, *NRC Continued Storage Rule*
Elliot School, GWU

Afternoon Session Moderated Panel Discussion

4:30 pm **Day 1 Wrap Up – Peter Davies**

5:00 pm **Adjourn**

Wednesday, May 18th

9:00 am **Introduction – Mark Peters**
Idaho National Laboratories

9:15 am **Industry and Regulatory Perspectives (*Christophe Poinssot, French Atomic and Alternatives Energy Commission*)**

- **Adam Levin**, *Industry Path to Back End Integration*
Excelon Generation Company - Director, Spent Fuel and Decommissioning, Retired
- **Eric Howes**, *Stranded Fuel Management and Pathways for Disposition*
Maine Yankee, Director of Public and Government Affairs

Short Break

- **John Kessler**, *Industry Models for Back End Integration*
Electric Power Research Institute (EPRI), retired
- **James Rubenstone and Mark Lombard**, *NRC Perspectives on Integration Across Storage, Transportation and Disposal Regulations*
U.S. Nuclear Regulatory Commission

Morning Session Moderated Panel Discussion

12:30 pm **Lunch**

1:30 pm **Broader Perspectives (*Moderator Mark Peters, Idaho National Laboratories*)**

- **David Lochbaum**, *Technical Issues and Needed Actions for Integrated Spent Fuel Management*
Union of Concerned Scientists
- **Ted Quinn**, *SONGS Community Engagement Perspective*
SONGS Community Engagement Panel

Short Break

- **Bob Halstead**, *Role of Transportation in Integration*
Nevada Nuclear Projects Office
- **Allison Fisher**, *Public Perspectives on Spent Fuel Storage, Transportation and Disposal*
Public Citizen's Energy Project

Afternoon Session Moderator Panel Discussion

5:00 pm **Comments from Meeting Host – Allison Macfarlane**
5:30 pm **Adjourn**

Steering Committee*



Professor Sally M. Benson is a Professor of Energy Resources Engineering at Stanford University and the director of Stanford's Precourt Institute for Energy and the Global Climate and Energy Project (GCEP), a pioneering university-industry partnership to develop innovative, low-carbon energy supplies to meet global energy needs. Prior to coming to Stanford, Professor Benson was at Lawrence Berkeley National Laboratory, a U.S. Department of Energy National Laboratory.

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Professor Rod Ewing is a Professor in the Department of Geological Sciences at Stanford University and the Frank Stanton Professor in Nuclear Security at the Center for International Security and Cooperation. Professor Ewing's research focuses on the back-end of the nuclear fuel cycle, mainly nuclear materials and the geochemistry of radionuclides with application to permanent geologic disposal.

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Dr. Peter Davies is the Director of Sandia's Nuclear Energy and Fuel Cycle Programs and responsible for programs and capabilities that include nuclear engineering, nuclear safety and risk analysis, nuclear material transportation and storage, and repository science and engineering.

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* Steering Committee members represent their own views and expertise not the positions or policies of their organization or employer.



Ms. Saida Laârouchi Engström is the Vice President of Strategy and Programs at SKB. She has a background in chemical engineering and started her career in the Swedish Nuclear Inspectorate as a safety inspector of nuclear installations in Sweden. After 11 years, she joined SKB, first as a leader for feasibility studies to select a site for a final repository for spent fuel in Sweden. Under the site investigation project, Ms. Laârouchi Engström was in charge of the environmental assessment studies and licensing. Ms. Laârouchi Engström has been and still is in charge of the dialogue between SKB and all the stakeholders in Swedish society.

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Professor Bernd Grambow, Ecole des Mines de Nantes, holds the Chair on nuclear waste disposal and is head of the Subatech laboratory. Professor Grambow is the former director of the national CNRS-academic/industrial research network NEEDS (nuclear: environment, energy, waste, society). His areas of scientific expertise are radiochemistry, nuclear waste disposal science, geochemical modeling, radionuclide migration in the environment, chemical thermodynamics, and dynamics of solid/liquid interfaces.

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Dr. John Kessler was with the High-Level Waste and Spent Fuel Management Program at the Electric Power Research Institute (EPRI) from 1993 to June 2015. His experience includes the Yucca Mountain total system performance assessment using probabilistic methods, colloid-aided contaminant migration, LLW and spent fuel storage system design, waste solidification R&D, and aging management for used fuel storage systems. John led EPRI's effort to develop a probabilistic approach to understanding the overall impact of disposing of spent fuel in the candidate repository at Yucca Mountain. In June 2015 John formed his own consulting company with work in the general area of spent fuel and HLW management.

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Dr. Allison M. Macfarlane is Professor of Science and Technology Policy at George Washington University and Director of the Center for International Science and Technology Policy at the Elliott School of International Affairs. She recently served as Chairman of the U.S. Nuclear Regulatory Commission from July 2012 until December 2014. She was the agency's 15th Chairman, its 3rd woman chair, and the only person with a background in geology to serve on the Commission. Dr. Macfarlane holds a PhD in geology from the Massachusetts Institute of Technology and a BSc degree in geology from the University of Rochester. During her academic career, she held fellowships at Radcliffe College, MIT, Stanford, and Harvard Universities. From 2010 to 2012 she served on the Blue Ribbon Commission on America's Nuclear Future.

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Dr. Daniel Metlay is a senior federal employee with more than 40-years of experience in the field of radioactive waste management. Dr. Metlay taught in the Political Science Department of Indiana University, Bloomington, for six years before teaching political science and technology policy at the Massachusetts Institute of Technology. He worked as a Research Scientist at Brookhaven National Laboratory, investigating operational and organizational issues at nuclear power plants. Dr. Metlay served as a Task Force Director on the Secretary of Energy Advisory Board and has testified before Congress and state legislatures.

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Dr. Mark Peters is the Director of Idaho National Laboratory. Prior to INL, Dr. Peters was Argonne's Associate Laboratory Director for the lab's Energy and Global Security Directorate, which is responsible for Argonne's programs in energy research—including energy storage, renewable energy, energy efficiency and nuclear energy—and national security. Dr. Peters also serves as a senior advisor to the Department of Energy on nuclear energy technologies and research and development programs and nuclear waste policy.

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Professor Christophe Poinssot is the Head of the RadioChemistry and Processes Department at the Nuclear Energy Division, French Atomic and Alternatives Energy Commission (CEA), and professor of nuclear chemistry at the National Institute of Nuclear Science and Technology (INSTN). Prior to joining the department, he spent 15 years in the field of nuclear waste management. Professor Poinssot is strongly involved in international collaborations and is a member of several scientific committees for international conferences and research teams evaluation.

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Dr. Chris Whipple is a Principal at ENVIRON, and has 40 years of environmental engineering experience in the management of human health and environmental risk. Dr. Whipple has served on and chaired numerous national committees studying and advising on radioactive waste management, including committees of the National Academy of Sciences, USEPA and the National Council on Radiation Protection and Measurement. He currently serves as co-chair of the National Academy of Sciences (NAS) Report Review Committee.

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Speakers



Dr. Tito Bonano has 36 years of professional experience following completion of his Ph.D. in 1980. During that span, he has spent the last 33 years working on issues related to nuclear fuel cycle with an emphasis in risk assessment and decision analysis for nuclear waste management. He is currently senior manager of the Advanced Nuclear Energy Programs Group at Sandia National Laboratories (SNL), where his primary customer is the Department of Energy's Office of Nuclear Energy (DOE-NE). He has programmatic responsibility for the DOE-NE Programs at SNL, which include Safety Analysis for Space Launch Missions; Small Modular Reactors; Advanced Energy Conversion Systems; Fuel Cycle Systems Engineering and Analysis; Storage, Transportation, and Disposal of Nuclear Waste; and Advanced Modeling and Simulation. In his previous assignment, Dr. Bonano was part of the management team for SNL's Lead Laboratory in the Yucca Mountain Project. He was the Lead Lab licensing manager during the development of the YMP license application with responsibility for directing and managing the preparation of the post-closure component of the license application as well as serve in the project's licensing strategy team. Following the submission of the license application, he assumed the role of the Lead Lab's senior program manager. ejbonan@sandia.gov



Dr. Thomas Cotton has over 42 years of experience in Washington, D.C. analyzing technical and policy issues and supporting decisions by Congress and the Executive branch. Beginning in 1969 analyzing regional economic development issues with the Appalachian Regional Commission, he then spent 12 years with the Congressional Office of Technology Assessment (OTA) in energy related studies dealing with issues such as coastal effects of offshore energy systems, enhanced oil recovery, and Outer Continental Shelf oil development. He directed OTA's study on high-level radioactive waste management that supported Congressional deliberations about the Nuclear Waste Policy Act of 1982. As a consultant since 1987 he has supported the U.S. Department of Energy (DOE) offices dealing with high-level radioactive waste management and environmental management in strategic planning, systems analysis and design evaluations, legislative and regulatory analysis, decision analysis, strategic communication, relations with external technical and stakeholder groups, and other areas. He has supported the White House Office of Science and Technology Policy, Japan's nuclear waste management organization, and the Blue Ribbon Commission on America's Nuclear Future. He served on the National Academy of Sciences/National Research Council's Committees on DOE Office of Science and Technology Peer Review, Environmental Management Technologies, Declassification of Information for the DOE Environmental Remediation and Related Programs, and Remediation of Buried and Tank Waste, and as consultant to the Committee on the DOE Office of Science and Technology Prioritization and Decision Making. He served as vice-chairman of the Openness Advisory Panel of the Secretary of Energy Advisory Board. cotton@complexsg.com



Allison Fisher joined Public Citizen's Climate and Energy Program in March 2007. She currently serves as the program's Outreach Director. Allison earned her master's degree in social work-community organizing from the University of Connecticut. She received her B.A. in international studies from the University of North Carolina at Chapel Hill. Her undergraduate years were followed by two years in Guatemala as a Rural Youth at Risk Peace Corps volunteer. For nearly a decade, she has been engaging and organizing communities to challenge dirty energy sources at the local and state level; fighting to hold Big Polluters and the agencies that oversee them accountable; and working to implement commonsense safeguards and regulations to protect our workers, communities and environment. afisher@citizen.org



Robert (Bob) Halstead has been Executive Director of the State of Nevada Agency for Nuclear Projects since September 2011. He has 35 years of experience working on nuclear waste issues at the national, state, and local levels. He advised the State of Wisconsin and the National Governors Association on the Nuclear Waste Policy Act of 1982, the DOE Crystalline Repository Project, and the Nuclear Waste Policy Amendments Act of 1987. He has also advised the State of Texas on the Deaf Smith County repository site; the State of Tennessee on the Oak Ridge MRS facility; the Land and Water Fund of the Rockies (on behalf of Ohngo Gaudadeh Devia, Skull Valley Goshute Tribe) regarding the PFS facility in Utah; and the State of Minnesota on dry cask storage at the Prairie Island reactor site. He has authored or coauthored more than 40 publications on energy policy, transportation planning, and environmental impact assessment. bhalstead@nuc.state.nv.us



Eric Howes is the Director of public and Government Affairs for Maine Yankee Atomic Power Company located in Wiscasset, Maine. Mr. Howes has been with Maine Yankee since 1993 working in the areas of federal, state, media and community relations. He was instrumental in the formation of the Maine Yankee Community Advisory Panel which continues to be active 17 years after its inception in 1997. Mr. Howes was with Maine Yankee the last few years of plant operations, through plant decommissioning, and now for over 10 years of stand-alone Independent Spent Fuel Storage Installation operations. Prior to Maine Yankee Mr. Howes served seven years as a State Office Representative for United States Senator William S. Cohen. ehowes@3yankees.com



Adam H. Levin is a private consultant to the international commercial nuclear power industry and the Department of Energy, providing expertise in all areas of used fuel management, and decommissioning strategy and operations. He retired in 2013 after ten years as the Director, Spent Fuel and Decommissioning for Exelon Generation Company, where he provided governance and oversight of used fuel management and decommissioning for Exelon's nuclear fleet. Mr. Levin has 39 years in the commercial nuclear industry, with both consulting and utility employment, and has authored and contributed to more than a dozen papers and books. adamhlevin@outlook.com



Dave Lochbaum is director of the Union of Concerned Scientists' (UCS) Nuclear Safety Project, Mr. Lochbaum monitors ongoing safety issues at U.S. reactors, testifies before Congress and the Nuclear Regulatory Commission (NRC), and provides informed analyses of nuclear plant conditions and incidents, such as the March 2011 disaster at the Fukushima Daiichi facility in Japan. A nuclear engineer by training, Mr. Lochbaum worked at nuclear power plants for 17 years, including many that are similar to the General Electric reactors at the Fukushima plant. He left the industry in the early 1990s after blowing the whistle on unsafe practices and joined UCS in 1996. He then left UCS in 2009 to work for the NRC as a reactor technology instructor and returned to his post at UCS a year later. dlochbaum@ucsusa.org



Mark Lombard is the Director of the Division of Spent Fuel Management in the Office of Nuclear Material Safety and Safeguards at the U.S. Nuclear Regulatory Commission. He has over 35 years' experience at more than 20 nuclear power plants and fuel cycle facilities in the U.S. and Europe in the areas of engineering, licensing, security, and spent fuel management. In his current position he oversees the NRC's regulatory, licensing, and inspection program for the storage of spent nuclear fuel and the domestic and international transportation of radioactive materials under 10 CFR Parts 71 and 72. mark.lombard@nrc.gov



Rod McCullum is Senior Director for Used Fuel and Decommissioning Programs at Nuclear Energy Institute (NEI). He has been working on regulatory issues at NEI since 1998. He has 30 years of nuclear engineering, licensing, management and regulatory policy experience. Currently, at NEI, he leads industry technical and regulatory efforts to improve used fuel and decommissioning management systems. He held prior positions in Government (with the Department of Energy) and Industry (at three commercial nuclear power plants). He has a Bachelor of Science degree in Nuclear Engineering (University of Cincinnati, 1985) and a Master of Business Administration degree (Lewis University, 2000). rxm@nei.org



Andrew Orrell is the Section Head for Waste and Environmental Safety at the International Atomic Energy Agency where he is responsible for the development and promulgation of internationally accepted standards, requirements and guides for the safe management of radioactive waste and spent fuel, decommissioning, remediation and environmental monitoring. In addition, Mr. Orrell oversees the planning and execution of support to the IAEA Member States for the implementation of the IAEA Safety Standards, and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Prior to joining the IAEA, Mr. Orrell was the Director of Nuclear Energy Programs for Sandia National Laboratories, where he was responsible for laboratory development initiatives involving all facets of the nuclear fuel cycle. He provided executive leadership for Sandia's Lead Laboratory for Repository Systems program, managing the completion of the post-closure performance assessment and safety case for a license to construct the nation's first geologic repository for high-level nuclear waste at Yucca Mountain. Prior to working on Yucca Mountain, he managed site characterization programs for a deep geologic repository for transuranic waste at the Waste Isolation Pilot Plant, and developed transportation optimizations for the National Transuranic Waste Management program. a.orrell@iaea.org

Tyler Owens is the majority clerk of the Subcommittee on Energy and Water Development of the Senate Appropriations Committee, where he has served since 2009. The subcommittee oversees more than \$37 billion in annual funding for the Department of Energy, Army Corps of Engineers and Bureau of Reclamation, and related agencies. Prior to his work on the subcommittee, Mr. Owens served as Counsel and later Senior Counsel to U.S. Senator Robert F. Bennett (R-UT). Mr. Owens received his *Juris Doctor* from George Mason University School of Law and a bachelor's degree in political science from Utah State University. tyler_owens@appro.senate.gov



Dr. James Rubenstone is Acting Director of the Yucca Mountain Directorate in the Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission. He joined NRC in 2003 as a technical reviewer for high-level waste disposal activities with a focus on hazards associated with volcanic disruption of a high-level waste repository. He has been deeply involved with the NRC review of the proposed geologic repository at Yucca Mountain, including development of the safety evaluation report and the environmental reviews. At NRC he has also worked on and managed NRC activities on extended storage and transportation of commercial spent nuclear fuel, reprocessing, and other ultimate disposal of spent fuel and high-level radioactive waste. Prior to joining NRC, he held research positions at Columbia University in New York, leading basic and applied research in Earth Sciences. He is a graduate of the College of William and Mary, and has a Ph.D. in Geological Sciences from Cornell University. james.rubenstone@nrc.gov



Sylvia Saltzstein has a Masters Degree in Public Health and Environmental Health Sciences from the University of California at Berkeley and is a Certified Industrial Hygienist. She has worked at Sandia National Labs (SNL) for the last 21 years where she has contributed in the areas of environmental health and safety, facilities, microelectronics development, production, and in the safe and secure disposal of used nuclear fuel. During much of her time at Sandia, her focus has been on occupational exposure assessment and hazard communication while serving as the operational manager for a 300-person production facility at Sandia. She is currently manager of the Used Nuclear Fuel Storage and Transportation Department at Sandia National Laboratories, where her primary customer is the Department of Energy's Office of Nuclear Energy (DOE-NE). Her department's main focus is to help develop the scientifically informed technical basis for understanding potential issues with the structural and material integrity of spent fuel and its containment during long term storage and subsequent transportation. She has presented work related to the storage and transportation of used nuclear fuel at numerous conferences, for the U.S. Department of Energy, the U.S. Nuclear Regulatory Commission, the U.S. Electric Power Research Institute, and at the International Atomic Energy Agency. cjsaltz@sandia.gov



Dr. Holger Völzke is a Professor and Director at Bundesanstalt für Materialforschung und -prüfung (BAM) (Federal Institute for Materials Research and Testing) in Berlin, Germany. After receiving his PhD in civil aircraft engineering in 1991 he began working with BAM. Since 2007 he has worked as head of BAM Division 3.4 Safety of Storage Containers for radioactive waste and spent nuclear fuel. His team of 25 has worked on cask design testing and safety evaluation for interim storage and final disposal of spent nuclear fuel and radioactive waste. He has also led various R&D projects concerning material and structural behavior under mechanical and thermal stresses, accident scenarios and long-term behavior. His division works to provide information and support to administration, industry, and the public. Since 2010 Völzke has been a member of the German Waste Management Commission Committee on Waste Conditioning, Transport and Interim Storage (ESK-AZ). He is also a consultant for the IAEA. holger.voelzke@bam.de



Edward (Ted) Quinn is currently President at Technology Resources. He has over 35 years experience in managing nuclear and fossil utility contracts and personnel in support of both project and supplemental assignments at various utilities in the U.S. He is past President of the American Nuclear Society (ANS) (1998-1999). Ted has managed and performed projects in licensing and compliance, electrical and controls design, startup and operation, including Standards development for the Instrument Society of America (ISA) and the International Electrotechnical Commission (IEC) and is the author of over 50 papers and presentations on nuclear instrumentation and control subjects. He has been an instructor at the MIT Summer Reactor Safety Course for over 15 years and a Board member of the nuclear engineering programs at both Oregon State and The Ohio State University. He currently provides the licensing support for the eight awarded IOM nuclear projects in China. In 2009, he was awarded the highest award in IEC, the 1906 Award, for the development of standards, and in 2011, he received the ANS Walter Zinn Award, named after the first President of ANS. tedquinn@cox.net



Dr. John C. Wagner is the Chief Scientist for the Materials and Fuels Complex at Idaho National Laboratory (INL). Wagner received a B.S. in nuclear engineering from the Missouri University of Science and Technology in 1992 and M.S. and Ph.D. degrees from the Pennsylvania State University in 1994 and 1997, respectively. Prior to joining INL in 2016, Wagner was the Reactor and Nuclear Systems Division Director at the Oak Ridge National Laboratory, where he spent nearly 17 years. Wagner's research interests span a wide range of issues associated with nuclear energy, spent nuclear fuel, and computational methods, with a current focus on RD&D to support advanced reactor technologies. Wagner is a Fellow of the American Nuclear Society and recipient of the 2013 E. O. Lawrence Award. john.wagner@inl.gov