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Developing a Long-Term Strategy for Low-Dose Radiation Research in the United States

PUBLIC MEETING #4 (Virtual)
October 27-28, 2021, All times are EDT

CONNECTION INFORMATION

ZOOM CONNECTION for BOTH DAYS for speakers, committee members, and observers.

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Also in the agenda:

- Pointers to Speakers
- Material of Interest
- Speaker Biographies
- Statement of Task

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AGENDA

DAY 1: October 27

10:45 AM	**Committee Members and Speakers Connect** **Test Microphones and Cameras/Resolve Connectivity Issues**
11:00 AM – 11:05 AM	**Welcome and Open Public Session** *Joe Gray, Committee Chair*
11:05 AM – 11:25 AM	**The Science of Risk Communication** *Baruch Fischhoff, Carnegie Mellon University*
11:25 AM – 11:35 AM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
11:35 AM – 12:50 PM	**Government Perspectives on Communication of Low-Dose Radiation Risks (~12-15 minutes each)** *Kristen Ellis, Department of Energy-Environmental Management* *Jonathan Gill, Department of Homeland Security* *Angela Leek, Iowa Department of Public Health* *Trish Milligan, U.S. Nuclear Regulatory Commission (retired)* *Jessica Wieder, Environmental Protection Agency*
12:50 PM – 1:15 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
1:15 PM – 1:30 PM	**BREAK**
1:30 PM – 2:15 PM	**Perspectives from Non-Governmental Organizations on Communication of Low-Dose Radiation Risks (~12-15 minutes each)** *Bemnet Alemayehu, Natural Resources Defense Council* *Terrie Barrie, Alliance of Nuclear Worker Advocacy Groups* *Dan Hirsch, Committee to Bridge the Gap*
2:15 PM – 2:35 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
2:35 PM – 3:50 PM	**Medical, Research, and Industry Perspectives (~12-15 minutes each)** *Gerry Thomas, Imperial College London* *Aditi Verma, Harvard Kennedy School* *Nima Ashkeboussi, Nuclear Energy Institute* *Nick Priest, CANDU Owners Group (COG) Expert Advisor for the Low Dose Strategic Program* *Rebecca Smith-Bindman, University of California San Francisco*
3:50 PM – 4:10 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*

4:10 PM – 4:20 PM	**BREAK**
4:20 PM – 5:00 PM	**Risk Management, Safety Policies, and Economics (~20 minutes each)** *Robin Cantor, Berkeley Research Group LLC* *Lisa Robinson, Harvard T.H. Chan School for Public Health*
5:00 PM- 5:20 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
5:20 PM – 5:40 PM	**Risk Perception and Public Policy** *Hank Jenkins-Smith, University of Oklahoma*
5:40 PM – 5:50 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
5:50 PM – 6:00 PM	**Opportunity for Follow-Up Questions to All Speakers** *Moderated by Joe Gray, Committee Chair*
6:00 PM	**Adjourn Day 1 Open Session**

DAY 2: October 28

10:45 AM	**Committee Members and Speakers Connect** **Test Microphones and Cameras/Resolve Connectivity Issues**
11:00 AM – 11:02 AM	**Welcome and Open Public Session** *Joe Gray, Committee Chair*
11:02 AM – 12:40 PM	**Stakeholder Engagement (~10 minutes each)** *Moderator: Lilly Adams, Union of Concerned Scientists* • *President Jonathan Nez, Navajo Nation* • *Jill Jim, Navajo Nation Department of Health* • *Mary Dickson, representative of downwinders of US nuclear tests* • *Keith Kiefer, National Commander of the National Association of Atomic Veterans* • *Benetick Maddison, Marshallese Educational Initiative (pre-recorded presentation)* • *Arjun Makhijani, Institute for Energy and Environmental Research* • *Trisha Pritikin, Hanford Downwinder, author of "The Hanford Plaintiffs: Voices from the Fight for Atomic Justice"* • *Beata Tsosie-Peña, Environmental Health and Justice Program at Tewa Women United in New Mexico (pre-recorded presentation)*

12:40 PM – 1:00 PM	**Discussion with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
1:00 PM – 1:20 PM	**Research Needs in Radiation Risk Communication** *Randall Hyer, Center for Risk Communication*
1:20 PM – 1:30 PM	**Q+A with the Committee and Staff**
1:30 PM – 1:50 PM	**Opportunity for Public Comments**
1:50 PM	**Adjourn Day 2 Open Session**

Pointers to Speakers

Baruch Fischhoff

- Why is communication or risks at low doses of radiation challenging?
- How can risk perception inform risk communication?
- How should the publics' processing of risk information influence the design of the low-dose radiation research program?
- What advice do you have for the committee on its task?

Government Perspectives

- What are your primary communication audiences?
- How do you/your organization engage with these audiences?
- What are some common concerns that these audiences have in relation to low dose radiation and how do these differ depending on context?
- From your perspective is there a difference on how the scientific community perceives risks compared to members of the public. If yes, how and why?
- What are your challenges with communicating low-dose risks and what information do you need to better communicate those risks?
- What are some techniques and strategies you use to communicate risks at low doses of radiation with your audiences? In your view what works and what does not work and in what context?
- How do you test the effectiveness of your communication strategies?
- Do you train staff within your organization on risk communication? ***New!***
- Do your tabletop exercises include communications? ***New!***
- In your view, how can the new low-dose program assist you with better communicating low-dose risks?
- What are in your view some high-priority research questions the program should try to address?

Nongovernment Organization Perspectives

- Please provide to the committee your perspectives on the statement of task.

- What are in your view some high-priority research questions the program should try to address?

Medical, Research, and Industry Perspectives

- Please provide to the committee your perspectives on the statement of task and the radiation communication issues that you have encountered in your professional environment.
- How should the publics' processing of risk information influence the design of the low-dose radiation research program?
- What are in your view some high-priority research questions the program should try to address?

Risk Management, Safety Policies, and Economics

- The committee is interested in your perspectives on environmental incidents, exposures, and economic impacts (Cantor).
- The committee is interested in your perspectives on estimating the costs and benefits of environmental, health, and safety policies and regulations (Robinson).
- How can the low-dose radiation research program assist with improving risk management or safety policies?

Risk Perception and Public Policy

- The committee is interested in your perspectives on concerns about radiation and public policy.
- From your perspective is there a difference on how the scientific community perceives risks compared to members of the public. If yes, how and why? What could be done to bridge the gap?

Randall Hyer

- The committee is interested in your views on effective radiation risk communication, particularly for low doses of radiation.
- What are some current directions in radiation risk communication research and how can these make an impact?
- Reflecting—to the extent possible—on the discussions and comments during this meeting, what are in your view some remaining research needs in radiation risk communication?
- Please provide any additional information/comments you think is appropriate for the committee's task.

Material of Interest

Marshallese Government

- The Marshall Islands National Nuclear Commission, 2020. NUCLEAR JUSTICE FOR THE MARSHALL ISLANDS, A Strategy for Coordinated Action, FY2020-FY2023

Message. https://rmi-data.sprep.org/system/files/RMI%20NNC%20Strategy%202019.pdf
- REPUBLIC OF THE MARSHALL ISLANDS NATIONAL NUCLEAR COMMISSION, ETHICS PROTOCOL FOR RESEARCHERS AND STUDY ABROAD INSTRUCTORS, https://rmi-data.sprep.org/system/files/NNC%20Research%20Protocol_Marshallese.pdf

Priest

- N. Priest, Addressing public concerns about their exposure to low doses of anthropogenic radiation. Report of the program advisory sub-committee 2020-2021, OP-20-714.

Pritikin

- The Hanford Plaintiffs, University Press of Kansas, 2020, https://kansaspress.ku.edu/978-0-7006-2904-6.html. Available in hard copies e-format via Kindle.

Robinson and Cantor

- https://www.whitehouse.gov/omb/information-regulatory-affairs/regulatory-matters/ provides a wealth of material on the Federal requirements for regulatory analysis and review
- https://www.whitehouse.gov/omb/information-regulatory-affairs/reports/ provides annual reports to Congress that summarize the costs and benefits of Federal regulations
- Industrial Economics, Inc. June 1997. Radiation Protection Standards for Scrap Metal: Preliminary Cost-Benefit Analysis. 402R97017.
- Industrial Economics, Inc. Nov 2000. Economic Analysis of the Radionuclides National Primary Drinking Water Regulation.
- Industrial Economics. Sept 2000. Scoping Analysis: Economic Impacts of Radiation Protection Standards for Metal Imports and Exports. 402R00010.
- U.S. Environmental Protection Agency. Jun 2001. Evaluation of Potential Economic Impacts of 40 CFR Part 197: Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada.
- U.S. Department of Health and Human Services. Guidelines for Regulatory Impact Analysis, 2016.
- U.S. Environmental Protection Agency. Guidelines for Preparing Economic Analyses, 2010 (with updates).
- U.S. Nuclear Regulatory Commission. NUREG/BR-0058 "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission", 2017 (draft update).
- https://yosemite.epa.gov/sab%5Csabproduct.nsf/F3DB1F5C6EF90EE1852575C500589157/$File/EPA-SAB-09-012-unsigned.pdf.
- NUREG-2161 https://www.nrc.gov/docs/ML1425/ML14255A365.pdf
- Regulation Requiring an Approved New Drug Application for Drugs Sterilized by Irradiation (Final Rule) - December 16, 2019
- Radiological Health Regulations; Amendments to Records and Reports for Radiation Emitting Electronic Products; Amendments to Performance Standards for Diagnostic X-ray, Laser, and Ultrasonic Products (Proposed Rule) - April 01, 2019

- Mammography Quality Standards Act; Amendments to Part 900 Regulations (Proposed Rule) - March 27, 2019
- Sunscreen Drug Products for Over-the-Counter Human Use; Proposal to Amend and Lift Stay on Monograph (Proposed Rule) -February 26, 2019
- U.S. Department of Health and Human Services. Guidelines for Regulatory Impact Analysis, 2016.
- U.S. Environmental Protection Agency. Guidelines for Preparing Economic Analyses, 2010 (with updates).
- U.S. Nuclear Regulatory Commission. NUREG/BR-0058 "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission", 2017 (draft update).
- Regulation Requiring an Approved New Drug Application for Drugs Sterilized by Irradiation (Final Rule) - December 16, 2019
- Radiological Health Regulations; Amendments to Records and Reports for Radiation Emitting Electronic Products; Amendments to Performance Standards for Diagnostic X-ray, Laser, and Ultrasonic Products (Proposed Rule) - April 01, 2019
- Mammography Quality Standards Act; Amendments to Part 900 Regulations (Proposed Rule) - March 27, 2019
- Sunscreen Drug Products for Over-the-Counter Human Use; Proposal to Amend and Lift Stay on Monograph (Proposed Rule) -February 26, 2019

EPA's Air and Radiation program

- Evaluation of Potential Economic Impacts of 40 CFR Part 197: Public Health And Environmental Radiation Protection Standards For Yucca Mountain, Nevada June 2001
- Scoping Analysis Economic Impacts of Radiation Protection Standards for Metal Imports & Exposure (Sept. 2000)(EPA 402/R-00-010).
- Radiation Protection Standards for Scrap Metal Preliminary Cost-Benefit Analysis, Preliminary Draft (June 1997)(EPA 402/R-97-017).
- Draft Economic Impact Analysis for Amendments to EPA's Radioactive Waste Standards (40 CFR Part 191)(June 1993)(EPA 402/R-92-007).
- Economic Criteria for Relocation(Radiation)(June 1989)(EPA 520/1-89-015) (PB89-226377).
- Economic Assessment--Environmental Impact Statement: NESHAPS for Radionuclides, Background Information Document-Vol. 3(Sept. 1989)(EPA 520/1-89-007).
- Low-Level and NARM Radioactive Wastes: Draft Environmental Impact Statement, Vol. 2: Economic Impact Assessment (Aug. 1987)(EPA 520/1-87-0122).
- Final Rule for Radon-222 Emissions from Licensed Uranium Mill Tailings -Economic Analysis, Final Report(Aug. 1986) (EPA 520/1-86-010) (PB87-207437).
- Radionuclides: RIA of Emission Standards for Elemental Phosphorus Plants(Oct. 1984)(EPA 520/1-84-025)(PB85-132744).
- Draft RIA for 40 CFR 191: Environmental Standards for Management & Disposal of Spent Nuclear Fuel, High-Level & Transuranic Radio-active Wastes, Draft Report (Dec. 1982) (EPA 520/1-82-024)(PB83-170217). **ALSO,** Draft EIS for 40 CFR 1991:Envir.Standards for Management & Disposal of ..., Final Report(Dec. 1982)(EPA 520/6-82-025) (PB83-171157).
- Economic Impacts of 40 CFR 191: Environmental Standards & Federal Radiation Protection Guidance for Management & Disposal of Spent Nuclear Fuel High-Level & Transuranic Radioactive Wastes (Dec.1980)(EPA 520/4-80-014)(PB81-156564).

EPA's Water program

- Technologies & Costs for the Removal of Radionuclides from Potable Water Supplies (June 2000)(Water Docket W-00-12, RADS F-L, II-B-25).
- Econ. Analysis of the Radionuclides National Primary Drinking Water Regulations, Final Report (Nov. 2000). **ALSO,** NPDWR, Radionuclides, Final Rule, **FR** Dec. 7, 2000(EPA 815/Z-00-006).
- Radon & Arsenic Regulatory Compliance Costs for the 25 Largest Public Water systems (Dec. 2000).
- Radionuclides Notice of Data Availability Technical Support Document (March 2000)(Water Docket W-00-12, RADS NODA I-B.15)..
- Preliminary Health Risk Reduction & Cost Analysis: Revised NPDW Standards for Radionuclides, Review Draft (Jn. 2000)(EPA 815/R-00-008)(Water Docket W-00-12, RADS, FW6, II.B.22).
- Technologies & Costs for the Removal of Radionuclides from Potable Water Supplies, Draft (April 1999)(Water Docket W-00-12, RADS NODA, I-F.9).
- RIA & Revised Health Risk Reduction & Cost Analysis for Radon in Drinking Water (Nov. 1999)(EPA 815/D-99-002)(PB2000-102449).
- RIA & Revised Health Risk Reduction & Cost Analysis for Radon in Drinking Water (Sept. 1999)(EPA 815/D-99-002)(PB2000-102449)(Water Docket W-99-08, Radon PRO.I-B-94). **ALSO,** RIA & Revised Health Risk Reduction….Draft (July 1, 1999). **ALSO,** NPDWR, Radon-222, Proposed Rule**, FR** Nov. 2, 1999.
- Technologies & Costs for the Removal of Radon from Drinking Water (May 1999)(EPA 815/D-99-004)(PB 2000-102456)Water Docket W-99-08, Radon PRO. I-B-92).
- Radon in Drinking Water Health Risk Reduction and Cost Analysis (February 1999) https://archive.epa.gov/water/archive/web/html/hrrcafr.html
- Actual Cost for Compliance with the Safe Drinking Water Act Standard for Radium 266 & Radium 229, Final Report (July 1998)(Water Docket W-00-12, RADS NODA, i-F.8).
- Radon in Drinking Water—Health Risk Reduction & Cost Analysis, Final Draft (Jan. 8, 1998). **ALSO,** Technologies & Costs for the Removal of Radon from Drinking Water (Sept. 1998).
- RIA: National Primary Drinking Water Regulations Radionuclides, Draft (Sept. 2, 1994).
- Report to the U.S. Congress on Radon in Drinking Water: Multimedia Risk & Cost Assessment of Radon (March 1994)(EPA 811/R-94-001)(Water docket W.99-08, Radon PRO, 1-C-28).
- Draft RIA of Proposed NPDWR for Radio-nuclides(Sept. 30, 1993).
- RIA of Proposed NPDWR for Radionuclides(May 15, 1991). **ALSO,** RIA of Proposed NPDWR for Radionuclides(June 14, 1991).
- RIA of Proposed NPDWR for Radionuclides(July 17, 1991) (Water Docket III-D, III-F-1)(EPA 68-CO-0069)(PB91-225698).
- Draft RIA of Proposed Radionuclide Regulations(Jan. 1988)

EPA's Waste Program

- EIA for the Proposed Reportable Quantity Adjustments for Radionuclides Under Section 102 of the Comprehensive Environmental Response, Compensation, & Liability Act (Dec. 1986).
- Estimated Economic Effects of Administrative Reporting Exemptions for Certain Releases of Radionuclides (May 30, 1995)

Thomas

- Oxford Martin Schools' restatement on the health effects of low dose radiation https://www.oxfordmartin.ox.ac.uk/downloads/restatements/Oxford%20_Martin%20_Restatement5_Radiation.pdf)
- IARC monograph on Thyroid Monitoring After Nuclear accidents (available to download from https://publications.iarc.fr/Book-And-Report-Series/Iarc-Technical-Publications/Thyroid-Health-Monitoring-After-Nuclear-Accidents-2018)
- lack of transgenerational effects of low dose radiation exposure (https://www.science.org/lookup/doi/10.1126/science.abg2365).

Speaker Biographies

Lilly Adams is an independent consultant specializing in nuclear weapons issues. Lilly is the founder and coordinator of the Nuclear Voices project, which builds connections between nuclear policy organizations and nuclear frontline communities and seeks to amplify issues of environmental and social justice related to nuclear weapons. She is a consultant for the Union of Concerned Scientists in their Global Security Program and is a member of the Board of Directors of the Arms Control Association. She is a 2019 alumna of the Institute on Global Conflict and Cooperation's Public Policy and Nuclear Threats Boot Camp, and previously ran the anti-nuclear weapons program at Washington Physicians for Social Responsibility. She has a bachelor's degree from UC Berkeley in Society and Environment and completed a year-long training program with Green Corps, the Field School for Environmental Organizing.

Bemnet Alemayehu is a Staff Scientist in the Climate and Clean Energy Program with the Natural Resources Defense Council. He concentrates on issues relating to the environmental monitoring of radiation and the health and environmental impacts of radiation. He received his PhD in radiation health physics from Oregon State University, where his dissertation focused on designing and developing advanced radiation spectrometers and new digital-pulse processing techniques. During the course of his doctoral studies, Alemayehu also worked at Oregon State's Radiation Detection and Dosimetry Laboratory. He is based in Washington, D.C.

Nima Ashkeboussi is currently the Senior Director of the Fuel and Radiation Safety Programs team at the Nuclear Energy Institute where he manages a group overseeing policy, regulatory, and market issues associated with uranium recovery, the nuclear fuel cycle, low-level waste, transportation, research and test reactors, and radiation protection. Prior to joining NEI in 2015, he spent 13 years with the U.S. Nuclear Regulatory Commission. Nima has a Bachelor's degree in Mechanical Engineering from the University of Maryland and a Master's degree in Environmental Planning and Management from the Johns Hopkins University.

Terrie Barrie is a Founding Member of the Alliance of Nuclear Worker Advocacy Groups (ANWAG). Formed in 2004, ANWAG is a grassroots organization which advocates for the Department of Energy's nuclear weapons workers who developed illnesses from their daily exposure to toxic substances, including radiation. ANWAG monitors the implementation of the Energy Employees Occupational Illness Compensation Act of 2000, as amended. ANWAG reports any concerns with the program to the responsible federal agencies, the Ombudsmen's offices, Congress, and the press. Ms. Barrie began her advocacy in 1995 by unsuccessfully representing her husband, a former Rocky Flats worker, before the Colorado Division of State Workers' Compensation for his occupational diseases. Ms. Barrie is the co-author *of Necessity*

for Public Domain availability of Computing Software for Federal EEOICPA compensation for exposure to Nuclear Weapon. Barrie T., Barker C., 2021 to appear.

Robin Ann Cantor has more than thirty years of experience in the areas of environmental, health, and energy economics, applied economics, statistics, risk management, and insurance claims analysis. She received a PhD in economics from Duke University and a BS in mathematics from Indiana University of Pennsylvania. Before joining Berkeley Research Group LLC (BRG) as a managing director, Dr. Cantor led practice groups at national consulting firms and conducted analysis for companies and financial institutions to better understand environmental, health, and other product liability exposures. Other positions she has held include practice director at several global consultancy firms; program director for the NSF Decision, Risk, and Management Sciences program; senior research appointments at Oak Ridge National Laboratory; and a faculty appointment in the graduate part-time program in engineering of the Johns Hopkins University. She was president of the Society for Risk Analysis in 2002, and from 2001 to 2003 served as an appointed member of the Research Strategies Advisory Committee of the US Environmental Protection Agency's Science Advisory Board. Dr. Cantor is a fellow of the Society for Risk Analysis and past president for the Women's Council on Energy and the Environment. She has served on many science review and advisory boards for universities and government agencies. Dr. Cantor's consulting practice focuses on economics at the interface of science and technology. Many of her projects involve evidence-based economic analysis used in litigation support, expert testimony, risk analysis, and other advisory services addressing energy, environmental, and health issues. Among her publications is an edited book on product liability published by the American Bar Association.

Award-winning writer **Mary Dickson** began her career as a journalist, telling other people's stories. After being diagnosed with thyroid cancer in 1985 while in her twenties, she began a tireless investigation of what radioactive fallout from atomic testing did to Americans living downwind of the Nevada Test Site. She has interviewed countless fellow downwinders, written and spoken about the human toll of nuclear weapons testing at symposia, conferences, classrooms and universities around the West, at MIT, and at Ritsumeikan University in Kyoto, Japan, and at the 2015 World Forum of Victims of Nuclear Weapons held in Hiroshima, Japan. During Covid, she has spoken at numerous national and international Zoom conferences on the subject. An internationally recognized advocate for downwinders, she was honored by the Alliance for Nuclear Accountability for her life-time work on behalf of those harmed by nuclear testing. Her full-length play, *Exposed*, which played to sold-out houses and critical acclaim during its world premiere in Salt Lake City, Utah, was nominated by the American Theatre Critics Association for the Steinberg Award for the Best New Play produced Outside New York. The play has subsequently toured universities and venues nationwide as a staged reading. A researcher involved in a longitudinal study of fallout's links to thyroid cancer and leukemia wrote, "Your play has done what we in academia never could."

Kristen G. Ellis is Acting Director of Regulatory, Intergovernmental, and Stakeholder Engagement, and oversees the EM Office of Regulatory Compliance and the EM Office of Intergovernmental and Stakeholder Programs. As Senior Advisor for STEM and Talent Acquisition, she assesses future STEM needs of the EM workforce. She additionally advises on EM workforce issues, including inclusion opportunities for EM's next generation workforce, and supporting partnerships building an EM talent pipeline. She previously served as the Chief of Staff for Under Secretary for Science Paul Dabbar, overseeing all daily operations, including personnel, budgets, policy, media, and interface with DOE senior leadership. That portfolio included over $14 billion in Federal funding for fundamental energy research, energy technologies, and science; direct management of 11 of the Department's national labs and user

facilities; the environmental and legacy management missions, the Artificial Intelligence and Technology program; the National Laboratory Operations Board; and technology commercialization activities for the Department. Previously, she served as the Director of the EM Office of External Affairs, directing the media and Congressional strategies of the EM complex. She also formerly served Director of the EM Intergovernmental Office, partnering with national intergovernmental organizations, tribal governments, and community organizations. She previously served as the Designated Federal Official for the EM Advisory Board. Earlier, she served within DOE's Office of Congressional and Intergovernmental Affairs, representing DOE at two White House committees, advising the Secretary of Energy on tribal government issues, and serving as the liaison to national intergovernmental organizations. She received her Juris Doctorate in 2006 from the University of Baltimore School of Law, and is licensed to practice law in the State of Maryland. She received a Bachelor of Arts degree in Political Science from Western Maryland College, with concentrations in Communications and Journalism.

Baruch Fischhoff is Howard Heinz University Professor, Department of Engineering and Public Policy and Institute for Politics and Strategy, Carnegie Mellon University. He is a graduate of the Detroit Public Schools, Wayne State University (BS, mathematics, psychology), and the Hebrew University of Jerusalem (PhD, psychology). He is an elected member of the National Academy of Sciences and National Academy of Medicine. He is past President of the Society for Judgment and Decision Making and the Society for Risk Analysis. He has chaired the Food and Drug Administration Risk Communication Advisory Committee and been a member of the Eugene (Oregon) Commission on the Rights of Women, the Department of Homeland Security Science and Technology Advisory Committee and the Environmental Protection Agency Scientific Advisory Board, where he chaired the Homeland Security Advisory Committee. His books include *Acceptable Risk*, *Risk: A Very Short Introduction*, and *Counting Civilian Casualties*.

Jonathan Gill is currently the Nuclear Incident Response Team and Nuclear Radiological Incident Task Force program manager in FEMA's Chemical, Biological, Radiological and Nuclear (CBRN) Office. Prior to this, Jon spent two and a half years at DOE/NNSA headquarters in the Office of Nuclear Incident Response as a fellow and lab detailee where he advised and assisted in the office's Consequence Management program. Before his time at DOE, Jon conducted graduate research at the University of Tennessee on optically stimulated luminescence applications to fission track counting for nuclear forensics, the manufacture of surrogate nuclear debris, and dissolution and fusion methods for mass spectral analysis of surrogate and real nuclear debris. Prior to this, he served eight years in the US Army as an Engineer Officer at various levels of leadership in construction and combat units. Jon has a Ph.D. in Nuclear Engineering from the University of Tennessee and a B.S. in Nuclear Engineering from the United States Military Academy.

Daniel Hirsch is President of the Committee to Bridge the Gap, a 50-year-old non-governmental organization focused on nuclear policy matters, including providing technical assistance to communities impacted by radioactively contaminated sites. He is the former Director of the Program on Environmental and Nuclear Policy at the University of California at Santa Cruz, and before that, the Stevenson Program on Nuclear Policy at UCSC. He co-chaired the Oversight Panel for the epidemiological study of radiation workers at the Atomics International facility at what is now known as the Santa Susana Field Laboratory near Los Angeles, an AEC/DOE site where a partial meltdown and other reactor accidents occurred. He is a former member of the National Council of the Federation of American Scientists and a former Energy and Environment Fellow there.

Dr. **Randall Hyer** is the deputy director of the Center for Risk Communication; he is a nationally and internationally recognized expert in risk and crisis communications. He has been a medical officer at the World Health Organization (WHO) and a senior advisor to the National Academy of Sciences and numerous other organizations. Dr. Hyer has published widely in the fields of medicine and public health. Dr. Hyer graduated with Distinction from the U.S. Naval Academy and received his MD from Duke University and his MPH and PhD from Oxford University.

Hank Jenkins-Smith is a George Lynn Cross Research Professor in the Political Science Department at the University of Oklahoma, and serves as Co-Director of the Institute for Public Policy Research and Analysis (IPPRA). Professor Jenkins-Smith has published books and articles on public policy, national security, natural disasters, and energy and environmental policy. He has served on National Research Council Committees, as an elected member on the National Council on Radiation Protection and Measurement, and as a member of the governing Council of the American Political Science Association. Dr. Jenkins-Smith's research focuses on theories of the public policy change, with particular emphasis on the management (and mismanagement) of controversial issues involving high risk perceptions on the part of the public. He is the science co-lead (with Dr. Carol Silva) on a 5-year NSF study focusing on finding sustainable solutions to the complex problems at the intersection of weather, water, land cover and infrastructure in Oklahoma. He was the PI on an NSF grant for a year-long study of the social and behavioral aspects of COVID-19 related behaviors that resulted in a Cambridge University Press book on the role of public trust in managing a pandemic. Much of Dr. Jenkins-Smith's research is based on IPPRA's substantial investment in data collection infrastructure – utilizing both social media and survey data – that enables both long-term and real-time monitoring of the social and policy contexts in which public health, security, and environmental programs operate. In his spare time, Professor Jenkins-Smith engages in personal experiments in risk perception and management via boxing, motorcycling and back-country hiking.

Dr. **Jill Jim**, an enrolled member of the Navajo Nation and fluent Navajo speaker, will be coming home to the Navajo Nation from Albuquerque, N.M. to serve as the Executive Director for the Navajo Nation Department of Health. Dr. Jim has a Doctorate in Public Health, a Master's Degree in Health Care Administration, a second Master's in Public Health from the University of Utah. She has a Bachelor's Degree in Health Promotion and Community Health Education from Northern Arizona University. Some of her work experience includes serving as a Health Care Analyst for HealthInsight in Albuquerque, N.M., consultant for Navajo Area Indian Health Service, and Epidemiologist for the Utah Department of Health.

Keith Kiefer is National Association of Atomic Veterans' (NAAV) National Commander, a veteran, and an advocate. NAAV (National Association of Atomic Veterans) advocates for Atomic Veterans deployed from 1945 to 1963 as defined by CFR title 38, Enewetak Atoll Radiological Cleanup Veterans deployed from 1977 to 1980, DU (Depleted Uranium) Veterans, Fukushima Veterans and any other veterans potentially exposed to ionizing radiation. Keith currently serves as the NAAV National Commander, is a past NAAV National Vice Commander, past Director at large and Past Minnesota State Commander. He is also a Humanitarian Service Medal awardee. Keith is an Enewetak Radiological Cleanup Veteran. He has testified and advocates for Atomic Veteran Legislation at the State and Federal level. Keith consults in the areas of System Safety, Reliability, Design Engineering, Production Engineering, Program Management and Statistical Process Control.

Angela Leek, CHP is the radiation control program director for the Iowa Department of Public Health where she is responsible for the licensing and inspection activities for all aspects of

radiation producing machines and radioactive materials within Iowa, as well as for dose assessment and technical advice for radiation emergency preparedness and response. She actively supports the development of training and presentations for various groups across the nation on radiation protection, regulatory control program perspectives, and emergency preparedness and response. Angela currently serves as the Chairperson for the Conference for Radiation Control Program Directors (CRCPD) and has served as Council Chair for the CRCPD's Suggested State Regulations (SSRs) Council for several years. She is Iowa's governor-appointed state liaison officer to the Nuclear Regulatory Commission, is Iowa's voting member for the Organization of Agreement States, and maintains active memberships with organizations across all aspects of radiation protection including the Health Physics Society. Angela has been involved in the radiation field for over 25 years and is certified by the American Board of Health Physics. She earned her Master's degree in Radiation Health Physics from Oregon State University and is currently working on her PhD at Iowa State University.

Before moving to Arkansas' Ozark Mountains, **Benetick Kabua Maddison** and his family lived in the low-lying island nation of the Republic of the Marshall Islands. As a result of high unemployment and limited opportunities, Benetick and his family relocated in 2001 to Springdale, Arkansas, where the largest concentration of Marshallese resides outside of the Marshall Islands. Benetick graduated from Springdale High School and currently attends Northwest Arkansas Community College. He is the Project Specialist for Youth, Climate, and Nuclear Issues at Marshallese Educational Initiative, a nonprofit organization that serves the Marshallese community, raises awareness of Marshallese culture, and facilitates intercultural dialogue to foster positive social change. For more than a decade, Benetick has worked with his peers and Marshallese students and their families on projects to increase retention rates and to promote Marshallese culture and history, as well as on issues affecting his people and homeland. Benetick was the keynote speaker at the I2SL Annual Conference in October 2019, where he spoke about the impact of climate change in the Marshall Islands, was featured on the Nuclear Voices website connecting advocacy groups to nuclear frontline community members (launched January 2020), served as a panelist on the Norwegian Peace Association's webinar, "Nuclear Weapons Testing, Consequences and Risks," in June 2020, and spoke to the impact of forced relocation and the current dangers of Runit Dome and climate change on the Marshallese people during the virtual commemoration of the 75th anniversary of the bombings of Hiroshima and Nagasaki.

Arjun Makhijani, is President of the Institute for Energy and Environmental Research in Takoma Park, Maryland. He earned his Ph.D. from the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley in 1972, specializing in nuclear fusion. Dr. Makhijani is the author and co-author of numerous reports and books on energy and environment related issues. He has done extensive work on nuclear and renewable energy as well as on the health and environmental impacts of nuclear weapons production and testing. He is also author or co-author of reports and analyses of radionuclides emissions from nuclear weapons facilities, radiological conditions at nuclear production and testing sites, worker exposures, and the risks of radiation exposure. He is principal editor and co-author of *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*, (MIT Press, 1995 and 2000). He published articles in journals and magazines as varied as *The Bulletin of the Atomic Scientists, Environment*, *The Physics of Fluids*, and the *Washington Post*. Since 2004, he has served on a team to provide scientific support to the Advisory Board on Radiation and Worker Health. In 2007, he was elected Fellow of the American Physical Society, an honor granted each year to at most half-a-percent of the Society's members. He has served as a consultant on energy issues to utilities, including the Tennessee Valley Authority, the Edison Electric Institute, the Lawrence Berkeley Laboratory,

and several agencies of the United Nations.

Patricia "Trish" Milligan is a former Senior Level Advisor for the Nuclear Regulatory Commission in Rockville, Maryland. She is certified by the American Board of Health Physics in the comprehensive practice of health physics. She holds a license in pharmacy with a specialization in nuclear pharmacy. Trish serves as the NRC's expert in the areas of emergency preparedness and response (EP) and incident response (IR). She joined the NRC in 1998 after 18 years in the nuclear power and radio-pharmaceutical industries.

Jonathan Nez was born in Tuba City, Arizona and raised in Shonto, Arizona. He is married to Phefelia H. Nez and they have two children, Christopher and Alexander. He is the son of John H. Nez and Mabel H. Nez. His grandfather, H.T. Donald, was the former Navajo Nation Council Delegate for Shonto Chapter, and his grandmother was Mae Donald from Shonto. Nez began his public service after being elected as Shonto Chapter Vice President. He was later elected to serve three terms as a Navajo Nation Council Delegate, representing the chapters of Shonto, Oljato, Tsah Bi Kin, and Navajo Mountain. He was also elected as a Navajo County Board of Supervisor for District 1 and served two terms. In 2015, Nez was elected Navajo Nation Vice President. Nez believes in education. He is currently a doctoral student in political science and completed research on local empowerment and mobilizing local communities of the Navajo Nation to reinstate their inherent local way of governance. His research focuses on the reduction of dependence on the central tribal government, upholding and enhancing the local inherent sovereignty of the chapter areas. He is an alumnus of Northland Pioneer College and Northern Arizona University. He earned a bachelor's degree in political science and a master's degree in public administration from NAU.

Nick Priest

- Graduated 1971 with BSc (Zoology) from the University of Wales and 1974 with a PhD (Medicine) University of London.
- In 1974 started to work at the National Radiological Protection Board, Harwell, UK as a research scientist working mostly on the metabolism and dosimetry of actinide radionuclides in the body.
- In 1983 moved to become head of Biomedical Research at United Kingdom Atomic Energy Authority, Harwell. Activities mostly related to radiological protection research, but also concerned with: metal toxicity, inhalation toxicology and clinical trials.
- When AEA Technology created moved to Middlesex University, London where was appointed to a research chair. Most research concerned with radioecology at the former Soviet Nuclear Test Site (Semipalatinsk) and in the Balkans. Was head of the Decision Analysis and Risk Management Research Centre.
- In 2007 moved to Chalk River Laboratory, Canada where, until retirement in 2016, he was responsible for the re-establishment of AECL/CNL as a major centre for radiobiology and radiological protection research.
- Currently, a subject matter expert working with CANDU Owners Group Inc. and an Associate Professor in the Department of Chemistry, Laval University, Quebec City.
- Fellow Royal Society of Biology
- Received 2007 NATO Science Prize
- Received 2014 Canadian Radiation Protection Association Distinguished Achievement Award

- Represented Canada on International Committees (IAEA, OECD-NEA and ISO) and was seconded by the Canadian Government to the IAEA Fukushima Accident Consequences Team in Vienna.
- More than 120 journal publications.

Trisha T. Pritikin, an attorney and former Occupational Therapist, was born and raised downwind of the Hanford nuclear weapons facility in eastern Washington State. She suffers from a range of debilitating health issues believed to be the result of chronic childhood exposure to the radioactive byproducts of plutonium production released offsite from Hanford. Trisha has worked for more than thirty five years as an advocate for civilians exposed to and injured by low dose ionizing radiation from nuclear weapons production and testing programs. She is the author of the award winning *The Hanford Plaintiffs: Voices from the Fight for Atomic Justice* (University Press of Kansas, 2020), introducing the stories of 24 personal injury plaintiffs in the Hanford downwinder litigation, *In re Hanford Nuclear Reservation Litigation.*

Lisa A. Robinson's research and teaching focus on the conduct of benefit-cost analysis, particularly for policies with outcomes that cannot be fully valued using market measures. She has led numerous assessments of the costs, benefits, and other impacts of environmental, health, and safety policies and regulations, developed related methods, and drafted guidance documents. She co-edited the National Academies book, "Valuing Health for Regulatory Cost-Effectiveness Analysis," led the creation of guidelines for benefit-cost analysis for the U.S. Department of Health and Human Services and the Bill & Melinda Gates Foundation, and developed approaches for government agencies and others to estimate the value of mortality risk reductions (the value per statistical life, VSL). She has explored the implications of behavioral economics and happiness research for benefit-cost analysis, approaches for assessing impacts on employment, and issues related to assessing the distribution of costs and benefits across advantaged and disadvantaged groups. She applies these methods in high-, middle-, and low-income settings, including developing guidelines for conducting benefit-cost analysis in global health and conducting research related to cost-effectiveness thresholds. She has also explored responses to various types of hazard warnings. Ms. Robinson is currently Deputy Director of the Center for Health Decision Science and affiliated with the Harvard Center for Risk Analysis. She was previously a Senior Fellow at the Mossavar-Rahmani Center for Business and Government as well as an Affiliate Fellow of its Regulatory Policy Program at the Harvard Kennedy School. She is a past President of the Society for Benefit-Cost Analysis and served as a Councilor of the Society for Risk Analysis as well as Chair of its Economics and Benefits Analysis Specialty Group. She is on the Editorial Boards of Risk Analysis and the Journal of Benefit-Cost Analysis.

Rebecca Smith-Bindman is Professor of Radiology, Epidemiology and Biostatistics, Obstetrics, Gynecology and Reproductive Medicine, and Health Policy at University of California San Francisco School of Medicine where she directs the Radiology Outcomes Research Lab. She graduated from Princeton University with a degree in Engineering, attended UCSF Medical School, and completed her Radiology Residency, and Radiology and Epidemiology and Biostatistics fellowship training at UCSF. She is a clinical researcher with expertise in radiology, epidemiology, outcomes research, comparative effectiveness research, health services research, and dissemination and implementation sciences focused on imaging. Her research has focused on evaluating the quality, utilization, accuracy, predictive values and impact of diagnostic testing on patient health, and she has quantified both the risks and benefits of medical imaging when used in different contexts and by different populations. She has published broadly on the use of medical imaging, exposure to ionizing radiation, and risk of cancer associated with these exposures. These publications have highlighted that radiation

doses are frequently far higher than needed for diagnosis, and higher than widely known. These papers also highlight that the variability is not driven by variation in patient need, but rather by local choices in how CTs are done. This work has brought attention to the greater need for standards in imaging. She is currently leading two large, multi-institutional epidemiological projects on medical radiation funded by the NIH. One project is collecting radiation dose metrics associated with CT from over 160 hospitals in the US, Europe and Asia, and in another she has tested the impact of providing feedback and education on average and high doses. She is leading a multi-national epidemiological study assessing the risk of cancer associated with medical imaging among 1 million children and 1 million pregnant patients. The study will be the first to quantify the risk of medical imaging in the U.S. including CT among a large cohort of patients, and uses novel methods to accurately estimate dose. She is also contracted to write a quality measure for CMS focused on CT including measures of image quality and radiation dose for consideration for use in their pay for performance programs. Separate from her research activities, she has been actively involved in raising awareness of the issues surrounding the need for greater safety and standards around medical imaging. She has spoken at the FDA, testified before the US Congress on several occasions, and worked with many leading professional societies to help focus attention on improving the safety of medical imaging. She has also written several quality measures on radiation dose that were adopted by the National Quality Forum, or are currently under consideration by them, and has developed many educational tools to help physicians and the lay public understand the importance of minimizing radiation exposures where possible.

Gerry Thomas is Professor of Molecular Pathology and has spent most of her research career on understanding the health effects of the Chernobyl accident. She established the Chernobyl Tissue Bank (www.chernobyltissuebank.com) in 1998, and has published extensively on the molecular pathology of thyroid cancer in children and young people. Following the Fukushima accident, she was asked to explain the health risks of low dose radiation on both broadcast and written media in the UK and internationally. She has been involved in a number of expert groups for the IAEA, UNSCEAR and IARC, the most recent of these focusing on thyroid monitoring after nuclear accidents. She has also been asked to provide advice to the Japanese and UK governments on communication of radiation risk, as well as providing expert advice to government agencies in other countries with regard to the health risks of nuclear power. She is a member of the UK's Committee on Radioactive Waste Management and was awarded an OBE in 2019 for services to Science and Public Health.

Beata Tsosie-Peña is from Santa Clara Pueblo and El Rito, NM. She is certified in Infant Massage, as a Developmental Specialist I-Advanced, an Educator, a full spectrum Doula and Lactation Counselor, and in Indigenous Sustainable Design (permaculture). Beata is on the steering committee for the Traditional Native American Farmers Association and is a board member for Flowering Tree Permaculture Institute. She also works with Breath of My Heart Birthplace. She is a Pueblo representative for the New Mexico Governor's taskforce on Missing and Murdered Indigenous Women and Relatives serving a second term. The realities of living next to a nuclear weapons complex has called her into environmental health and justice work with the local non-profit organization, Tewa Women United, for over a decade. As part of Beata's work with TWU, she currently manages the creation of the Española Healing Foods Oasis demonstration garden project and Seed Library.

Aditi Verma is a Visiting Scholar at the Belfer Center's Project on Managing the Atom and a Research Scientist in the Department of Nuclear Engineering and Radiological Sciences at the University of Michigan where she will begin an appointment as an Assistant Professor in Fall 2022. Aditi was previously a Stanton Nuclear Security Postdoctoral Fellow at the Belfer Center's

Project on Managing the Atom and the International Security Program. Aditi is broadly interested in how nuclear technologies specifically and complex systems broadly—and their institutional infrastructures—can be designed in more just, equitable, and participatory ways that are epistemically inclusive of both lay and expert perspectives. To this end, she is interested in developing a more fundamental understanding of the early stages of the design process to improve design practice and pedagogy, and also improve the tools with which designers of complex sociotechnical systems work. Prior to her appointment at the Belfer Center, Aditi worked at the OECD Nuclear Energy Agency, where her work, endorsed and funded by policymakers from the NEA member countries, focused on bringing epistemologies from the humanities and social sciences to academic and practitioner nuclear engineering, thus broadening their epistemic core. Aditi holds undergraduate and doctoral degrees in Nuclear Science and Engineering from MIT. Her doctoral research, funded by the Sloan Foundation and a Spira Fellowship, combined theoretical and methodological resources from design studies and sociology to study how reactor designers make decisions in the foundational early stages of design, particularly those bearing on safety. Aditi has also previously held positions at the International Atomic Energy Agency, Framatome (formerly Areva), and the Center for the Study of Science, Technology and Policy. Her work, authored for academic as well as policymaking audiences, has been published in Nuclear Engineering and Design, Nature, Nuclear Technology, Issues in Science and Technology, Bulletin of the Atomic Scientists, and Inkstick.

Jessica Wieder is the Director of the Center for Radiation Information and Outreach at the U.S. Environmental Protection Agency (EPA). She served as EPA's senior radiation public information officer during the 2011 Fukushima Daiichi nuclear accident response and was part of the contingency planning team for the 2020 and 2011 U.S. Mars rover launches. In 2013, she was awarded EPA's Exemplary Customer Service Award for her leadership in enabling all levels of government to provide quick, effective communications to the American people in response to large-scale radiological emergencies. Ms. Wieder is on the Board of Directors for the National Council on Radiation Protection and Measurement (NCRP). In 2019—in her role with NCRP—Ms. Wieder became a TED educator on how to survive nuclear fallout.

Statement of Task

The National Academies of Sciences, Engineering, and Medicine will perform a study and provide a report with findings and recommendations on the current status and development of a long-term strategy for low-dose radiation research in the United States. Specifically, the objectives of the study will be to:

1. Define the health and safety issues that need to be guided by an improved understanding of low dose and low dose rate radiation health effects.
2. Identify current scientific challenges for understanding low dose and low dose rate radiation health effects.
3. Assess the status of current low dose radiation research in the United States and internationally.
4. Recommend a long-term strategic and prioritized research agenda to
    - address scientific research goals for overcoming the identified scientific challenges in coordination with other research efforts

- support education and outreach activities to disseminate information and promote public understanding of low-dose radiation.

5. Define the essential components of the research program that would address this research agenda within the universities and National Laboratories.
6. Address coordination between federal agencies (including the National Institutes of Health, the National Science Foundation, National Aeronautics and Space Administration, and different DOE offices) and with international efforts to achieve objectives.
7. Identify and, to the extent possible, quantify, potential monetary and health-related impacts to Federal agencies, the general public, industry, research communities, and other users of information produced by such research program.

The National Academies will prepare a report with findings and recommendations that addresses the objectives above.