The National Academies of
SCIENCES • ENGINEERING • MEDICINE

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

PUBLIC MEETING #4 (Virtual)
September 24, 2021, All times are EDT

PUBLIC AGENDA

ZOOM CONNECTION

https://nasem.zoom.us/j/94640646246?pwd=MW5kMGczbFVwQ0RVSVhEdlNiTUVadz09
Meeting ID: 946 4064 6246
Password: 543498

11:00 AM – 11:05 AM	**Welcome and Open Public Session** *Joe Gray, Committee Chair*
11:05 AM – 11:35 AM	**Coordination of Low-Dose Radiation Research with the National Cancer Institute (NCI)** *Amy Berrington de González, Division of Cancer Epidemiology and Genetics, NCI* *C. Norman Coleman, Center for Cancer Research, NCI*
11:35 AM – 11:50 AM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
11:50 AM – 12:10 PM	**Coordination of Low-Dose Radiation Research with the Nuclear Energy Agency-Organisation for Economic Co-operation and Development (NEA-OECD)** *Jacqueline Garnier-Laplace, Division of Radiological Protection and Human Aspects of Nuclear Safety, Nuclear Energy Agency, OECD* *Dominique Laurier, French Institute for Radiological Protection and Nuclear Safety (IRSN) and Chair of the NEA's High Level Group on Low Dose Research*
12:10 PM – 12:25 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
12:25 PM – 12:40 PM	**Coordination of Low-Dose Radiation Research with the National Institute of Allergy and Infectious Diseases (NIAID)** *Andrea L. DiCarlo-Cohen, Radiation and Nuclear Countermeasures Program, NIAID*

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12:40 PM – 12:50 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
12:50 PM – 1:10 PM	**BREAK**
1:10 PM – 1:25 PM	**Coordination of Low-Dose Radiation Research with the National Institute for Occupational Safety and Health (NIOSH)** *Kaitlin Kelly-Reif, Division of Field Studies and Engineering, NIOSH*
1:25 PM – 1:35 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
1:35 PM – 1:50 PM	**Coordination of Low-Dose Radiation Research with the Armed Forces Radiobiology Research Institute (AFRRI)** *Alexandra C. Miller, PhD, USUHS IACUC Chair and Senior Scientist, Science Research Department (SRD), Armed Forces Radiobiology Research Institute (AFRRI), Uniformed Services University of the Health Sciences (USUHS)*
1:50 PM – 2:00 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
2:00 PM – 2:15 PM	**Coordination of Low-Dose Radiation Research with the Centers for Disease Control and Prevention (CDC)** *Armin Ansari, Radiological Assessment Team, CDC*
2:15 PM – 2:25 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
2:25 PM – 2:40 PM	**Coordination of Low-Dose Radiation Research with the Electric Power Research Institute (EPRI)** *Don Cool, Radiation Safety, EPRI*
2:40 PM – 2:50 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
2:50 PM – 3:00 PM	**BREAK**
3:00 PM – 3:30 PM	**Space Radiation: Opportunities for Tactical Collaboration** *S. Robin Elgart, Human Research Program, NASA* **NASA BPS Open Science Data Systems for Low Dose Data** *Sylvain Costes, Radiation Biophysics Laboratory, NASA*
3:30 PM – 3:45 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
3:45 PM – 4:05 PM	**Perspectives from DOE Management of the Previous DOE Low-Dose Radiation Research Program** *Arthur Katz, Biological and Environmental Research, DOE (retired)*

4:05 PM – 4:20 PM	**Q+A with the Committee and Staff** *Moderated by Joe Gray, Committee Chair*
4:20 PM – 4:45 PM	**General Questions and Discussion with All Invited Speakers** *Moderated by Joe Gray, Committee Chair*
4:45 PM – 5:30 PM	**Public Comment Period**
5:30 PM	**Adjourn Meeting**

Pointers to Speakers

NASA, NCI, NIAID, NIOSH, CDC, AFRRI, EPRI, NEA-OECD

- Please introduce the mission of your agency/organization and the specific role of your Division/Program.
- Did your agency/organization coordinate research with the previous DOE low-dose program? If yes, please describe the main coordinated projects and how this coordination was achieved.
- Please provide examples of this coordination that have resulted in multi-authored presentations or publications.
    - Are you tracking the extent to which this occurs?
- What structures do you use in your organization to promote coordination/collaboration across both government and academic researchers?
- Do you currently conduct research on low dose radiation? If yes, please describe the main focus areas. If not, please explain why this type of research is outside scope.
- ***New!*** Is your organization involved in radiation training (e.g., hosting courses, lectures, issuing grants/fellowships, other)? If yes, please describe. Do you address low-dose radiation issues?
- ***New!*** Please describe low dose and low dose rate knowledge gaps that you would like to see addressed.
- Are you tracking low-dose radiation publications separately within radiation research?
- Please provide your perspectives on opportunities for coordination with the new low dose program.
- What are some radiation research capabilities that your agency/organization has (facilities, expertise, databases, other resources) that in your view are useful assets for low-dose radiation research coordination?
- What are some possible avenues (e.g., interagency or other agreements) that could be employed to achieve coordination with DOE's low dose program? Please provide your views on successful models of coordination of research.
- What are some impediments that in your view prevent coordination with DOE's low dose program and how can these be overcome?
- What are some low-dose radiation research areas that your organization sees as high-priority?
- What advice do you have for the committee related to any of the aspects of its statement of task?

DOE Manager (retired)

- Please provide an overview of the program including number of projects and laboratories funded per year and $ amounts.
- Major scientific achievements and implications in regulations/guidance.
- Views on essential elements for a successful new low-dose program.
- *New!* Did the previous low dose program keep a comprehensive list of irradiation facilities available for low dose research and capabilities? If yes, can the list become available to the committee?
- What advice do you have for the committee related to any of the aspects of its statement of task?

Publications/Documents Provided

From Kaitlin Kelly-Reif, NIOSH

1) A summary of the Occupational Energy Research Program (OERP) studies can be found here: https://www.cdc.gov/niosh/oerp/study.html
2) 353 NIOSH products about radiation can be found in NIOSHTIC-2, which is a searchable bibliographic database of occupational safety and health publications, supported in whole or in part by the National Institute for Occupational Safety and Health (NIOSH). https://bit.ly/38PlPMI

From Norman Coleman, NCI

C. Norman Coleman, Jeffrey C. Buchsbaum, Pataje G. S. Prasanna, Jacek Capala, Ceferino Obcemea, Michael G. Espey, Mansoor M. Ahmed, Julie A. Hong, and Bhadrasain Vikram. "Moving Forward in the Next Decade: Radiation Oncology Sciences for Patient-Centered Cancer Care." JNCI Cancer Spectrum (2021) 5(4): pkab046. doi: 10.1093/jncics/pkab046.

From Donald Cool, EPRI

International Dose Effect Alliance (IDEA) Virtual Workshop – December 2, 2020: https://www.epri.com/research/programs/061197/events/34A11135-FD9B-48B1-B08C-5A3704B7421D

From Andrea DiCarlo-Cohen, NIAID

Animal Models and Medical Countermeasures Development for Radiation-Induced Lung Damage: Report from an NIAID Workshop. Jacqueline P. Williams, Isabel L. Jackson, Jui R. Shah, Christine W. Czarniecki, Bert W. Maidment and Andrea L. DiCarlo. Radiation Research 177, e0025–e0039 (2012)
0033-7587/12. DOI: 10.1667/RROL04.1.

Cellular Therapies for Treatment of Radiation Injury: Report from a NIH/NIAID and IRSN Workshop. Andrea L. DiCarlo, Radia Tamarat, Carmen I. Rios, Marc Benderitter, Christine W. Czarniecki,

Theresa C. Allio, Francesca Macchiarini, Bert W. Maidmentf, and Jean-Rene Jourdain. Radiation Research 188, 000–000 (2017); 0033-7587/17. DOI: 10.1667/RR14810.1.

Challenges and Benefits of Repurposing Products for Use during a Radiation Public Health Emergency: Lessons Learned from Biological Threats and other Disease Treatments. Andrea L. DiCarlo, David R. Cassatt, William E. Dowling, John L. Esker, Judith A. Hewitt, Oxana Selivanova, Mark S. Williams and Paul W. Price. Radiation Research 190, 659–676 (2018); 0033-7587/18. DOI: 10.1667/RR15137.1.

Cutaneous Radiation Injuries: Models, Assessment and Treatments. Andrea L. DiCarlo, Aaron C. Bandremer, Brynn A. Hollingsworth, Suhail Kasim, Adebayo Laniyonu, Nushin F. Todd, Sue-Jane Wang, Ellen R. Wertheimer and Carmen I. Rios. Radiation Research 194, 315–344 (2020); 0033-7587/20. DOI: 10.1667/RADE-20-00120.1.

Medical Countermeasures against Nuclear Threats: Radionuclide Decorporation Agents. David R. Cassatt, Joseph M. Kaminski, Richard J. Hatchett, Andrea L. DiCarlo, Jessica M. Benjamin and
Bert W. Maidment. Radiation Research 170, 540–548 (2008); 0033-7587/08.

Medical Countermeasures for Platelet Regeneration after Radiation Exposure. Report of a Workshop and Guided Discussion. Andrea L. DiCarlo, Mortimer Poncz, David R. Cassatt, Jui R. Shah, Christine W. Czarniecki and Bert W. Maidment. Radiation Research 176, e0001–e0015 (2011); 0033-7587/11. DOI: 10.1667/RROL01.1.

Medical Countermeasures for Radiation Combined Injury: Radiation with Burn, Blast, Trauma and/or Sepsis. Andrea L. DiCarlo, Richard J. Hatchett, Joseph M. Kaminski, G. David Ledney, Terry C. Pellmar, Paul Okunieff and Narayani Ramakrishnan. Radiation Research 169, 712–721 (2008); 0033-7587/08.

Neutron Radiobiology and Dosimetry. Daniela L. Stricklin, Jama VanHorne-Sealy, Carmen I. Rios, Lisa A. Scott Carnell and Lanyn P. Taliaferro. Radiation Research 195, 480–496 (2021); 0033-7587/21. DOI: 10.1667/RADE-20-00213.1.

Use of Growth Factors and Other Cytokines for Treatment of Injuries During a Radiation Public Health Emergency. Andrea L. DiCarlo, Zulmarie Perez Horta, Jennifer T. Aldrich, Ann A. Jakubowski, William K. Skinner and Cullen M. Case, Jr. Radiation Research 192, 99–120 (2019); 0033-7587/19. DOI: 10.1667/RR15363.1.

From Jacqueline Garnier-Laplace, OECD-NEA

- Nuclear Energy Agency (NEA) - High-Level Group on Low-Dose Research (HLG-LDR) (oecd-nea.org)
- Nuclear Energy Agency (NEA) - Improving global networking in low-dose radiation research (oecd-nea.org)
- Nuclear Energy Agency (NEA) - International Horizon-style Exercise to Evolve the Use of the Adverse Outcome Pathway (AOP) Framework in Radiation Research and Regulation (oecd-nea.org)

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.

Speaker Biographies

Armin Ansari is the Radiological Assessment Team Lead at the Centers for Disease Control and Prevention (CDC). He received his B.S. and PhD degrees in radiation biophysics from the University of Kansas and completed his postdoctoral research in radiation mutagenesis at Oak Ridge and Los Alamos National Laboratories. His focus since joining CDC in 2002 has been on public health preparedness and response planning for nuclear and radiological emergencies and he has led the development of key national guidance documents as well as numerous training programs directed at public health professionals. He is a fellow and past president of the Health Physics Society and is certified in comprehensive practice by the American Board of Health Physics. He is also an elected member of the National Council on Radiation Protection and Measurements, and serves as member of the United States delegation to the United Nations Scientific Committee on the Effects of Atomic Radiation.

Amy Berrington de González, D.Phil., is the Branch Chief of the NCI's Radiation Epidemiology Branch. She is an internationally recognized expert in the potential cancer risks from medical radiation exposures. Dr. Berrington is co-PI of the UK Pediatric CT scans cohort, which was the first epidemiological study to suggest a direct link between CT scans and subsequent cancer risk. She also leads studies on the risk of second cancer after proton therapy and other emerging radiotherapy techniques. Dr. Berrington is currently a member of the NAS Nuclear and Radiation Studies Board and has participated in many national and international radiation committees. She is an elected member of the American Epidemiological Society and served on the editorial board for the American Journal of Epidemiology. Before joining the NCI in 2008 she held faculty positions at Oxford and Johns Hopkins University. She has a DPhil in Cancer Epidemiology from the University of Oxford.

C. Norman Coleman, MD is the Associate Director for the Radiation Research Program in the Division of Cancer Treatment and Diagnosis and a Senior Investigator in the Radiation Oncology Branch in the Center for Cancer Research, National Cancer Institute, NIH. He is also a Senior Medical Advisor in the Office of the Assistant Secretary for Preparedness and Response in the US. Department of Health and Human Services. He received his BA in Mathematics (University of Vermont), MD (Yale University School) and is Board Certified in internal medicine (UC San Francisco), medical oncology (NCI) and radiation oncology (Stanford). He served in the US Public Health Service (O-4). Dr Coleman became a tenured faculty member in Radiology and Medicine at Stanford (1978 – 1985) and then moved to Harvard Medical School (1985 – 1999) as the Alvan T. and Viola D. Fuller- Medicine Cancer Society Professor and Chairman of the Joint Center for Radiation Therapy. He returned to the NCI in 1999. His interests include an ongoing NCI laboratory program in radiation-inducible molecular targets (using radiation "as a drug"), radiation biomarkers of normal tissue injury and multi-modality cancer therapy. His honors include: Gold Medal, ASTRO (2005), Service to America Homeland Security Medal (2011), Radiation Research Society Failla Award (2016), University of Vermont, Doctor of Science Honoris Causa (2015) and National Coalition for Cancer Survivorship Ellen Lewis Stovall Patient Centered Cancer Care Award (2018).

Dr. **Donald A. Cool**, Ph.D., is currently the Technical Executive for Radiation Safety with the Electric Power Research Institute (EPRI). He joined EPRI in 2015 following retirement from the U.S. Nuclear Regulatory Commission, where he served more than 32 years. Dr. Cool received his B.S. degree in Biology from Houghton College. His Masters and Doctorate degrees are in Radiation Biology from the University of Rochester, School of Medicine and Dentistry. He is the Vice-Chair of the Main Commission of the International Commission on Radiological Protection. He is a Council Member of the U.S. National Council on Radiation Protection and Measurements and was the Co-Chair of NCRP Council Committee 1 which produced NCRP Report 180, Management of Exposure to Ionizing Radiation: Radiation Protection Guidance for the United States. He has served on numerous panels and expert groups of the International Atomic Energy Agency and Nuclear Energy Agency. He is a Fellow of the Health Physics Society.

Dr. **Sylvain Costes** is the Branch Chief for the Space Biosciences Research Branch at NASA Ames research center and a senior research scientist leading the Ames radiation biophysics laboratory. He obtained his Ph.D. in the Nuclear Engineering Department at the University of California, Berkeley, where he studied radiation biology. Dr. Costes has spent his career leading multidisciplinary research teams in both academic and government scientific institutions. As a staff scientist at the Lawrence Berkeley National Lab, he was modeling risk for the NASA Human research program and developing biomarkers for the DOE low dose program. He is now the project manager for Open Science at NASA Biology and Physical Science Division, where he

leads the systems biology research, AI/ML modeling effort and the software development for two large NASA data systems: the GeneLab Omics repository and the ALSDA repository for physiological data from spaceflight relevant experiments.

Andrea DiCarlo earned her doctorate from the University of Maryland, for work focused on targeting heat shock proteins to reduce oxidative stress caused by ionizing radiation exposures and other stressors. These studies led her to carry out post-doctoral work at The Catholic University of America (CUA), where she studied radioprotection of normal tissues in animal models of cancer. While at CUA, Andrea initiated collaborations with staff from the Armed Forces Radiobiology Research Institute (AFRRI) as well as the Georgetown Lombardi Comprehensive Cancer Center, and parlayed her postdoctoral work into a position as the Project Manager of the laboratory, and as a CUA faculty member. In 2004, Andrea became a Program Officer in the Radiation and Nuclear Countermeasures Program (RNCP) at the National Institute of Allergy and Infectious Diseases (NIAID), within the National Institutes of Health (NIH), where she was responsible for the oversight and management of a research portfolio exceeding ~$20 million dollars per year. She has published extensively in government reports and peer-reviewed journals on the biological effects of radiation exposure, testing of medical countermeasures, and evaluation of biodosimetry devices and biomarkers for triage. Representing NIAID, she has worked with other US government agencies and non-governmental organizations to highlight and support national and international research activities, reviewed grant applications and manuscripts, and has served as a subject matter expert and invited presenter for numerous research working groups and conferences. She was named Director of the RNCP in 2019.

Shona "Robin" Elgart is the Space Radiation Element Scientist for the NASA Human Research Program. Dr. Elgart has more than 20 years of research experience across multiple life-science disciplines, including medical physics and radiation biology. She received a Bachelor's degree in microbiology from the University of California at Santa Barbara and a Master's and Doctorate in biomedical physics from the University of California at Los Angeles in the laboratory of Dr. Keisuke Iwamoto. Her dissertation focused on characterizing the DNA damage response following low-dose radiological exams in patient samples. Before joining The Space Radiation Element in April 2020, Dr. Elgart served as a subject matter expert specializing in space radiation health risks for NASA's Space Radiation Analysis Group (SRAG) where she directed and managed reviews of radiation health outcome evidence, translated research findings into evidence-based operational radiation protection strategies, and analyzed astronaut exposure and risk for the Radiation Health Office. She also has four years of mission operations experience as a Space Environment Officer and Radiation Mission Manager for Mission Control Center in Houston. As the Element Scientist for the Space Radiation Element, Dr. Elgart's primary objective is to develop and execute a robust applied research strategy to meet the agency's goal to put the first woman on the Moon and the first humans on Mars.

Jacqueline Garnier-Laplace is Deputy Head of the Division of Radiological Protection and Human Aspects of Nuclear Safety at the OECD Nuclear Energy Agency (NEA). She joined the Agency in May 2019. She serves as the Scientific Secretary for the Committee on Radiological Protection and Public Health (CRPPH), and a number of subsidiary groups such as the High-Level Group on Low Dose Research. Previously, she was the Deputy Director in charge of Research for Radiological Protection at the French Institute for radiological protection and nuclear safety (IRSN). During her 28-year career in the field of radiological protection, she held various manager positions e.g., Deputy Director of the Environment (2015-2017), Head of Department on Research and Expertise on Environmental Risks (2007-2015). She is a member of the International Commission on Radiological Protection (ICRP). After being the scientific secretary of Committee 1 on "Effects of ionising radiation" for the period 2017-2021, she is now

serving Committee 4 on “Application of the Commission’s recommendations” until 2025. She has (co)-authored ca. 110 peer-reviewed papers mainly dealing with various radiological protection scientific issues.

Dr. **Arthur M. Katz** spent almost 40 years in the U.S. Department of Energy and predecessor agencies dealing with a wide range of energy and science topics including advanced nuclear reactors, planning and international collaboration in fusion energy, and fundamental biological and environmental research. In the Office of Biological and Environmental Research (OBER) he was responsible for managing projects that were part of DOE’s contribution to the Human Genome Program, research into low dose radiation health effects, and a variety of molecular imaging and structural biology projects. He was a member of the Low Dose Radiation Expert Subcommittee reporting to the Biological and Environmental Research Advisory Committee on Low Dose Radiation research. He received a PhD in chemistry from the University of Rochester, 1969 and a M.S. in meteorology from MIT, 1974.

Kaitlin Kelly-Reif is an epidemiologist in the NIOSH Division of Field Studies and Engineering, Field Research Branch. She earned her masters and PhD in environmental and occupational epidemiology from the Gillings School of Global Public Health, University of North Carolina Chapel Hill where she studied cancer among underground uranium miners in the Czech Republic. In 2014 she was a US National Science Foundation fellow at the Radiation Effects Research Foundation in Hiroshima, Japan. Dr. Kelly-Reif leads chronic disease studies of workers exposed to ionizing radiation, particulate matter, and industrial chemicals. At NIOSH Dr. Kelly-Reif leads two large and historically important studies of radiation-exposed workers, the US Colorado Plateau uranium miners’ study and the pooled US Nuclear Workers study. She also represents NIOSH in two international research consortia, the Pooled Uranium Miners Analysis (PUMA) and the International Nuclear Workers Study (INWORKS).

Dominique Laurier, PhD, is the head of a research department on the biological and health effects of low-dose radiation exposure at the French Institute for Radiation Protection and Nuclear Safety (IRSN). He has 25 years of experience in the field of radiation epidemiology and has participated in numerous national and international research projects on the health effects of low-dose radiation exposure. He has been Chair of the Nuclear Energy Agency's (NEA) High Level Group on Low Dose Research (HLG-LDR) since 2020. He has been a member of the main commission of the International Commission on Radiological Protection (ICRP) since 2017 and is currently the chairman of ICRP Committee 1, as well as the French representative to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

Alexandra C. Miller, PhD., is a senior scientist and research biologist in the Science Research Department (SRD) at the Armed Forces Radiobiology Research Institute (AFRRI) at the Uniformed Services University of the Health Sciences (USUHS). Dr. Miller is an internationally recognized researcher in the field of depleted uranium toxicity and late radiation biological effects. She is the AFRRI/SRD program leader of the chronic low dose radiation program otherwise known as the Combat Operations at Low Dose research program (COAL-R) at AFRRI. Dr. Miller is a trained radiation biologist educated at the State University of NY at Buffalo in the Roswell Park Cancer Division. Dr. Miller has over 74 publications, 1 book on Depleted uranium, and multiple book chapters on low dose radiation and uranium metal toxicity. She holds adjunct or visiting scientist positions at USUHS Department of Radiology and Radiation Science, Columbia University Center for Radiological Research NY, NYU Langone Medical Center, and the Department of Chemistry and Life Science at US Military Academy West Point. A long-time AFRRI scientist, Dr. Miller has publications in the areas of radiation biochemistry, radiation protection, radiation mechanisms, military medicine, depleted uranium and heavy

metal biological effects. Currently she leads funded-studies on low dose mixed field neutron effects, radiation cardiotoxicity, radiation countermeasure development, and use of 3-D models to assess low dose neurological responses. Dr. Miller serves as the lead AFRRI member of the NATO Science and Technology Organizations (STO) Working Group on Radiation Bioeffects RTG291 and was recently invited to serve as a Department of Defense member of the ICCVAM – Consideration of Alternate Methods Working Group. Dr. Miller has successfully guided the advanced degree studies of MD-PhD, and PhD students at NYU, an MS student at Georgetown University and currently has 2 PhD students, 1 at USUHS, and 1 at NYU.