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The National Academy of Sciences and the National Cancer Institute host:

The 2014 Gilbert W. Beebe Symposium

The Science and Response to a Nuclear Reactor Accident

May 13, 2014

Keck Center of the National Academy of Sciences
500 Fifth Street, NW
Washington, DC 20001
Room 100

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Introduction

The National Academy of Sciences and the National Cancer Institute are hosting the 2014 Gilbert W. Beebe symposium to promote discussions among federal, state, academic, research institute, industry, and media on current scientific knowledge and response plans for a nuclear reactor accident. Specifically, the symposium will address:

- Offsite emergency response (e.g., shelter, prophylactic medicine, evacuation) and long-term management of the accident consequences (e.g., cleanup of contaminated areas, resettlement).
- Estimating radiation exposures of affected populations.
- Health effects (e.g., mental distress, cancer, other diseases) and population monitoring.
- Other radiological consequences (e.g., land and water contamination, disruption of food distribution, disruption of the economy).
- Communication among plant officials, government officials, and the public and the role of the media.

The symposium is sponsored by the National Institutes of Health through a subcontract from RTI International and by the Environmental Protection Agency.

The Gilbert W. Beebe Symposium is dedicated in honor of the distinguished National Cancer Institute radiation epidemiologist who died in 2003. Dr. Beebe was one of the designers and key implementers of the epidemiology studies of the A-bomb survivor cohorts and was a co-founder along with the distinguished surgeon Dr. Michael DeBakey of the Medical Follow-up Agency at the National Academies.

The Symposium series is held under the auspices of the Nuclear and Radiation Studies Board (NRSB). To submit feedback and comments on the 2014 Gilbert W. Beebe Symposium, or suggestions for future themes, please contact us at: nrsb@nas.edu.

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Abstracts

8:05 AM Past Nuclear Reactor Accidents: Where? When? Why?

Steve L. Simon, National Cancer Institute

The International Atomic Energy Agency (IAEA) classifies nuclear accidents according to the type and magnitude of radioactive materials released and the potential health impacts:

(i) Accidents without off-site risk where the release of radioactivity results in a dose to the critical group of the order of a few millisieverts, such as the 1957 Windscale fire in the U.K,

(ii) Accidents with potential off-site risk characterized by releases of radioactive material in quantities radiologically equivalent to the order of hundreds to thousands of terabecquerels of ^{131}I and that would likely result in partial implementation of countermeasures covered by emergency plans to lessen the likelihood of health effects and severe damage to the installation; an example is the 1979 Three Mile Island (TMI) accident in Pennsylvania,

(iii) Serious accidents characterized by releases of radioactive material in quantities radiologically equivalent to the order of thousands to tens of thousands of terabecquerels of ^{131}I and that would likely to result in full implementation of countermeasures covered by local emergency plans to limit serious health effects; an example is the 1957 Khystym accident in the former USSR,

(iv) Major accidents characterized by release of a large fraction of the radioactive material inventory in a large facility, e.g. the core of a power reactor. This latter type of accident would typically involve a mixture of short and long-lived radioactive fission products in quantities radiologically equivalent to more than tens of thousands of terabecquerels of ^{131}I and would result in the possibility of acute health effects; delayed health effects over a wide area, possibly involving more than one country; long-term environmental consequences; examples are the 1986 Chernobyl accident in the Ukraine or the 2011 Fukushima accident in Japan.

Despite the negative view of nuclear power that is engendered by these accidents, the World Nuclear Association notes that Three Mile Island, Chernobyl, and Fukushima are the only major reactor accidents in the history of civil nuclear power

and that they have been the only major accidents to have occurred in over 14,500 cumulative reactor-years of commercial nuclear power operation in 33 countries. While a seemingly safe industry in terms of frequency of occurrence and the number of deaths that can be directly attributed the accidents, nuclear power plant accidents can result in huge economic losses as well as significant societal disruption and psychological trauma. Moreover, the cost of technical measures to ensure such a low accident rate is monetarily high. Given the high scrutiny the nuclear power industry receives through regulatory and advisory organizations and the high level of engineering skill and expertise applied to their designs, it may be valuable to examine the root causes of nuclear power plant accidents. Like other types of accidents, accidents in the nuclear industry can generally be traced to one or more of the following reasons which are often not completely independent: poor judgment, mechanical failures, and acts of nature (aka ‘acts of God’). Nuclear power, like other complex technologies, occasionally has failures that become significant events in history and that need to be thoroughly evaluated in order to minimize their future occurrence and scale.

8:20 AM

Emergency Response Research Needs

Nicole Lurie, Department of Health and Human Services

Public health preparedness is an ongoing effort. Despite significant enhancements to the public health preparedness arena over the years, public health emergencies continue to reveal previously unforeseeable gaps in knowledge and practice. Past disasters such as the 2009 Influenza A (H1N1) pandemic, the Deepwater Horizon oil spill, and Hurricane Sandy have highlighted the need for rapidly initiated research in the midst of and immediately following a disaster, which would benefit and inform improved response and recovery.

The diversity of past disasters, and the subsequent responses to them, illustrates our vulnerability to a wide array of potential threats, and our current limitations to collect, analyze and leverage critical scientific research rapidly and in real-time. A research infrastructure needed for rapid funding and institutional review board (IRB) processes, clinical protocols, and baseline collection of data, to allow a rapid and flexible research response represent a handful of the gaps needing to be filled.

To directly address these challenges, the Assistant Secretary for Preparedness and Response (ASPR) has initiated an integrated approach to provide for the inclusion of scientific research into the health and medical response, coordinated alongside lifesaving response activities. This research will provide an evidence base to support decision making for the long-term recovery and resilience of healthcare systems and communities. A guiding principle for ASPR’s approach includes the “Whole of Community”, the creation of sustained and ongoing collaborations, and decreasing the time necessary to initiate scientific research. Such an approach will help facilitate an effectively integrated science response during the next disaster.

ASPR's Science Preparedness and Response efforts will continue to shorten the lead time necessary to initiate research in the context of a public health emergency. As the program evolves, ASPR will continue to lead interagency efforts to enhance public health preparedness, response and recovery through innovative and achievable approaches to rapid science research before, during and after a disaster.

8:40 AM

Physical Health Effects

Alina V. Brenner, National Cancer Institute

There have been four major reactor accidents in the nuclear industry history that resulted in irreparable damages to the power plant and radiation exposures to ≥ 1,000 people: Windscale, UK, 1957; Three Mile Island, US, 1979; Chernobyl, UA, 1986; and Fukushima Daiichi, JP, 2011. Most knowledge about health consequences of nuclear reactor accidents derives from the Chernobyl accident, the most severe in history, with additional support from studies of other environmentally exposed populations (e.g., a-bomb survivors, individuals exposed to above-ground atomic testing).

Following the Chernobyl accident, 134 plant and emergency workers received high whole body doses resulting in acute radiation syndrome (ARS); 28 of these died within four months with their deaths being directly attributed to high radiation doses. No acute health effects were reported among evacuees or general population.

Due to consumption of iodine-131 contaminated milk, Chernobyl area residents received substantial radiation doses to the thyroid. A dramatic increase in incidence of thyroid cancer among those exposed in childhood was observed as early as 1991 and was attributed to iodine-131 exposure. Epidemiological studies with individual dosimetry reported that radiation risk estimates for thyroid cancer were comparable to those from external radiation. There is no convincing evidence of radiation-related increase in thyroid cancer among residents exposed in adulthood or other health outcomes in general population.

Over 500,000 workers from the former Soviet Union were involved in recovery operations following the Chernobyl accident. The main pathway of their exposure was external gamma radiation from contaminated material deposited on ground and building surfaces. The most consistent finding in clean-up workers is increased risk of all leukemia. Some studies also reported elevated risks of chronic lymphocytic leukemia, previously considered unrelated to radiation exposure. In addition, dose-response relationship for different lens opacity endpoints was found, at substantially lower radiation doses than those on which radiation protection guidelines were based, along with increased risk of thyroid cancer consistent with that from childhood exposure.

Knowledge acquired from the Chernobyl accident coupled with knowledge from other studies of exposed populations helped mitigate consequences of the recent accident at the Fukushima Daiichi nuclear power plant that followed the Great East Japan earthquake. No patients with ARS or deaths attributed to radiation have been reported in Fukushima. Due to the nature of the accident and countermeasures taken (evacuation, sheltering, control of milk contamination), radiation dose estimates currently available for residents and recovery workers indicate that on average these are substantially lower than after the Chernobyl accident. Thus, magnitude of radiation-related health consequences is expected to be considerably lower too. However, to assure the well-being of residents and recovery workers and extend knowledge about physical consequences of nuclear reactor accidents, various health programs in Japan are currently in progress.

9:05 AM

Social, Psychological and Behavioral Impacts

Steven M. Becker, Old Dominion University College of Health Sciences

Research and experience over the past several decades has made it clear that social, psychological and behavioral effects constitute some of the most important impacts of nuclear accidents. Some of these impacts can be widespread and long-lasting, potentially touching the lives of large numbers of individuals, families and communities. In some cases, social, psychological and behavioral effects can even spread well beyond the directly-impacted areas, affecting regions and populations located much farther away. In this presentation, some of the most significant social, psychological and behavioral effects of nuclear accidents are summarized using key findings and lessons from research and experience. At the individual level, this includes such mental health impacts as anxiety, depression, poor subjective health ratings and other emotional repercussions. Information regarding the groups at highest risk is also reviewed.

The presentation then moves to a discussion of what is known about social and behavioral impacts. Included here is the phenomenon of social stigma, in which people, products and places seen as associated in some way with the accident come to be viewed by others as tainted or dangerous. Fear and discrimination resulting from social stigma can constitute a secondary disaster, eroding much-needed social support for people and communities affected by the accident and making recovery much more complex and difficult. Other significant social and behavioral impacts include deep cultural fatalism that can be left in the wake of an accident; the effects of people having to leave their homes and communities in connection with evacuation and/or relocation; reactions and concerns of emergency responders and healthcare professionals; issues specific to children; and post-accident population shifts and demographic changes that can significantly affect recovery efforts and the viability of affected regions. The presentation closes with a summary of the overall significance of social, psychological and behavioral impacts, and a consideration of the crucial implications of these impacts for nuclear accident planning, preparedness, response and recovery.

10:05 AM Emergency Biodosimetry

William F. Blakely, Armed Forces Radiobiology Research Institute/Uniformed Services University of the Health Sciences

Early emergency response for a radiological accident involves a multiple-parameter biodosimetry diagnostic strategy, since no single assay is sufficient to address all potential radiation scenarios including partial-body exposures. The accepted generic multiple-parameter approach includes: measuring for radioactivity associated with the exposed individual; observing and recording prodromal signs and symptoms; obtaining serial complete blood counts with white blood cell differential; sampling blood for the chromosome-aberration cytogenetic bioassay using the “gold standard” dicentric assay (or other suitable cytogenetic chromosome aberration assay) for dose assessment; bioassay sampling from various sources (i.e., urine, fecal, blood, nasal, oral, etc.), if appropriate, to determine radionuclide contamination; biosampling blood for measurement of proteomic and gene-expression radiation-responsive biomarkers; biosampling nail clippings for measurement of free radicals by electron paramagnetic resonance (EPR) for dose assessment; and using other available dosimetry approaches. Life-saving procedures in the medical management of the radiation accident patient take precedent to biodosimetry assessments. Radioactivity assessment and decontamination procedures are then typically followed by the generic early-phase biodosimetry procedures as described above. In the case of radiological mass-casualty incidents, a diagnostic triage system should be set up where rapid sentinel biodosimetry tests are used to prioritize casualties for subsequent confirmatory radiation injury and dose diagnostic tests to develop guidance for medical management treatment decisions.

Readiness for a potential nuclear reactor accident dictates that local resources need to have prior established and exercised medical triage competency including radiation injury and dose assessment capability. This capability should be broadly based and include: access to radiation detection devices; stockpiling of supply materials and protocols for appropriate biosampling; and reagents and devices supporting point-of-care triage diagnostics for measurement of a complete blood cell count, C-reactive protein, and amylase activity. Prior arrangements for reach-back diagnostic support to include: i) establishing deployable (i.e., hematology and biodosimetry) laboratories and reference (i.e., cytogenetic biodosimetry, radiation bioassay, EPR biodosimetry) laboratories are essential. Recording dynamic medical and other radiological relevant data to support dose reconstruction is an important component of an effective response to a suspected radiation overexposure incident. This is especially important in cases of the general population, who are potentially exposed to low doses in the local area of a nuclear reactor accident, where the low doses are below the limit of detection of current biodosimetry assays.

At present the Food and Drug Administration has not approved any biodosimetry devices, however, the nation's response to the September 11, 2001 incident has prompted a recent renaissance of biodosimetry research activities to develop point-of-care and laboratory biodosimetry devices to enhance response capability. Research efforts to focus on early and rapid assessment of partial-body exposures are needed, since this is critical for early-phase medical management treatment decisions. A similar national initiative to enhance operational resources and capability is also essential for effective readiness.

The views expressed do not necessarily represent the Armed Forces Radiobiology Research Institute, the Uniformed Services University of the Health Sciences, or the Department of Defense.

10:25 AM

Some Lessons Learned Regarding Medical Preparedness and Response from Several Types of Nuclear Power Plant Accidents

Albert L. Wiley, Jr., Radiation Emergency Assistance Center/Training Site and World Health Organization Collaborating Center at Oak Ridge National Laboratories

History has taught us that Nuclear Power Plant (NPP) accidents have been rare and that the medical significance of the radiation exposure from these NPP accidents to workers and the public is usually minimal, with the Chernobyl accident as the exception. We have also learned that, compared to other electrical power fuel cycles, the public and the regulatory agencies will insist on a special excellence in the medical preparedness and response for NPP accidents. Although there may be rather generic medical preparedness and planning for most types of NPP, the Chernobyl-type of accident required a significantly different medical response capability, compared to that of the Fukushima or the Three Mile Island types of accidents. This paper is a discussion of some of the lessons learned from past NPP accidents, as well as discussion of the required resources and the current gaps in the planning of an optimal response to each of these types of NPP accidents.

10:45 AM Potassium Iodide – Mechanism of Action

Jan Wolff, National Institutes of Health (Retired)

Iodide intake in substantial excess of what is required for thyroid hormone synthesis leads to inhibition of numerous metabolic processes within the thyroid gland including thyroid vascularity, adenylyl cyclase and iodide transport into the gland by the Na/I symporter. Such inhibitions are probably caused by formation, by iodination, of double bonds in arachodonic acid and other unsaturated lipids. These compounds then act as inhibitors without further need of iodide or oxidized iodine. Although the t1/2 of iodide ion is brief, once oxidized and incorporated into thyroxine in thyroglobulin the biological t1/2 becomes very long, with the effective t1/2 approaching the physical half-life of the isotope. Hence early oral application of KI for protection against radioiodine must be as fast as possible. Side reactions are rare, KI is cheap, and its shelf-life (bubble wrapped) is long. Thus KI is a useful prophylactic measure for protection against accidental release of radioiodines.

11:05 AM Issues in Planning for Potassium Iodide Distribution

Patricia A. Milligan, Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) changed its emergency planning regulations to include consideration of the use of potassium iodide (KI) as an urgent protective action. The final rule was published in April 2001 and the NRC committed to providing KI stockpiles to eligible requesting states in accordance with Food and Drug Administration guidelines. The NRC's KI program began in late 2001 and since that time millions of potassium iodide tablets have been distributed to the states. There are 33 States and 1 Tribal government with populations within the 10 mile Emergency Planning Zones (EPZ) and therefore eligible for KI tablets. To date 25 States have elected to participate with a variety of State-specific distribution programs. The NRC is currently in the third replenishment cycle.

Steven A. Adams, Centers for Disease Control and Prevention

This presentation will discuss historic decisions to include various forms of potassium iodide (KI) in the formulary of the Strategic National Stockpile, subsequent decisions made by the Department of Health and Human Services (HHS) Public Health Emergency Medical Countermeasures Enterprise (PHEMCE) to remove KI from the formulary, as well as a recent decision to reintroduce modest quantities.

The presentation will also summarize the Centers for Disease Control and Prevention collaborative efforts with state and local public health authorities to develop and maintain the capacity to rapidly carry out a medical countermeasure response to biological scenarios, and discussion of using this capacity to complement the ongoing KI work of local authorities and the Nuclear Regulatory Commission. Additionally, some potential challenges to developing a large scale potassium iodide dispensing strategy will be discussed.

Brad Leissa, Food and Drug Administration

Since 2012, FDA has issued guidance documents on potassium iodide (KI) use and shelf-life extension. FDA has also commented on emergency dispensing of KI during a radiologic incident. Dr. Leissa will summarize this information.

Adela Salame-Alfie, New York State Department of Health

New York State revised its 1982 policy for the administration of potassium iodide (KI) to the general public upon recommendations issued by the Food and Drug Administration (FDA) in December 2001. The previous policy recommended distributing KI only to emergency workers and captive populations. The New York State Department of Health (DOH) evaluated the safety of KI distribution to the general public with advice from its Radiological Health Advisory Committee. The committee recommended distribution to the general public since the benefit outweighed the risk. DOH led a multidisciplinary team to develop the new policy and its implementation. The team included members of the nuclear facilities, county health and emergency management agencies, and several state agencies. Prior to distribution, DOH developed fact sheets at different reading levels and for different audiences and translated them to several languages. DOH worked closely with the Board of Pharmacy to allow non-nurses to administer KI to children in settings such as schools and day care centers.

New York State is a “home rule” state, and as such, the decision regarding distribution of KI was left to the local agencies. DOH and the Office of Emergency Management worked with the local counties to devise plans for distribution. KI has been pre-distributed to the general public, schools and day care centers in the 10-mile Emergency Planning Zone (EPZ) in seven counties. KI is also staged at the county offices.

Evacuation has been and remains the primary protective action and KI is considered a supplement to evacuation. Upon declaration of a general emergency workers and captive populations are advised to take KI and the public is advised to evacuate and take KI, but they are warned not to delay evacuation if KI is not available.

Prior to the initial KI distribution, the state agencies conducted presentations for the local health, emergency management and school officials, where they discussed KI distribution, public education material, and answered their questions. Additional road shows have been conducted prior to or in combination with replenishing of KI that is about to expire.

Some states opted to decline participation in the Nuclear Regulatory Commission sponsored KI stockpiling program. The reasons for declining vary, but include concern that people may incur increased radiation dose from a radioactive plume if they assume that KI will protect them from all isotopes, low population densities and short evacuation times for their EPZs, cost of implementation (not just for the state but for the local counties), and difficulty experienced by other states in maintaining and tracking doses of KI previously distributed. States that opted out of the KI distribution can still request KI from the Strategic National Stockpile or other emergency response caches in their states.

1:00 PM

Environmental Monitoring

Daniel J. Blumenthal, Department of Energy

Environmental radiation measurements are critical in responding to a nuclear reactor accident. A radiological release to the environment complicates all response activities, from search and rescue to debris removal. Knowing the radiological environment, both what radionuclides have been released and where the hazards are, is key to ensuring that the response is appropriate, avoiding unjustified protective actions. This requires coordination of monitoring activities among agencies, aggregating all data, and analyzing them to create a common operating picture of the radiological environment. Monitoring following an accident poses many challenges, in part because of the large volume of data and the importance of proper quality control, including integrating data of varying quality from multiple sources during an international response. We have to be fast and right, yet the information may be incomplete and is changing over time. The Fukushima accident taught us of the thirst for more information, more quickly, over extended periods of time. For example, data from the Department of Energy's Aerial Measuring System (AMS) were available within one day of the team's arrival and remained in such high demand that the Japanese government enhanced their capabilities to meet this need over the long-term. Monitoring does not end when the initial response team leaves, but is needed to ensure knowledge of the radiological environment for many years. The Fukushima experience also taught us of the need for additional analysis capabilities and monitoring tools.

1:20 PM

Population Monitoring after a Radiation Emergency: The Early Response

Armin Ansari, Centers for Disease Control and Prevention

Following a radiation incident involving release of radioactive materials, people may be contaminated with radioactive materials or think that they have been exposed to radiation or contaminated with radioactivity. This population needs to be monitored for radioactive contamination, provided assistance with decontamination, and registered for subsequent follow-up and long-term health monitoring, if necessary. Population monitoring is a process that engages multiple local government agencies including public health, emergency management, and law enforcement, and it begins as soon as possible after the incident. Although screening for radioactive contamination and assistance with decontamination are accomplished as soon as practicable, monitoring for long-term health effects is usually determined through a population registry and an epidemiologic investigation that will likely span several decades. The focus of this presentation is on the early phase of the response and population monitoring.

Initial population monitoring activities are focused on preventing acute radiation health effects. Cross-contamination issues are a secondary concern, especially when the contaminated area or the affected population is large. The population to be screened includes the people in the affected community and service animals. Pets are also included in planning for population monitoring although priority is given to people and service animals. Scalability and flexibility are important parts of the planning process. The criteria used for contamination screening and the specific methods for radiation detection may have to be adjusted to accommodate the magnitude of the incident and availability of resources. Furthermore, people evacuated from the affected areas and displaced to other cities and communities will be in need of shelter and other health-related services. Therefore, a well-planned and executed population monitoring response will facilitate the provision of mass care and other health-related services.

The burden of providing radiation screening and monitoring services is likely to fall on local authorities who host this displaced population. This presentation will discuss strategies and resources that are available to local public health, medical and emergency management officials to plan for population monitoring activities using–to the extent possible–locally available resources.

1:40 PM

Planning for Long-Term Follow-Up and Health Risk Studies

Martha S. Linet, National Cancer Institute

There is a notable literature on late health effects associated with radiation disasters from the 60 years of studies of the Japanese atomic bomb survivors and the 20-year follow-up of persons exposed to the Chernobyl nuclear accident. Yet, many important questions remain about health effects following a radiation disaster. The difficulties of implementing a high-quality comprehensive long-term follow-up study after a nuclear reactor accident may be further complicated by associated disasters *e.g.*, the earthquake-triggered tsunami that led to the Fukushima nuclear accident, or by chaotic conditions that would follow a nuclear reactor accident caused by radiological terrorism. Nevertheless, there are many reasons to prepare and plan for long-term follow-up of the proximate population and workers exposed to radiation from serious nuclear reactor accidents if key requirements are met. These include sufficient levels of exposure and population sizes to detect increased risks of outcomes of concern, and the likelihood of obtaining high quality measurements, high follow-up rates, and minimization of bias or confounding.

If long-term follow-up is appropriate and feasible, the most important goal is to identify high-risk radiation-exposed individuals that would benefit from early evidence-based measures to prevent or mitigate physical and psychological disorders. Other goals include quantifying physical and mental health problems for public health and clinical planning purposes, to provide accurate information about late health problems to the affected community, and to contribute quantitative information for future risk projection efforts soon after a nuclear accident. However, the decision about whether to go forward with a long-term follow-up study after a nuclear reactor accident needs to be considered carefully, since such epidemiologic studies will not yield useful information if radiation exposure levels are very low, the number of persons exposed is small, the planned follow-up is very short, follow-up rates are likely to be low, or if potentially important confounding factors are not considered. If a long-term epidemiologic study is unlikely to provide meaningful results but is nevertheless undertaken due to public pressure, the absence of meaningful results or spurious findings could lead to unnecessary disillusionment.

This presentation will address several important questions. Why is long-term follow-up needed and what are the goals? Who should be studied and what are effective strategies for identifying the population? What are the outcomes to be studied and what are effective strategies for ascertaining the outcomes? What exposure assessment strategies would be feasible and would provide high-quality estimates? What are effective strategies for limiting bias and confounding? While there has been extensive effort devoted to emergency preparedness measures, only limited attention has been directed at developing approaches for long-term follow-up to identify late health effects.

2:00 PM

Post Emergency Transition to Recovery

William E. Irwin, Vermont Department of Health

As in most states, the Health Department in Vermont recommends radiological protective actions to the governor's emergency management agency coordinating emergency response and recovery. Assessment scientists use accident and meteorological data to estimate doses and recommend that people should shelter in place or evacuate. If there is high radiation fallout, severe weather, damage to evacuation routes or hostile actions that would lead to higher doses or other harm, people may be told how and where to effectively shelter. Evacuation is preferred when people can do so without harmful exposure as in slow-developing events. In rapidly-developing events including an improvised nuclear device (IND) or radiological dispersal device, waiting for a release to stop or for fallout to decay may minimize doses and, in the case of an IND, save many lives. Knowing the magnitude of environmental radiation levels and the health status of evacuees and ensuring the availability of reception centers and other care facilities is important to successful evacuation. Plans must highlight these variables and note that the choice between evacuation and shelter is rarely simple.

The presence of nuclear facilities and high profile targets for nuclear or radiological attack prompts government agencies to plan and exercise for emergencies. Jurisdictions lacking these "targets" may have little or no radiological emergency planning or training. Transportation accidents and terrorism incidents that may occur anywhere make mobile resources and scalable plans essential. States must be able to promptly convert facilities into reception centers and transportation staging areas and move large numbers of monitoring, decontamination and health care workers anywhere. If an event is widespread, evacuation and resettlement activities are more difficult, especially where multiple jurisdictions have not coordinated planning, integrated capabilities and evaluated the compatibility of their laws. Jurisdictions also have to be prepared for evacuees from well outside their borders.

There are Environmental Protection Agency (EPA) protective action guidelines (PAGs) for evacuation and relocation. Evacuation occurs early in the response based on computer models of the release and gross estimates of dose. Relocation occurs after the plume has passed when samples of food, water and the environment show certain products must not be consumed and certain lands must not be used or occupied. There are no resettlement PAGs because radiological dose is only one measure considered when people are allowed to return to places once evacuated or when they are permanently relocated elsewhere. Other considerations are the economic and other values people assign to the land and structures and the costs of cleanup and safely managing contaminated waste and debris. Recent experience around Fukushima and during exercises like Liberty

RADEX in Philadelphia indicates more people than might at first be estimated are willing to tolerate some radiation dose if they can return to “normalcy”.

Gerilee W. Bennett, Federal Emergency Management Agency

Ms. Bennett will provide an overview of the federal efforts to incorporate lessons from the Fukushima nuclear disaster into the ongoing update of the Nuclear Radiological Incident Annex to the Federal Interagency Operational Plan. The Annex previously was appended to the National Response Framework. The new Annex will support both the National Response Framework as well as the National Disaster Recovery Framework. Focusing on integrating recovery objectives for the intermediate and late phase actions, she will discuss the unique challenges of a nuclear reactor accident. She will outline federal support roles and interagency coordination mechanisms related to assisting the residents, businesses, and local and state governments in the affected areas as they manage their recovery.

Sara D. DeCair, Environmental Protection Agency

The newly revised Protective Action Guides Manual provides several key improvements over the 1992 version currently in use. Issues identified during the response to Fukushima as well as updated dosimetry are two. Discussion will focus in this presentation on ways that state and local emergency managers can tailor protective actions to a particular situation, and on reentry considerations based on Operational Guidelines published in 2009. Flexibility is critical in emergency planning so that evacuation, sheltering, relocation, and reentry decisions have as few negative impacts as possible.

S. Y. Chen, Illinois Institute of Technology

Much of the preparedness effort on radiological emergency to date has focused on the initial responses to an event (e.g., rescue or triage) while guidance on the more complicated issues of long-term recovery (e.g., remediation or resettlement) has been lacking. The recent major nuclear accidents at Chernobyl (Ukraine, 1986) and Fukushima (Japan, 2011) have clearly shown that radiological effects can spread over extended areas and last for many years, thus making planning for long-term recovery an essential extension to the overall response. Given the potentially unprecedented nature of the impact, the affected communities would have to face a series of daunting issues in attempting to return to normality.

A top priority to achieve the recovery objective is to conduct an effective and timely remediation of the contaminated areas. In contrast to emergency responses, the recovery effort is necessarily community focused and therefore will be driven by stakeholders. However, due to the nature of the contamination and the widespread impact, cleanup in the aftermath of a major incident could involve a rather complex decision-making process for which the requisite experiences may not be readily obtainable from the traditional remediation practices.

To this end, the National Council on Radiation Protection and Measurements (NCRP) established a scientific committee (SC5-1) in 2010 to prepare a comprehensive study that develops a framework of and recommends an approach to optimizing decision making in late-phase recovery in the wake of major nuclear or radiological incidents. This study, to be published as NCRP Report 175, addresses all relevant dimensions in decision making for long-term recovery. The NCRP considers optimization to be a fundamental approach to decision making for balancing the multiple factors that could be encountered in recovery from a major event such as a nuclear reactor accident. The NCRP report describes optimization as a flexible, graded and iterative process that consists of a series of steps, all of which involve deliberations with stakeholders as central to the success of a community-focused recovery. Above all, it also presents a new paradigm that specifically addresses a long-term approach to managing the challenging radiological conditions that could be experienced by the communities. In conclusion, the report makes a series of recommendations aimed at enhancing and strengthening the effort toward long-term recovery following a major nuclear or radiological incident.

3:15 PM

The Federal Response; Lessons Learned from Fukushima

Major General Julie A. Bentz, Office of the President

The provision of assistance following an international chemical, biological, radiological, or nuclear (CBRN) incident supports our commitment to international treaties and agreements, facilitates protection of vital national security, diplomatic, and/or economic interests, and maintains our tradition of providing assistance to save and sustain lives, stabilize the situation, and meet basic human needs in affected populations and countries. Additionally, such assistance may deter adversaries from using CBRN materials as weapons of mass destruction (WMD) when our resolve to provide such assistance is strategically communicated.

Major General Bentz will discuss how to add CBRN-specific considerations to existing mechanisms covering operations such as humanitarian assistance and disaster relief (HA/DR), support to USG counter-terrorism operations, law enforcement investigations, public health response, and Department of Defense's prompt response actions.

She will describe the assumptions applicable for providing assistance to CBRN incidents abroad that provide context for planning and decision-making; the principles, guidance, and considerations when assessing requests for assistance from impacted nations and/or international organizations; roles and responsibilities of USG departments and agencies for coordinating and providing CBRN hazard-specific advisory, technical, and/or humanitarian assistance; and CBRN-specific, response-focused operational considerations for USG activities during an international CBRN incident response.

3:30 PM

Environmental Data Sharing During Radiological Emergencies: A Collaboration Effort between Local, State and Federal Radiation Programs

Adela Salame-Alfie, New York State Department of Health

The experience of Fukushima demonstrated the need for strategies, procedures, protocols and tools to facilitate the collection and sharing of radiological data among a wide variety of governmental organizations for the assessment of the impact on the environment and public health. That experience also provided insight into the gaps that currently exist in the U.S. that would allow the collection of data from a variety of sources and integration into a single comprehensive repository for analysis and decision making. With support from the United States Environmental Protection Agency (EPA), and in collaboration with the Department of Energy (DOE) and the Federal Emergency Management Agency (FEMA), in early 2013 the Conference of Radiation Control Program Directors (CRCPD) formed the E-43 Task Force for Interagency Environmental Data Sharing and Communication. The E-43 Task Force is charged with working with federal partners on a coordinated effort to identify and address the policy issues and concerns to facilitate the implementation process for data sharing and communication. Beyond the ability to share data among state and federal response agencies are a number of policy and procedural issues that need to be addressed in order to ensure that data may be quickly and effectively shared among agencies immediately during a radiological emergency.

The task force is focusing on expanding a pilot project initiated by the New Jersey Department of Environmental Protection (NJDEP) where they began working on an improved method to share New Jersey's nuclear power plant fixed point data internally with other state response agencies for the purposes of decision making and protection of public health and the environment. Over the past year, FEMA has been working to improve response capabilities through the development of a widely available set of tools to assist with the integration of data into the federal response assets and the National Nuclear Security Administration's (NNSA) RAMS system. In partnership with FEMA and the EPA, RAMS was expanded for use by state and local emergency responders. This joint, publicly accessible system is now known as RadResponder.

One of the goals of the E-43 Task Force is to find ways to share critical data with a variety of response organization, provide insights into the policy development required to seamlessly share data outside the states' organization and the path forward to expand capabilities to include all types of radiological data into the process. The Task Force has been working with federal partners on a coordinated effort to identify and address the policy issues and concerns to facilitate the implementation process for data sharing and communication before, during and after a radiological emergency and is currently working on a pilot project to upload and share environmental data among several states.

3:45 PM

Media Meltdown

Miles O'Brien, PBS NewsHour

Newsrooms are filled with liberal arts majors who are ignorant and downright hostile to the subject of science because of a bad experience they had in ninth grade with the periodic table. So when it comes to stories about highly complex subjects such as nuclear energy, it should be no surprise the facts are seldom allowed to get in the way of a good story. So what's a scientist or an engineer to do? Better start tweeting.

4:00 PM

Communication in Nuclear Emergency

James McIntyre, Federal Emergency Management Agency

<u>The National Response Framework (NRF)</u>
The National Response Framework is a guide to how the Nation responds to all types of disasters and emergencies. It is built on scalable, flexible, and adaptable concepts identified in the National Incident Management System to align key roles and responsibilities across the Nation. The Framework describes specific authorities and best practices for managing incidents that range from the serious but purely local to large-scale terrorist attacks, catastrophic natural or man-made disasters.

The NRF also describes the principles, roles and responsibilities, and coordinating structures for delivering the core capabilities required to respond to an incident and further describes how response efforts integrate with those of the other mission areas. This Framework is always in effect, and elements can be implemented at any time. The structures, roles, and responsibilities described in this Framework can be partially or fully implemented in the context of a threat or hazard, in anticipation of a significant event, or in response to an incident. Selective implementation of National Response Framework structures and procedures allows for a scaled response, delivery of the specific resources and capabilities, and a level of coordination appropriate to each incident.

Emergency Support Function 15: External Affairs
Emergency Support Function 15 External Affairs (ESF-15) supports Federal domestic incident management during an event requiring a coordinated Federal response by ensuring that sufficient Federal external affairs resources are assigned during an incident requiring a coordinated Federal response to provide accurate, coordinated, and timely information to affected audiences, including governments, media, the private sector, and the local populace. ESF15 integrates Public Affairs and the Joint Information Center (JIC), Congressional Affairs, Intergovernmental Affairs (state, local, tribal and territorial), Planning and Products and the Private Sector under the coordinating auspices of external affairs.

Patricia A. Milligan, Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) Incident Response Program encompasses the NRC response to incidents that occur at nuclear facilities and incidents that involve nuclear materials or radiological activities licensed by NRC or an Agreement State. The program provides a framework for agency personnel to prepare and respond to licensee incidents affecting public health and safety, common defense and security, and the environment. Consistent with the National Response Framework, NRC coordinates with other Federal, State, Tribal, and local emergency organizations in response to various types of events. The purposes of NRC's response activities are to (a) obtain awareness of the plant conditions, accident progression, and licensee activities to prevent or mitigate the accident, (b) provide assistance to State and Local authorities with respect to Protective Action Decisions, and (c) ensure communications and coordination with Federal agencies, with respect to the command and control of the broader Federal response activities.

Lee Ann B. Veal, Environmental Protection Agency

During any radiological or nuclear disaster, it is vitally important to provide for public information sharing and media responses. However, it is also difficult and important to communicate well among the many governmental stakeholders with various interests and needs. This panelist will present information on communicating among federal and state agency partners in the United States during the Fukushima foreign nuclear incident as well as thoughts around better preparing to communicate for future international nuclear or radiological accidents.

People will be concerned and interested in radiation contamination for any significant nuclear incident no matter how far away or how limited the actual expected impacts may be to them personally. It is almost certain that any significant release of radioactive material will be detectable across the hemisphere through national monitoring programs. The challenges of conveying what these technical data mean deserve special attention. It is important to plan and prepare for extensive internal and external communication from the earliest states of incident response. This includes planning for internal and external leadership briefings, updates for Congressional staff or members, and communication among scientific experts who advise this broad range of federal, state, tribal and local officials representing health, environmental and emergency response communities. Information to these key stakeholders must be consistent, though the relative timing, scope and level of details should be tailored to their needs. These types of communications demand significant resources, alongside more technical response actions and analysis.

Communicating technical radiation data across varied agencies and among people with varying expertise is a particular challenge. This challenge is further complicated by the demand for transparency, and with the internet, an expectation of quick and broad access to news about events all around the world.
It's important as early in a response as possible to thoughtfully explain that analyses and interpretation are necessary and take time—otherwise, lag time in providing information can be seen as a tactic to delay or cover up. This explanation should also include how soon data will be become available, how it is to be vetted, and how it is shared with various stakeholders. The subsequent interpretive remarks and public messages on these data must also be developed as early as possible to allow partner agencies to brief their own constituents and decision makers. Advance preparation can be quite useful and should include tools such as guidance explaining technical concepts or templates for dose information, as well as building a familiarity with the capabilities of partner agencies.

Daniel J. Blumenthal, Department of Energy

The U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) coordinates all Federal environmental radiological monitoring, including analysis and the creation of data products. Following a formal and familiar protocol, we work with our Federal partners to provide situational awareness of the radiological environment to decision makers at the Federal, State, and local level. Those government officials use the information to make protective action decisions and communicate them to the public. The response to the Fukushima accident involved a different mix of agencies, including Japanese ministries, facing different decisions and concerns than addressed following a domestic accident. The Fukushima experience has both improved domestic preparedness and led to an interagency effort to develop an international response protocol.

Leeanna Allen, Centers for Disease Control and Prevention

If an accident occurs at a nuclear reactor, whether in the United States or in another country, a crucial task for federal, state, and local authorities will be communicating clear and consistent messages to the public. The Centers for Disease Control and Prevention (CDC) is one of many agencies who will be responding as part of the National Response Framework's Emergency Support Function #8, Public Health and Medical Services.

Radiation is a topic often feared and misunderstood by the public. Many professionals in medical fields and public health will have the same questions and concerns as the public. These trusted professionals will be called upon to provide information, or answer questions about information already out there.

The Radiation Studies Branch at the CDC provides information on radiation and health effects and emergency instructions. This information comes from research with public and professional audiences, as well as lessons learned from past radiation emergencies.

In a nuclear reactor accident, people want to know what to do to protect themselves and their families. They may have questions about potassium iodide. Special populations such as pregnant women and nursing mothers will have unique health concerns. CDC will work with state and local partners to communicate information about population monitoring efforts and health registries. Travelers' health may be of concern in international incidents. CDC will also communicate information to the public health and medical communities about risks, screenings, and treatments, using a variety of tools and channels, including traditional and social media.

A key communication channel for CDC is the radiation emergencies website (http://emergency.cdc.gov/radiation) with information on protective actions people can take, potassium iodide, and radiation emergencies. This website uses icons and graphics to explain technical concepts. This content been tested with the public to make sure it is comprehensible, credible, and can motivate the desired actions. In the case of a nuclear reactor accident, CDC can highlight topic areas relevant to the specific emergency. CDC's subject matter experts also have extensive knowledge and experience with radiation emergency communications.

People will receive information through different channels, so it is important to make sure messages are consistent by working with other federal agencies and state and local partners. Language resources for non-English speakers will also be critical to the success of a response.

These resources should also be tested for cultural appropriateness and relevance. In the case of a nuclear reactor accident, CDC will work collaboratively with response partners to ensure information needs are met, the gap between technical information and risk perception is bridged, and radiation is described in ways that promote responsible public action.

Major Jama VanHorne-Sealy, Uniformed Services University of the Health Sciences

During the Fukushima disaster in Japan, the US military had distinctive challenges. The US military provides in country support to the government of Japan, in accordance with the 1945 WWII agreement. The US Forces serving in Japan maintained the military chain of command with all aspects of response during Fukushima. Communication was no different. Non-DoD agency coordination and communication were funneled through and coordinated at the US Forces Japan and US Forces Pacific Command levels. While consistent messaging was initially a challenge at some military locations, with so much ambiguity, methods were refined as the events unfolded. Public messaging was done at some locations via social media, allowing for clarification and timely updates. Repeated Town Hall events allowed for face-to-face interaction between the military community and medical and scientific personnel, answering questions while actively avoiding confusing scientific vernacular. This communication method allowed for two way interaction helping to clarify information provided in other forms or forums. The learning points for Department of Defense radiation health professionals were consistent messaging with clear information is paramount to maintaining public confidence and health physics professionals should integrate non-scientific communication skills to allow them to more clearly inform decision makers and the public. Both of these challenges can be translated to the global health physics community. Fukushima has taught us it is no longer just about the message, but how we deliver it.

2014 Gilbert W. Beebe Symposium Organizing Committee

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Biographies

Steven A. Adams has served as the Deputy Director of the U.S. Strategic National Stockpile Program located within HHS's Centers for Disease Control and Prevention (CDC) from the time of its inception in 1999. As such, he has been intimately involved with the development and evolution of the national doctrine for response to a public health crisis and directly engaged with state and local authorities in the planning and implementation of the civilian medical response to large scale public health emergencies. His extensive interagency planning and coordination efforts include membership on the USDA National Veterinary Stockpile's formal advisory committee. In addition to programmatic leadership, Mr. Adams has managed large scale emergency responses and led rapid field deployment teams.

Mr. Adams has served CDC in a variety of leadership roles for 25 years in contingency response programs as well as Public Health efforts as varied as HIV field epidemiology and radiological dose reconstruction related to cold war era nuclear weapons production. He holds a Master's Degree in Public Health from the University of North Carolina at Chapel Hill.

Leeanna Allen, MPH, MCHES is a Health Communications Fellow with the Radiation Studies Branch (RSB) at the Centers for Disease Control and Prevention. Since 2008, she has worked on radiological and nuclear terrorism preparedness communication initiatives, research, and products for RSB. During the 2011 Japan Earthquake and Tsunami Response, she served as the subject matter expert in the CDC Joint Information Center. Ms. Allen received her BS from the Georgia Institute of Technology, and her MPH from Emory University. She has previously served as training and exercise coordinator in the hospital preparedness program for the Georgia Division of Public Health, and also as an emergency risk communicator and health educator for the Arizona Department of Health Services.

Armin Ansari is a health physicist at the Centers for Disease Control and Prevention, the lead author of the CDC guide for state and local public health planners on population monitoring, and a contributing author to the federal planning guidance for response to a nuclear detonation. He is also an adjunct associate professor of nuclear and radiological engineering at Georgia Institute of Technology, and author of the textbook Radiation Threats and Your Safety: A Guide to Preparation and Response for Professionals and Community. Dr. Ansari earned his BS and PhD degrees in radiation biophysics from the University of Kansas, starting his career as a radiation biologist, and did his postdoctoral research at Oak Ridge and Los Alamos National Laboratories. He is certified in comprehensive practice by the American Board of Health Physics and is the immediate Past President of the Health Physics Society.

John S. Applegate, J.D., is executive vice president for university regional affairs, planning and policy of Indiana University and Walter W. Foskett Professor of Law in the Indiana University Maurer School of Law. He teaches and has written extensively in the fields of environmental law, regulation of chemicals and hazardous wastes, international environmental law, risk assessment, and the management of radioactive waste. From 1993-1998, he chaired the Fernald Citizens Advisory Board at the Department of Energy's Fernald facility in Ohio, and he served on the Department of Energy environmental management advisory board from 1994-2001. He has participated in several National Research Council studies as committee member or reviewer. Professor Applegate served as Indiana University's first presidential fellow from 2007-2008; in 2008, he was appointed vice president for planning and policy, with responsibilities for strategic planning and university-wide academic coordination, public safety, and environmental safety and health. A member of the American Law Institute, Professor Applegate has taught at the University of Paris 2 (Panthéon-Assas) and University of Erlangen-Nürnberg and been a research fellow at Cardiff University. Before moving to Indiana, he was the James B. Helmer, Jr., professor of law at the University of Cincinnati College of Law, and was a visiting professor at Vanderbilt University Law School. He was a judicial law clerk for the United States Court of Appeals for the Federal Circuit and an attorney in private practice in Washington, D.C. Professor Applegate received his B.A. in English from Haverford College in 1978 and his J.D. from Harvard Law School in 1981.

Steven M. Becker, Ph.D. is professor of community and environmental health at Old Dominion University. He is an internationally recognized expert on community impacts, reactions, and responses to radiation emergencies. Dr. Becker has had extensive field experience at the sites of radiation incidents around the world, including the 1999 nuclear criticality accident in Tokaimura, Japan. He has done Chernobyl disaster follow-up work in Ukraine and Belarus, and was a member of a three-person radiological emergency assistance team invited to Japan in 2011 in response to the earthquake-tsunami disaster and the Fukushima Dai-ichi accident. Dr. Becker serves on the National Council on Radiation Protection and Measurements (NCRP), and on the recently-formed National Academy of Sciences-National Research Council scientific panel examining cancer risks in populations living near nuclear facilities. In September 2012, Dr. Becker was appointed by President Barack Obama to the United States Nuclear Waste Technical Review Board.

Julie A. Bentz is the Director, Strategic Capabilities Policy on the National Security Staff within the Executive Office of the President. She is responsible for writing presidential policy, coordinating interagency dialogue, informing presidential budgetary decisions and building consensus on interagency initiatives in programs that develop United States strategic capabilities to meet 21st-century requirements.

Gerilee W. Bennett is the Deputy Director of the FEMA's National Disaster Recovery Planning Division. Ms. Bennett's team is responsible for leading implementation of the National Disaster Recovery Framework, published in September 2011. She has been responsible for leading national disaster recovery planning and exercise initiatives since 2003. Ms. Bennett has supported an array of disaster assistance operations at headquarters and field offices, including Hurricanes Isaac and Sandy in 2012, the 2010 Gulf Coast oil spill, the 2004 and 2005 Hurricanes, the 2001 World Trade Center attacks, Hurricanes Opal and Fran in the 1990s, and the 1993 and 2008 Midwest floods. Ms. Bennett has a Bachelor of Arts degree in political science and German language and literature from the University of Idaho. She is currently completing a Master of Arts Degree in Security Studies at the Naval Postgraduate School Center for Homeland Defense and Security.

William F. Blakely received his Ph.D. in 1980 at the University of Illinois-Urbana-Champaign in radiation biology; his doctoral advisor was Dr. Howard S. Ducoff. He completed his post doctorate study on DNA radiation chemistry in Dr. John F. Ward's laboratory at the University of California, San Diego. In 1983 he joined the Armed Forces Radiobiology Research Institute (AFRRI)–Uniformed Services University of the Health Sciences (USUHS), his present affiliation.

Dr. Blakely's research activities have focused on molecular mechanisms of radiation sensitivity, cell-cycle effects, DNA damage and repair, and biological dosimetry. He served as a guest editor for several issues of journals associated with international meetings, an associate editor for the Radiation Research journal, and Chairman of the North Atlantic Treaty Organization (NATO) Research Study Group-Radiation Bioeffects and Countermeasures (RTG-033). He presently is the course director of the Radiation Biology graduate course at his University. He also serves as a U.S. representative on the International Organization for Standardization (ISO) Technical Committee (TC)85/SC2 (Radiation Protection) Working Group 18 (Performance Criteria for Service Laboratories Performing Biological Dosimetry by Cytogenetics), Council member for the National Council on Radiation Protection and Measurements (NCRP), an assistant professor in the Uniformed Services University of the Health Sciences Preventive Medicine and Biometrics Department, and an senior associate facility at Radiation Emergency Assistance Center/Training Site (REAC/TS).

Daniel J. Blumenthal manages the Consequence Management programs in the Office of Emergency Response at the National Nuclear Security Administration (NNSA) within the DOE. In 2009, he transferred from the Department of Homeland Security's Domestic Nuclear Detection Office where he was the Chief Test Scientist. Prior to joining the Federal government he was a Senior Scientist at the Department of Energy's Remote Sensing Laboratory from 1996 to 2006 where he managed or provided scientific support to several DOE emergency response teams. Most recently Dr. Blumenthal led the initial DOE response team to Japan where he spent a total of 7 weeks following the Fukushima Dai-ichi nuclear power plant accident in Mar 2011. Dr. Blumenthal's background is in nuclear physics and he is also a Certified Health Physicist (CHP).

Alina V. Brenner received her M.D. and Ph.D. (in immunology) degrees in 1995 from the Russian State Medical University, Moscow. She completed an MPH program in epidemiology at the George Washington University and joined the Radiation Epidemiology Branch, NCI as a post-doctoral fellow in 1999. In 2004, she became a staff scientist. Dr. Brenner has a long-standing involvement in studies of health consequences from the Chernobyl nuclear power plant accident and more recently in studies of atomic bomb survivors. Her scientific interests include epidemiology of thyroid and brain cancers with a special focus on radiation exposure. More generally, she is interested in how radiation risk depends on age, genetics, immunologic, and other factors. Dr. Brenner has served on the Public Health Committee of the American Thyroid Association (2012-2014) and IAEA Working Group on radiological consequences of Fukushima nuclear power plant accidents (2014). In 2013, as part of the Chernobyl studies team, she received an NIH Merit Award.

S.Y. Chen is currently Director of Professional Health Physics Program at the Illinois Institute of Technology (IIT), Chicago, Illinois. Prior to joining IIT, he was Senior Environmental Systems Engineer and manager at Argonne National Laboratory, Argonne, IL. Dr. Chen is a member of the National Council on Radiation Protection and Measurements (NCRP); he also serves on the U.S. Environmental Protection Agency's Science Advisory Board/Radiation Advisory Committee. Dr. Chen chairs NCRP Program Area Committee on Environmental Radiation and Radioactive Waste Issues. He also chairs NCRP Scientific Committee SC5-1, which work is to be published as NCRP Report 175, Decision Making for Late-Phase Recovery from Nuclear or Radiological Incidents.

Sara D. DeCair has been a health physicist with the Environmental Protection Agency's Office of Radiation and Indoor Air since 2003. She works on policy, planning, training, and outreach for EPA's radiological emergency preparedness and response program. Ms. DeCair is the project and technical lead for revising the Protective Action Guides and is especially interested in emergency worker dose limits and turnback levels.

William "Bill" E. Irwin leads a group of scientists who provide guidance on the health consequences of chronic and acute exposures to ionizing and non-ionizing radiation, toxic chemicals and other physical phenomena. He and his team place great emphasis on emergency preparedness. The team works closely with state and federal agencies for health, public safety, emergency management, homeland security, environmental protection and agriculture on radiological emergency preparedness. Bill and his team exercise and train regularly and collaborate with numerous national working groups to improve their readiness. He has a master of science in radiological physics, a doctor of science in work environment engineering and is a certified health physicist. Before coming to Vermont, Bill worked as a technician in the US Naval reactor program, as a trainer at numerous commercial nuclear facilities and as a health physicist at Massachusetts Institute of Technology (MIT) and Harvard.

Brad Leissa received his medical degree from The Ohio State University. He received postgraduate training in internal medicine and pediatrics at the Ohio State University Hospitals. He went on to receive subspecialty training in pediatric infectious diseases from George Washington University and the Children's National Medical Center in Washington, DC. He began his career at FDA back in 1989 as a medical officer with a focus on anti-infective drug development in the Center for Drug Evaluation and Research (CDER). During the October 2001 anthrax attacks, Dr. Leissa was assigned as the FDA liaison to the Secretary's Bioterrorism Command Center at the Department of Health and Human Services. Since then he has continued to work on medical countermeasure development at FDA. He currently holds the position of Deputy Director in CDER's Office of Counter-Terrorism and Emergency Coordination (OCTEC).

Martha S. Linet has served as Chief of the Radiation Epidemiology Branch of the National Cancer Institute since 2002. She has been a senior investigator at NCI since 1987, and was previously an Associate Professor in the Department of Epidemiology at the Johns Hopkins School of Public Health. Dr. Linet is principal investigator of studies assessing the role of protracted low-dose radiation exposure and cancer risks in medical radiation workers, including radiologic technologists and physicians performing fluoroscopically-guided interventional procedures. She has also studied the role of magnetic field exposures from power lines and electrical appliances in relation to childhood leukemia; cellular telephone use and risk of adult brain tumors; and ultraviolet solar radiation exposure and risk of skin and other cancers. Dr. Linet has a long-standing interest in assessment of a broad range of postulated risk factors for childhood and adult hematopoietic malignancies, including occupational benzene and other occupational and environmental exposures, medical conditions, medications, measures of early life infections, and potential protective factors such as breastfeeding, vitamin D, and preconceptional folic acid supplements. She served on the Board of Directors (1999-2004) and as President of the American College of Epidemiology (2004-2005), and is currently a member of council the National Council on Radiation Protection and Measurements, and the National Academy of Sciences Nuclear and Radiation Studies Board. Dr. Linet has also served on other advisory groups to the International Agency for Research on Cancer and the Leukemia and Lymphoma Research Society, and on Editorial Boards (*Am J Epidemiol* and *J Natl Cancer Inst*) Among her honors are election to the American Epidemiological Society, the NIH Director's and NIH Merit Awards, the NCI Mentor of Merit Award, the Henry L. Moses Award for outstanding clinical paper, the American College of Epidemiology Distinguished Service Award and election to the Johns Hopkins Society of Scholars.

Nicole Lurie is the Assistant Secretary for Preparedness and Response (ASPR) at the US Department of Health and Human Services (HHS). The ASPR serves as the Secretary's principal advisor on matters related to bioterrorism and other public health emergencies. The mission of her office is to lead the nation in preventing, responding to and recovering from the adverse health effects of public health emergencies and disasters. Previously, Dr. Lurie was Senior Natural Scientist and the Paul O'Neill Alcoa Professor of Health Policy at the RAND Corporation. Dr. Lurie attended college and medical school at the University of Pennsylvania, and completed her residency and MSPH at University of California–Los Angeles, where she was also a Robert Wood Johnson Foundation Clinical Scholar. Dr. Lurie continues to practice clinical medicine in the health care safety net in Washington, DC.

James McIntyre serves as the Director of Disaster Operations, Cadre Management and Training. As the Director, he serves as the senior External Affairs official on incident response and reports directly to the Director of External Affairs (ESF 15 Operations Director, when activated). He coordinates the External Affairs Emergency Support Function 15 activation activities to include the appointment and deployment of ESF 15 lead, deputy lead and EA Situational Awareness teams. Mr. McIntyre also provides incident actions plans, deployment support through national and regional cadres, coordinates EA messaging and support with all EA functions as well as federal and non-government partners. He oversees the recruiting, hiring, administrative support, training qualification of the FEMA External Affairs Incident Management Workforce.

Mr. McIntyre has also served as the Press Secretary and the Chief of Media Relations, managing the functions of the agency's News Desk operations, including the media monitoring/analysis function, rapid response to media issues and inaccuracies, and the Multilingual Operations.

As well, he has extensive field disaster experience including the 1999 Midwest Tornadoes in Oklahoma, Hurricane Floyd in North Carolina, 20 months as FEMA's lead public affairs officer in New York City after the September 11, 2001, terrorists attack on the World Trade Center, Hurricane Isabel in Washington, DC, the agency's chief of media relations in Florida during its response to the 2004 Hurricane Season, the Republican National Convention, and lead public affairs officer and primary housing spokesperson in Louisiana during the agency's response to Hurricane Katrina and Rita in 2005 and the FEMA HQ Emergency Support Function: External Affairs Operations Officer for the 2008 Hurricane Season.

Mr. McIntyre has a Bachelor of Arts degree in Organizational Management and is a former U.S. Air Force public affairs officer who retired in 1996 after 24 years of military service.

Patricia A. Milligan is Certified Health Physicist as well as a nuclear pharmacist. She works for the Nuclear Regulatory Commission in their headquarters office in Rockville Maryland office. She is a Senior Advisor in the Office of Nuclear Security and Incident Response-Division of Preparedness and Response. Ms. Milligan has worked for the NRC since 1998. Prior to joining the NRC, she worked for 13 years in the nuclear power field as a health physicist and for 5 years as a nuclear pharmacist.

Miles O'Brien is veteran, independent journalist who focuses on science, technology and aerospace. He is the science correspondent for the *PBS NewsHour*, a producer and director for the PBS science documentary series *NOVA*, and a correspondent for the PBS documentary series *FRONTLINE* and the National Science Foundation *Science Nation* series. For nearly seventeen of his thirty-two years in the news business, he worked for CNN as the science, environment and aerospace space correspondent and the anchor of various programs, including *American Morning*. While at CNN, he secured a deal with NASA to become the first journalist to fly on the space shuttle. The project ended with the loss of Columbia and her crew in 2003–a story he told to the world in a critically acclaimed sixteen-hour marathon of live coverage. Prior to joining CNN, he worked as a reporter at television stations in Boston, Tampa, Albany, NY and St. Joseph, MO. He began his television career as a desk assistant at WRC-TV in Washington, DC. O'Brien is an accomplished pilot and is frequently called upon to explain the world of aviation to a mass audience. He has won numerous awards over the years, including a half-dozen Emmys, and a Peabody and DuPont for his coverage of Hurricane Katrina and its aftermath.

In February of 2014, a heavy equipment case fell on his forearm while he was on assignment. He developed Acute Compartment Syndrome, which necessitated the emergency amputation of his left arm above the elbow. Born in Detroit and raised in Grosse Pointe Farms, MI, he is based in Washington, DC. He has a son at the US Naval Academy and a daughter at Davidson College in North Carolina. He was a history major at Georgetown University.

Jerome S. Puskin is director of the Center for Science and Technology within the Office of Radiation and Indoor Air of the Environmental Protection Agency since 1985. Prior to his work at the Center for Science and Technology, he was a biophysicist in the Nuclear Regulatory Commission. He is Distinguished Emeritus Member of the National Council of Radiation Protection and Measurements (NCRP) and member of the Committee to Assess the Risks from Low Energy Photons and Electrons. He received a B.A. from Johns Hopkins University and a Ph.D. from Harvard University.

Adela Salame-Alfie is the acting director of the Division of Environmental Health Investigations of the New York State Department of Health. Prior to this appointment, she was the director of the Bureau of Environmental Radiation Protection. Since joining the Bureau in 1993, Dr. Salame-Alfie has been actively involved in radiological emergency response, evaluation of remedial actions for contaminated sites, radon, and the radioactive materials and x-ray regulatory programs. She is the chair of the Conference of Radiation Control Program Directors' Homeland Security Emergency Response Task Force charged with the development of the radiological dispersal device first responder's pocket guide and the handbook for responding to radiological dispersal devices companion. Dr. Salame-Alfie is a member of the NCRP SC4-2 Committee charged with the development of the population monitoring and decontamination following a nuclear or radiological incident publication and a workgroup charged with the development of a competency standard for first responders. Dr. Salame-Alfie received her B.S. in energy engineering in Mexico City and her M.S. and Ph.D. in nuclear engineering from Rensselaer Polytechnic Institute in Troy, New York.

Steve L. Simon, Ph.D., joined National Cancer Institute's (NCI) Radiation Epidemiology Branch as an expert in dose reconstruction and presently heads the dosimetry unit in that group. Previously he was on the research faculty at the University of Utah, the academic faculty at the University of North Carolina-Chapel Hill, was a medical physicist for the University of New Mexico at Los Alamos National Laboratory, a senior staff officer at the National Research Council, and director of the Marshall Islands Nationwide Radiological Study (NWRS). Dr. Simon has worldwide experience in monitoring nuclear test sites for residual radioactivity and at assessing historical radiation doses from nuclear weapons fallout. He has provided advice over many years to national and international organizations on issues related to environmental contamination from nuclear testing and related radiation exposures. More recently, he has directed his efforts to estimating historical doses to patients and medical staff from medical diagnostic procedures. Dr. Simon is a member of NCRP and has been an associate editor of Health Physics for 16 years. He received a B.S. in physics from the University of Texas, an M.S. in radiological physics from the University of Texas Health Sciences Center in Dallas, and a Ph.D. in radiological health sciences from Colorado State University.

Jama VanHorne-Sealy is an Assistant Professor of Preventive Medicine and Biometrics and Director of Radiation Safety for the Uniformed Services University of the Health Sciences. Concurrently, she is the primary advisor on nuclear and radiation issues for the Office of Health Affairs and the Chief Medical Officer of the Department of Homeland Security (DHS). She began serving in this position in May of 2013. Major VanHorne-Sealy has served as the lead for the Department of Defense's Medical Radiobiology Advisor Team and Instructor for Armed

Forces Radiobiology Research Institute's Medical Effects of Ionization Course. During the Fukushima Reactor release in Japan, she established an in-country presumptive radiation detection laboratory for the Pacific U.S. Forces and served as a technical advisor to U.S. Forces Japan and U.S. Embassy staff. Major VanHorne-Sealy developed and implemented the first Radiation Safety Program for U.S. Forces in Afghanistan.

Lee Ann B. Veal joined EPA's Radiation Protection Division in 2010 as the Director for the Center for Radiological Emergency Management. Her role during the Fukushima incident was to manage EPA's Emergency Operations Center. EPA's primary function was to collect and analyze environmental samples taken from locations across the United States and our territories and publicly report on all findings. EPA was significantly involved in the scientific team supporting the United States' response in Japan and to concerns for American citizens living there. Prior to her current responsibilities, Ms. Veal held positions with the Department of Homeland Security, Los Alamos National Laboratory, EPA's Office of Homeland Security and EPA's air pollution monitoring program. Ms. Veal began her career as an electrical engineer working for Dominion Energy.

Albert Lee Wiley, Jr., BNE, MD, PhD, FACR is the Medical and Technical Director of Radiation Emergency Medicine programs at REAC/TS, a DOE National Nuclear Security Administration (NNSA) asset managed by Oak Ridge Associated Universities. He is also head of the World Health Organization (WHO) Radiation Emergency Medical Preparedness and Assistance Network (REMPAN) Collaborating Center and of the Radiation Emergency Assistance Center/Training Site (REAC/TS)-International Atomic Energy Agency Response and Assistance Network (IAEA RANET) medical radiation emergency response team at Oak Ridge. He began his work history as a nuclear engineer (BNE from North Carolina State University) and later received the MD degree (University of Rochester Medical School). He also holds a Ph.D. in Radiological Sciences (minor in nuclear engineering) from the University of Wisconsin–Madison, where he also spent most of his career as professor of radiation oncology and is now an Emeritus Professor. He also has served as Professor and Interim Director of the East Carolina University Cancer Center. He was Medical Director of U.S. Naval Radiological Defense Laboratory (USNRDL) and at REAC/TS has been medical team leader for NNSA-sponsored courses in over 20 countries and has been deployed as a medical consultant to radiological accident sites in Venezuela, Trinidad and Chernobyl. He has also worked with National Aeronautics and Space Administration (NASA) on the Pluto and Mars Science Lab radioisotope thermoelectric generator (RTG) launches and is in the U.S. Navy Reserve (retired).

Jan Wolff was born in 1925 and schooled in Germany, Holland and California. Dr. Wolff worked on iodine metabolism at University of California–Berkeley (PhD 1949). This was followed by an MD degree (Harvard 1953) and internship at Massachusetts General Hospital and transfer to the new Clinical Endocrinology Branch at the National Institutes of Health (NIH) where he resumed studies on iodine metabolism, including two trips to the Marshall Islands and one to Kiev for the Chernobyl accident and consultations regarding KI prophylaxis with the U.S. Food and Drug Administration (USFDA), National Center for Radiation Protection, and the Nuclear Regulatory Commission (NRC). He later switched to studies on adenosine receptors, toxic adenylyl cyclase in pertussis, and the protein tubulin. Dr. Wolff retired in 2006.