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NEWS

Media Contact: John Dobken, (626) 302-2255

SCE Awards San Onofre Spent Fuel Strategic Plan Contract to North Wind

ROSEMEAD, Calif., June 13, 2019 — Southern California Edison today awarded a consulting contract to North Wind, Inc. to develop a strategic plan that will assess the feasibility of relocating spent nuclear fuel at the San Onofre nuclear plant to a commercially reasonable, off-site facility.

SCE is committed to the safe, secure storage of spent nuclear fuel, recognizing that efforts to relocate San Onofre's spent nuclear fuel off-site must proceed in a thoughtful, forward-thinking and responsible way, ensuring that relevant interests are recognized and heard. Moving San Onofre's spent nuclear fuel off-site is a top priority for SCE, as is safely managing the fuel while it is on-site. There is currently no federally licensed facility to receive spent nuclear fuel from a commercial nuclear energy site.

The North Wind consultants will work in concert with SCE and its Experts Team, which will support development of the strategic plan by reviewing North Wind's work during the anticipated 20-month timeframe of the contract. The Experts Team is chaired by Tom Isaacs, former Department of Energy Office of Policy director, and includes former Nuclear Regulatory Commission chairman Allison Macfarlane, both of whom have expertise in spent fuel siting and licensing, as well as nationally recognized leaders in radiation science, spent nuclear fuel transportation and nuclear engineering. North Wind will also engage with a broad range of stakeholders to learn their preferences and attitudes about spent nuclear fuel and its eventual disposition.

"SCE looks forward to the development of a strategic plan that brings us closer to long-term solutions for moving spent nuclear fuel off-site," said Kevin Walker, SCE senior vice president for Customer and Operational Services. "The North Wind team is uniquely qualified to lead this effort and provide a roadmap that will benefit the local community, SCE customers, other stakeholders and the nuclear energy industry overall."

To develop the strategic plan, North Wind assembled a team of experts possessing many decades of experience with spent nuclear fuel. The team has a depth of expertise in all aspects of this work, including policy and legal analysis, regulatory strategies and compliance, stakeholder engagement, fuel handling and transportation logistics and commercial and financial analysis. Former Energy secretary Dr. Ernest Moniz will lend his considerable expertise to developing the strategic plan.

SCE launched this effort following a 2015 settlement agreement related to the permitting of the on-site expanded spent fuel storage installation. SCE is optimistic that the strategic plan will set forth practical steps that SCE can and will take to support efforts to relocate San Onofre spent fuel to an off-site, licensed facility.

About Southern California Edison
An Edison International (NYSE:EIX) company, Southern California Edison is one of the nation's largest electric utilities, serving a population of approximately 15 million via 5 million customer accounts in a 50,000-square-mile service area within Central, Coastal and Southern California.

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NEWS

Media Contact: John Dobken, (626) 302-2255

SCE, Communities Near San Onofre Removing Long-Retired Emergency Sirens

ROSEMEAD, Calif., June 26, 2019 — Utility crews will begin Monday depowering the 50 community alert sirens once required for operation of the San Onofre nuclear plant. The sirens are located within a 10-mile radius of the plant in the communities of San Clemente, Dana Point, San Juan Capistrano, unincorporated Orange County, the Camp Pendleton Marine base and on state park lands.

The Nuclear Regulatory Commission, along with the Federal Emergency Management Agency, determined in 2015 the sirens were unnecessary because accident scenarios at the defueled nuclear plant can no longer exceed Environmental Protection Agency protective action values that recommend evacuation or sheltering in place.

While the reactors at San Onofre were operating, the sirens would only have been activated during the two highest emergency levels, known as a site-area and a general emergency. Neither can occur at San Onofre now that the reactors are retired. In the more than 39 years that the sirens were in service, they were never activated due to an emergency at San Onofre.

“Although emergency planning requirements are changing with the elimination of almost all accident scenarios, we continue to maintain a robust emergency planning and preparedness program,” said Kelli Gallion, SCE’s senior manager for Emergency Planning at San Onofre. “We thank our local community partners for working with us on the siren removal process.”

Local communities were given the option of maintaining the sirens or poles for their own use. While none are keeping the actual siren function, some jurisdictions will be keeping the physical infrastructure. Camp Pendleton, for instance, will use the siren hardware as part of its public address system. In other communities, the poles on which the sirens were attached will remain for street lighting or to support communication or video infrastructure. The three sirens located on California State Parks land will be removed and the areas will be served by the adjacent communities and Camp Pendleton.

See below for more information on how communities will use any remaining pole infrastructure:

San Clemente – 19 sirens: San Clemente will retain five poles to support existing streetlights and infrastructure. The city has an active Emergency Planning and Preparedness program with details available here.

San Juan Capistrano – 9 sirens: San Juan Capistrano will be retaining two of the poles to support existing streetlights and infrastructure. The city maintains a comprehensive Emergency Management program and encourages residents to learn more about these efforts here.

Dana Point – 8 sirens: Dana Point is keeping seven of the eight poles installed by SCE and is actively looking for a new system that will provide the city with additional siren and messaging capabilities and allow for clear verbal messaging. The system would be used to disseminate information regarding disasters, hazards or public announcements, as well as providing systemwide and individual siren control for disbursement of specific information to specific areas of the city.

About Southern California Edison

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Douglas R. Bauder
Vice President Decommissioning &
Chief Nuclear Officer
San Onofre Nuclear Generating Station

Via U.S. Mail & Email

July 11, 2019

Mr. Daniel T. Stetson
Vice Chair
SONGS Community Engagement Panel
c/o The Nicholas Endowment
5319 University Drive, Suite 314
Irvine, CA 92612

Subject: SONGS ISFSI Radiation Monitoring System

Dear Dan:

Thank you for your inquiry regarding Southern California Edison's planned radiation monitoring system for the Independent Spent Fuel Storage Installation (ISFSI) at the San Onofre Nuclear Generating Station (SONGS). Below you will find information regarding the forecast for completion and system capabilities, background on why the system was developed, current radiation monitoring and reporting, and the U.S. Nuclear Regulatory Commission (NRC) radiation monitoring requirements for spent fuel storage facilities.

Background

As you will recall, the concept of a real-time radiation monitoring system was developed by SCE in response to concerns expressed by members of the public about the ISFSI during meetings of the SONGS Community Engagement Panel (CEP) and during the California State Lands Commission's (CSLC) environmental review of the decommissioning project. While current radiological monitoring of the ISFSI meets all NRC requirements, SCE agreed to investigate the feasibility of a real time monitoring system and concluded it is feasible to do so. As a result, as part of the CSLC's Mitigation Monitoring Program, SCE committed to install and maintain an ISFSI gamma radiation monitoring system to supply a real-time radiation data stream to local and state agencies. The monitoring system that will be installed at SONGS is based on a similar type system installed at the Prairie Island nuclear power plant.

Timing

The SONGS ISFSI real-time radiation monitoring system will be placed in service prior to the start of decommissioning activities, which is forecast for first quarter 2020. At present, the ISFSI radiation monitoring system is in the design and procurement phase. Installation and testing of the system is expected to be complete during the fourth quarter of 2019. Once complete, the system will be capable of streaming data to offsite agencies with radiological expertise. SCE currently is contracting with local and state agencies that will monitor the real-time data feed from SCE and publish monthly data reports which will be accessible to the public via the Web.

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doug.bauder@sce.com

Current Radiation Monitoring and Reporting

Continuous perimeter direct radiation monitoring: An ISFSI area radiation monitoring system already is in place and will continue after all fuel is transferred to passive dry cask storage. The monitoring system consists of Thermoluminescent Dosimeters (TLDs) installed around the perimeter of the ISFSI. TLDs measure total accumulated radiation dose and are read by trained personnel on a quarterly basis. The dose recorded for each TLD is reported annually in the SONGS Annual Radiological Environmental Operating Report (AREOR), which is available on the NRC's ADAMS website for public review. SCE also makes the reports available here via SONGScommunity.com. The area radiation monitoring system will remain in service until all spent fuel has been removed from the site.

Quarterly radiological surveys: In addition to the ISFSI-area TLD system for radiation monitoring, routine radiological surveys of the ISFSI and surrounding areas are performed quarterly by radiological technicians using sensitive hand-held instruments. Quarterly surveys will continue until all spent fuel has been removed from the site.

Radiological monitoring during fuel transfer operations: Real time radiation monitoring and radiological surveys are performed during each fuel transfer operation as spent fuel canisters are placed in the ISFSI.

NRC requirements
Current radiation monitoring of the SONGS ISFSI meets all NRC requirements. The NRC does not require real-time direct radiation monitoring for ISFSIs. The new system will provide real-time radiation data to local and state agencies for monitoring and monthly reporting of data to the public.

Please contact us if you have questions regarding the information provided or additional questions related to the SONGS radiation monitoring system.

Sincerely,

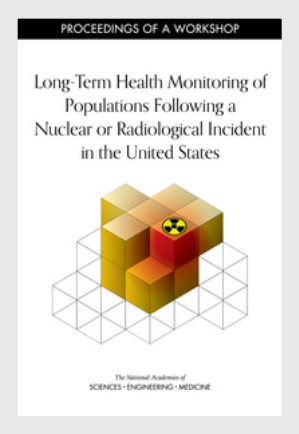


cc: Dr. David Victor, CEP Chairman
Manuel C. Camargo, SCE
Ronald Pontes, SCE

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Long-Term Health Monitoring of Populations Following a Nuclear or Radiological Incident in the United States

PROCEEDINGS OF A WORKSHOP

Ourania Kosti, *Rapporteur*

Nuclear and Radiation Studies Board

Division on Earth and Life Studies

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Reviewers

This Proceedings of a Workshop was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published proceedings as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

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TED LAZO, Nuclear Energy Agency
ANGELA LEEK, Iowa Department of Public Health
OLEG MURAVOV, Agency for Toxic Substances and Disease Registry

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the content of the proceedings nor did they see the final draft before its release. The review of this proceedings was overseen by **PAUL A. LOCKE,** Johns Hopkins Bloomberg School of Public Health. He was responsible for making certain that an independent examination of this proceedings was carried out in accordance with standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the rapporteur and the National Academies.

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Acronyms and Abbreviations

ARS	acute radiation syndrome
ASPR	Assistant Secretary for Preparedness and Response
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CRC	Community Reception Center
DHS	Department of Homeland Security
EPA	Environmental Protection Agency
ESF	Emergency Support Function
FEMA	Federal Emergency Management Agency
GSR	General Safety Requirements
Gy	gray
HHS	Department of Health and Human Services
HIPAA	Health Insurance Portability and Accountability Act
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer
IND	improvised nuclear device
kT	kiloton

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LSS	Life Span Study
mGy	milligray
mSv	millisievert
NACCHO	National Association of County & City Health Officials
NCRP	National Council on Radiation Protection and Measurements
R	roentgen
RABiT	Rapid Automated Biodosimetry Tool
RDD	radiological dispersal device
REAC/TS	Radiation Emergency Assistance Center/Training Site
RERF	Radiation Effects Research Foundation
RITN	Radiation Injury Treatment Network
Sv	sievert
TMT	Triage Monitoring and Treatment
WHO	World Health Organization

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Overarching Workshop Themes

In the United States, state and local agencies are responsible for population monitoring following a nuclear and radiological incident (HHS-CDC, 2014). The Department of Health and Human Services (HHS), through Emergency Support Function (ESF) #8–Public Health and Medical Services, has the responsibility of coordinating federal resources to assist state and local agencies with responding to the public health and medical consequences of such an incident (DHS-FEMA, 2016a,b).

ESF #8, when activated, is coordinated by the Office of the Assistant Secretary for Preparedness and Response (ASPR). The office's focus is on life-saving medical responses happening during the first days to weeks following an incident and on assisting with transitioning to recovery. The Centers for Disease Control and Prevention (CDC) is responsible for assisting state and local agencies with long-term population monitoring including establishing a radiation registry.[1] CDC also performs many of the administrative functions of the Agency for Toxic Substances and Disease Registry (ATSDR), an independent operating agency within HHS directed by congressional mandate to perform health surveillance and registries.

CDC states that a registry needs to be established as early as possible after a radiation emergency.[2] However, there are fundamental gaps in the

[1] The term "radiation registry" is used to describe a structured system for collecting and maintaining data on those affected by the nuclear or radiological incident. The data may need to be acquired, maintained, and updated over a long period of time, usually years or decades.

[2] See Public Health Preparedness Capabilities at https://www.cdc.gov/nceh/radiation/emergencies/publichealthpreparedness.htm.

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nation's plans for recovery, including a lack of federal laws to support recovery operations and laws to allow for immediate follow-up of the populations affected by a nuclear or radiological incident. As a result, there are insufficient federally appropriated funds available to help plan for recovery. Experience from past public health emergencies shows that congressional authorization and appropriation and construction of code and statute to set up and operate a public health surveillance system such as a registry take approximately 1–2 years.

CDC recognizes that an effective analysis of how information collected immediately after the incident[3] can be transferred to the registry planners likely months or years after the incident, what type of registry needs to be set up, and who to include cannot happen during the response to an incident when the emergency management community focuses on life-saving activities. Therefore, it identified the need for planning for the radiation registry in advance, before an incident occurs.

The March 12–13, 2019, National Academies of Sciences, Engineering, and Medicine (the National Academies) workshop on Challenges in Initiating and Conducting Long-Term Health Monitoring of Populations Following Nuclear and Radiological Emergencies in the United States provided a forum for exchanging information, sharing experiences and good practices, and expressing opinions on important activities related to planning in advance for a radiation registry.

Many of the discussions at the workshop were focused on planning for a radiation registry following a mass casualty incident such as an improvised nuclear device (IND) detonation that would affect a large number of people across multiple states. Participants' discussions regarding important activities for planning in advance for a radiation registry can be organized in the following themes:

THEME 1: (Section 2.1) Engaging Stakeholders. Bringing the key stakeholders together before there is an urgent need to set up the registry is essential to build trust, discuss scientific and sociopolitical challenges that relate to setting up a radiation registry, and identify issues of possible disagreement that would require some time to resolve. Stakeholders who are expected to be involved in setting up and maintaining a radiation registry would be anyone with a mission, interest, influence, and expectations related to the purpose and outcomes of a radiation registry.

THEME 2: (Section 2.2) Defining the Purpose of a Registry. The purpose of the registry defines who to enroll; methods to reach out to those individuals

[3] For example, creating a roster of the affected populations using existing tools such as the Rapid Response Registry developed by ATSDR.

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who qualify for enrollment; what data need to be collected; the consent, authorization, and legal requirements that govern the registry; and the resources needed to operate the registry including personnel and funding. Workshop participants noted the following list of potential purposes of a radiation registry:

- Medical monitoring of those who exhibited clinical symptoms related to acute radiation syndrome
- Public health monitoring of those affected
- Access to health care for those affected
- Research on radiation health effects
- Financial compensation for victims
- Social recognition of the tragedy
- Outreach to those affected such as updates on new scientific and medical developments or new programs or policies relevant to the incident

THEME 3: (Section 2.3) Agreeing on Roles and Responsibilities. Two high-level officials from the federal government acknowledged that currently the roles and responsibilities for setting up long-term health monitoring following a nuclear or radiological incident are ill-defined. Stakeholder agreement on the distribution of roles and responsibilities before an incident occurs would help plan for a framework to which everyone subscribes and alleviate confusion, duplicative or conflicting efforts, and competition for available resources that are expected to be scarce. The state and local public health community expects CDC to have a central role in setting up a radiation registry. Four different approaches for CDC's involvement were discussed at the workshop:

1. CDC, with input from the stakeholders, develops the framework for setting up a radiation registry, but its implementation is the responsibility of the state or local health authorities.
2. CDC, with input from the stakeholders, creates a radiation registry template and then transfers it to state or local authorities to set up and operate the registry.
3. CDC, with input from the stakeholders, sets up and operates the radiation registry.
4. The state or local health authorities perform the data collection for the registry and transfer the data to CDC, which is the responsible agency for operating a centralized registry and for reporting the adverse outcomes.

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Workshop participants discussed advantages and disadvantages of the different approaches. It is likely that support for one approach versus another will depend on state and local capabilities and these differ considerably across the United States.

THEME 4: (Section 2.4) Linking Immediate Response to Long-Term Follow-Up. Workshop participants described three areas of pre-planning to help transfer information collected early in the response phase of a nuclear or radiological incident to radiation registry planners.

1. Capture basic information on those affected
2. Screen for radiation contamination and assess exposure
3. Consider data systems needs

For (1), a number of workshop participants acknowledged that although it is important that collection of data for long-term population monitoring start as early as possible, it should not impact the responders' ability to accomplish life-saving tasks and other early response priorities. Therefore, only a few critical fields such as name and contact information can likely be collected early in the response phase and be transferred to registry planners later in the recovery phase.

For (2), screening for radiation contamination and early exposure assessment can provide information on initial projections about the impact of the incident and its acute and long-term health effects in the affected community as a whole. They can also provide the first evaluation of the effect of the incident on an individual's health. Therefore, screening for radiation contamination and early exposure assessment can affect decisions about the need for a registry and an individual's interest to participate. Workshop participants asked for more guidance on how to set a radiation screening criterion following a large radiological incident to avoid inconsistencies across different states and local jurisdictions.

For (3), workshop participants discussed that the process of transferring information collected during the early response phase to registry planners raises issues related to system compatibility for merging information collected by different entities. They also discussed the importance of leveraging existing systems to build a radiation registry.

THEME 5: (Section 2.5) Implementing Radiation Dose Threshold as a Registry Inclusion Criterion. The decision about what dose threshold (if any) is appropriate for a radiation registry in the United States will be a political decision driven by social considerations and will only partly be informed by scientific evidence about radiation health effects. Planning in advance can help balance these considerations.

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In the past, radiation registries whose main purpose was research or public health surveillance—such as the Japanese atomic bombing survivor cohort studies, the Chernobyl State Registry, and the Fukushima Health Management Survey—did not have a dose threshold criterion for eligibility of participants. Instead, geographic location of exposure defined eligibility. In contrast, the Goiânia registry, whose main purposes are to provide medical care and compensation for victims, used a dose above a certain threshold to define eligibility to the registry.

THEME 6: (Section 2.6) Screening for Disease. A radiation registry could pay special attention to diseases recognized as being associated with radiation exposure, for example, certain cancers and psychological effects, and screen for those. Decisions about screening for cancer will involve balancing scientific evidence in relation to screening principles and other considerations that affect screening policies, including costs of implementation, available resources, public expectations, and ethical and legal factors. Psychological health effects following a nuclear or radiological incident are expected to be significant because of the high perception of risk among those affected. Available resources for large numbers of affected individuals may be limited and Internet-based resources and treatments for psychological effects may expand care, although with decreased efficacy.

THEME 7: (Section 2.7) Preparing for Long-Term Communications. Experts in risk communication who presented at the workshop noted gaps in planning for communications during the long-term recovery from a nuclear or radiological incident, including what messages would be most useful and who would communicate those messages. Workshop participants discussed several pre-planning considerations for messaging related to the radiation registry. These considerations were that radiation registry planners need to

- Develop relationships in the affected communities;
- Communicate clearly the purpose of the registry;
- Explain eligibility for the registry;
- Make complex radiation terms and measurements easily understood by members of the public;
- Explain data confidentiality and data security;
- Communicate findings of the registry;
- Prepare to deal with emotion;
- Prepare to be viewed as the overall incident communicator;
- Establish social media presence and build awareness of social media influences; and
- Plan for succession of registry communicators.

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Many participants recognized that the list of pre-planning activities identified during the workshop is not exhaustive and that ultimately, an exercise focusing on long-term recovery that includes setting up a radiation registry would reveal additional gaps and planning needs.

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1

Introduction and Background

Nuclear and radiological incidents arise from releases of radioactive materials following accidents and terrorist attacks. Such releases can cause deaths, injuries, and a range of psychosocial effects to emergency responders and members of the public. Affected members of the public (referred to as "populations" in this proceedings) may require immediate medical care and follow-up, dose assessments to ascertain exposures to radiation, and monitoring to identify adverse long-term physical and psychological impacts.

In the United States, state and local agencies are responsible for population monitoring following a nuclear and radiological incident (HHS-CDC, 2014). HHS, through ESF #8–Public Health and Medical Services, has the responsibility of coordinating federal resources to assist state and local agencies with responding to the public health and medical consequences of such an incident (DHS-FEMA, 2016a,b). ESF #8, when activated, is coordinated by ASPR. CDC is responsible for assisting state and local agencies with long-term population monitoring including establishing a radiation registry. CDC also performs many of the administrative functions of ATSDR, an independent operating agency within HHS directed by congressional mandate to perform health surveillance and registries.

1.1 ABOUT THE STUDY REQUEST

The experiences from the 2011 Fukushima Daiichi Nuclear Power Plant accident in Japan and most recently the 2017 Gotham Shield National

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Level Exercise[1] exemplified the need for planning for efficient and timely health effect surveillance for a large number of affected populations. CDC recognizes that an effective analysis of what type of registry needs to be set up and who to include cannot happen during the response to an incident while the emergency management community focuses on life-saving activities, and identified the need for planning before an incident occurs.

1.2 THE WORKSHOP GOAL

CDC asked the National Academies to organize a workshop to discuss challenges and considerations for setting up a radiation registry for monitoring long-term health effects of populations affected by a nuclear or radiological incident in the United States (see Sidebar 1.1 for the workshop's Statement of Task). The workshop on Challenges in Initiating and Conducting Long-Term Health Monitoring of Populations Following Nuclear and Radiological Emergencies in the United States was held on March 12–13, 2019, at the National Academies facilities in Washington, DC. The workshop's goal was to provide a forum for exchanging information, sharing experiences and good practices, and expressing opinions on important activities related to planning in advance for a radiation registry.

The workshop was organized by a committee of seven experts chaired by Dr. Jonathan Fielding (University of California, Los Angeles [UCLA]), and featured a range of presentations on the topics listed in the Statement of Task. The workshop also featured a panel discussion with international, federal, state, and local government representatives to trigger an exchange of viewpoints with audience participation (see Figure 1.1). Appendix A of this proceedings provides the workshop agenda, and Appendix B provides biographical information on the workshop organizing committee members, speakers, and panelists.

A number of participants said that the workshop achieved its goal and some commented on its value in bringing the emergency management community together to discuss the challenges for setting up a radiation registry. For instance, a representative of a local health department in Texas noted that his initial concern with attending the workshop was that the federal vision regarding a radiation registry would outstrip local capacity. Instead, he found that the workshop demonstrated the strength of federal, state, and local partnerships. He also heard that representatives from various organizations with different missions and perspectives have a common understanding of the challenges and a realistic view of the possibilities regarding

[1] The 2017 Gotham Shield National Level Exercise involved a scenario of a 10 kiloton (kT) IND being detonated in the New Jersey/New York metro area. It was a 4-day exercise with the majority of the activities being response-related rather than recovery-related.

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SIDEBAR 1.1
Statement of Task

The National Academies will establish an ad hoc planning committee that will organize a workshop to discuss challenges and considerations for setting up a registry for long-term health monitoring of populations following nuclear or radiological emergencies in the United States. Workshop participants will discuss the following topics:

- Existing international inclusion criteria for such registries and possible alternative approaches, including a dose-tiered approach.
- Challenges associated with communicating inclusion criteria for a registry with the affected population.
- Considerations regarding health screening of the affected population, such as thyroid screening.
- Operational considerations for setting up and maintaining a registry, taking into account practicality and implementation issues.

The workshop presentations and discussions will be summarized in a National Academies proceedings of a workshop authored by a rapporteur.

setting up and maintaining a radiation registry following a nuclear or radiological incident.

However, a dose reconstruction expert observed from the workshop discussions that there was compartmentalization of resources across agencies and organizations without a common plan for coordinating those for setting up a radiation registry. The expert expressed his hope that the workshop would assist with addressing this problem and offer for consideration a list of priorities, which, if addressed by the emergency management community, can help create a coherent and executable plan for setting up a radiation registry. Chapter 2 of this proceedings summarizes opinions on eight potential pre-planning activities that were distilled by the rapporteur (Dr. Ourania Kosti, the National Academies) from the workshop discussions.

This Proceedings of a Workshop was prepared by the workshop rapporteur as a factual summary of what occurred at the workshop. The planning committee's role was limited to planning and convening the workshop. The views contained in the proceedings are those of individual workshop participants and do not necessarily represent the views of all workshop participants, the planning committee, or the National Academies.

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FIGURE 1.1 Panel discussion on operational considerations for setting up a radiation registry. NOTES: The purpose of the panel was to allow for an exchange of viewpoints among international, federal, state, and local government representatives with responsibilities in emergency management following a nuclear or radiological incident. From left to right: Dr. Eduardo Herrera (International Atomic Energy Agency), Dr. Daniel Sosin (Centers for Disease Control and Prevention), Mr. John Koerner (Office of the Assistant Secretary for Preparedness and Response), Dr. Oleg Muravov (Agency for Toxic Substances and Disease Registry), Ms. Tess Konen (Minnesota Department of Health), Ms. Jennifer Beggs (National Alliance for Radiation Readiness), Dr. Betsy Kagey (Georgia Department of Public Health), Mr. Andrew Pickett (Pennsylvania Department of Health), and Mr. Richard Kozub (Middlesex County Office of Health Services).

1.3 BACKGROUND INFORMATION AND CONTEXT

This section provides background information and context on radiation health effects, the expected impacts of different nuclear or radiological incidents, and radiation dose reconstruction for assessing those impacts. Most of the information summarized in this section was provided by presenters during the plenary session of the workshop.

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1.3.1 Radiation Health Effects

Radiation health effects of those affected by a nuclear or radiological incident depend on the dose of radiation received. Exposure to high levels of radiation can kill hematopoietic or gastrointestinal stem cells, resulting in acute radiation syndrome (ARS). Clinical symptoms of ARS include nausea, vomiting, and diarrhea and can manifest within hours or days following exposure. Patients with ARS will require ongoing screening and monitoring; death or recovery from ARS typically occurs within weeks.

Generally speaking, individuals exposed to whole body doses of 2–3 gray (Gy) will recover with appropriate hospital care; at higher doses, however, cytokine therapy and in some cases bone marrow transplants are additionally warranted,[2] and if exposures exceed 10 Gy, the patient is unlikely to recover.

Specialized centers such as the Radiation Emergency Assistance Center/Training Site (REAC/TS) provide advice, management, and education to health care providers about ARS and other radiation injuries. Dr. Carol Iddins, director of REAC/TS, noted that the center deploys its capabilities both nationally through the Department of Energy's National Nuclear Security Administration and internationally through the World Health Organization's (WHO's) Radiation Emergency Medical Preparedness and Assistance Network or the International Atomic Energy Agency's (IAEA's) Radiation Assistance Network.[3]

Exposure to whole-body doses of less than about 2 Gy does not generally cause immediate health effects but it can increase the overall risk of developing radiation-related disease in the future. In addition, individuals who receive high doses of radiation and survive ARS could have a greater risk of developing radiation-related disease later in life, depending on the level of radiation exposure (Sachs and Brenner, 2005). The main stochastic effect of concern following radiation exposure is cancer. Leukemia and thyroid cancers can manifest a few years after exposure, and other types of cancer can develop decades later.

Epidemiological studies on radiation-exposed populations such as the survivors of the atomic bombings in Hiroshima and Nagasaki have shown significant increases in cancer risk at high and moderate doses and at doses as low as the range from 0–100 milligray (mGy) (Grant et al., 2017). This is consistent with epidemiological studies in children who received medical exposures from computerized tomography scans (Berrington de Gonzalez et al., 2016).

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[2] Dr. David Brenner (Columbia University) pointed out that LD_{50}, the whole-body dose of radiation expected to cause death in 50 percent of an exposed human population, is about 3–4 Gy without treatment and about 7 Gy with appropriate hospital treatment.

[3] Dr. Iddins did not discuss the center's capability to respond to large-scale incidents.

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Current understanding of radiation health effects led some workshop participants to consider three rather distinct groups of populations who may require long-term health monitoring following a nuclear or radiological incident through a radiation registry:

1. Those who exhibited clinical symptoms related to ARS and require continued medical follow-up or those who received high doses without exhibiting clinical symptoms but are likely to exhibit stochastic effects like cancer in the future.
2. Those who received moderate radiation doses within the range where stochastic effects are likely.
3. Those who received low radiation doses where stochastic effects like cancer are less likely.

A potential radiation registry could enroll individuals in one or more of these categories.

1.3.2 Impacts of Nuclear and Radiological Incidents

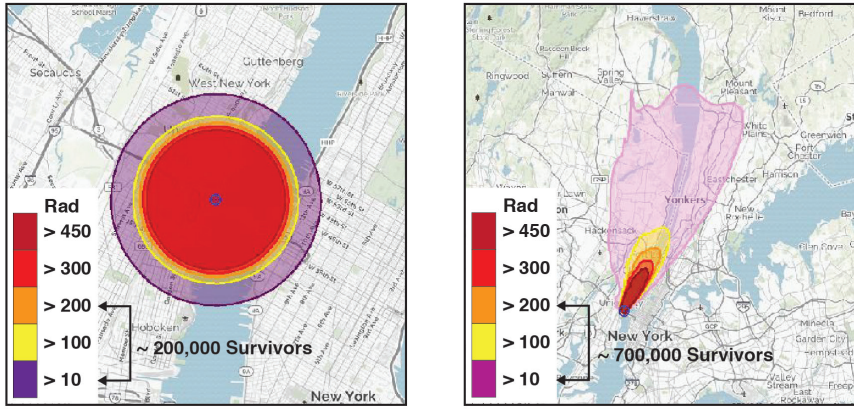
The impacts of a nuclear or radiological incident will vary depending on the type of the incident and therefore the size of the radiation registry that enrolls the affected individuals will also vary. Dr. Stephen Musolino (Brookhaven National Laboratory) illustrated four nuclear/radiological scenarios to help contextualize the expected radiation dose impacts to the exposed populations (see Figures 1.2–1.5). He clarified that the actual dose impacts depend on a number of factors including whether there is a warning before the incident occurs and if members of the public had time to take protective actions such as evacuating the area or sheltering in place; the time during the day that the incident occurs; and meteorological conditions. The dose impacts presented by Dr. Musolino were derived using the National Atmospheric Release Advisory Center dose projection models. Impacts for doses lower than 100 mGy (or 10 rad) were not discussed or shown in the figures he presented.

The scenarios illustrated were

1. A 10 kT IND surface detonation in New York City, representative of a terrorist attack (see Figure 1.2a–b). Following this scenario, the impact to the physical infrastructure will be immense, and there will be an overwhelming number of casualties with physical trauma and thermal burns. Prompt radiation effects will be greatest near the epicenter of the detonation, causing those in close proximity and who survive the blast wave to be afflicted with ARS. Radiation levels will decrease with distance from the point of the

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a. Prompt Effects b. Fallout Effects

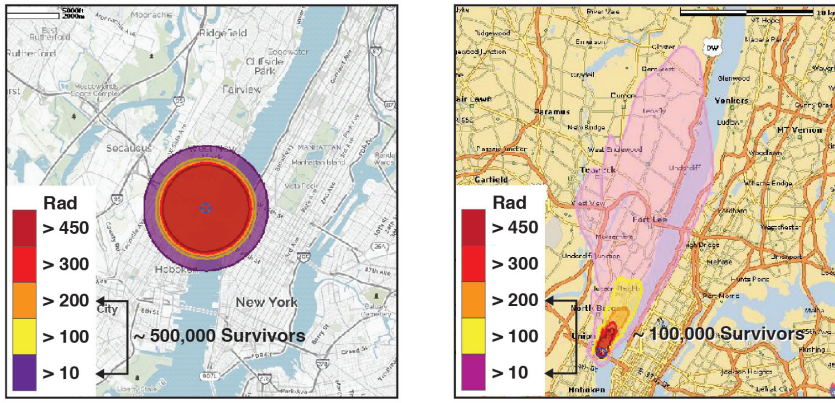
FIGURE 1.2 Dose impacts following a 10 kT improvised nuclear device surface burst scenario. (a) Approximately 200,000 people will receive doses within the range of 100 mGy–2 Gy (10–200 rad) by the prompt effects of the detonation. (b) Approximately 700,000 people will receive similar doses from the fallout.
NOTE: Impacts to populations exposed to <100 mGy (<10 rad) are not shown.
SOURCE: Modified slide from presentation by Dr. Stephen Musolino (Brookhaven National Laboratory).

detonation. Fission and activation products will combine with the massive volume of valorized material that is uplifted by the mushroom cloud and be carried at long distance (160 kilometers [about 100 miles] or more) and deposit as fallout. As a result, a large population will be at risk of exposure to a lethal level of radiation in the hours and days post detonation. Dr. Musolino estimated that approximately 200,000 people will receive doses within the range of 100 mGy–2 Gy (or 10–200 rad) by the immediate effects of the detonation (see Figure 1.2a) and 700,000 people will receive similar doses from the fallout (see Figure 1.2b).

2. A 100 kT high-altitude burst would be representative of a state-sponsored weapon detonated at 1,000 feet above New York City, which is representative of a nation-state attack (see Figure 1.3a–b). The immediate effects from this scenario extend further compared to the previous scenario. Dr. Musolino estimated that approximately 500,000 people will receive doses within the range of 100 mGy–2 Gy (or 10–200 rad) by the immediate detonation effects (see Figure 1.3a). However, this scenario is much less impactful from fallout compared to a surface detonation and fewer people (about 100,000) will receive doses within the range of 100 mGy–2 Gy (or 10–200 rad) from the fallout (see Figure 1.3b).

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a. Prompt Effects b. Fallout Effects

FIGURE 1.3 Dose impacts following a 100 kT improvised nuclear device high-altitude scenario. (a) Approximately 500,000 people will receive doses within the range of 100 mGy–2 Gy (10–200 rad) by the prompt detonation effects. (b) This scenario is less impactful from fallout compared to the surface detonation illustrated in Figure 1.2 and fewer people (about 100,000) will receive doses within the range of 100 mGy–2 Gy (10–200 rad) from the fallout.
NOTE: Impacts to populations exposed to <100 mGy (<10 rad) are not shown.
SOURCE: Modified slide from presentation by Dr. Stephen Musolino (Brookhaven National Laboratory).

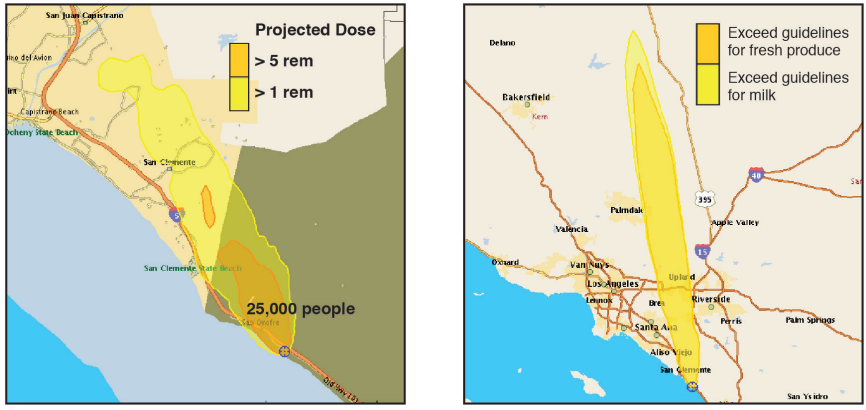
This lesser impact from fallout is because the fireball does not reach the ground.

3. A nuclear power plant accident that involves the San Onofre Nuclear Generating Station[4] in California was modeled as a case study. Dr. Musolino said that in contrast to the previous scenarios where there will likely be little to no warning, a nuclear power plant accident evolves slowly and releases of radioactivity to the environment occur hours or even days after a general emergency is declared. Therefore, the doses illustrated in Figure 1.4a (25,000 people exposed to 0.01–0.05 sievert [Sv] [or 1–5 rem]) over a 4-day period will likely be doses that are avoided because of protective actions such as evacuations. Similarly, although the agricultural impacts are expected to be large (see Figure 1.4b), protective actions such as embargoes of food and pasture can prevent the dose from affecting members of the public.

[4] The San Onofre Nuclear Generating Station is a nuclear power plant located south of Saint Clemente, California, that is currently being decommissioned, but for the purposes of this illustration it is assumed to be operating.

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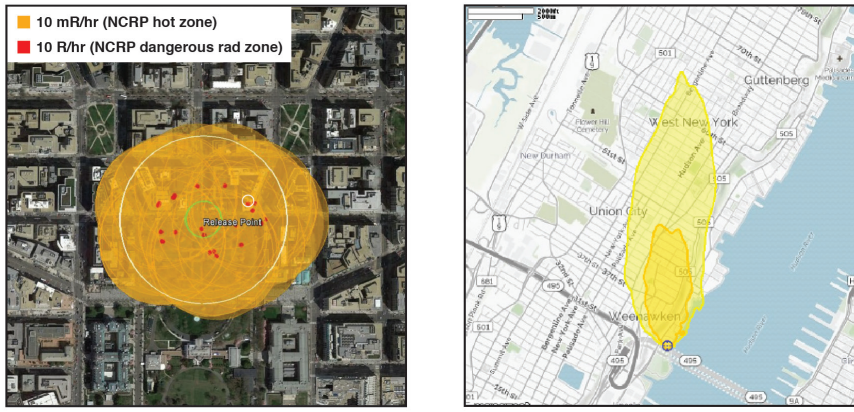
a. Projected Doses **b. Agricultural Impacts**

FIGURE 1.4 Dose impacts following a nuclear power plant accident at San Onofre Nuclear Generating Station in California.
NOTES: A nuclear power plant accident evolves slowly and releases of radioactivity into the environment occur hours or even days after a general emergency is declared. Therefore, the projected doses illustrated in (a) (25,000 people exposed to 0.01–0.05 Sv [or 1–5 rem]) will likely be doses that are avoided because of protective actions such as evacuations. (b) Similarly, although the agricultural impacts are expected to be large (covering an area where 1 million people reside), protective actions such as food embargoes can prevent the dose from affecting members of the public. The San Onofre Nuclear Generating Station is currently being decommissioned but for the purposes of this illustration it is assumed to be operating.
SOURCE: Modified slide from presentation by Dr. Stephen Musolino (Brookhaven National Laboratory).

4. A radiological dispersal device (RDD) in New York City. The detonation of a device could result in fragmentation (see Figure 1.5a) or aerosolization (see Figure 1.5b) of the radioactive material and the dose impacts will differ depending on the type of the RDD. For a fragmentation RDD, a large fraction of the radioactive material in the device disperses as large particles (see the red dots in Figure 1.5a) that are deposited in the vicinity of the detonation. Exposure rates near fragments could be greater than 100 mGy per hour (or 10 roentgen [R] per hour) and all of them combined can create a larger hot zone where the exposure rates are around 0.1 mGy per hour (or 10 mR per hour). An aerosol RDD deposits radioactive material both in the vicinity of the explosion and possibly over a long distance of a few kilometers down wind, but because the concentration of the radioactive material is very low, the dose rates affecting people are low.

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a. High activity Fragmentation RDD

b. High activity aerosol RDD

FIGURE 1.5 Dose impacts following a radiological dispersal device (RDD) in New York City. NOTES: The device can be (a) a fragmentation RDD or (b) an aerosol RDD, and the dose impacts differ. A fragmentation RDD would likely affect a small area of about five blocks. Doses next to the fragments could be around 100 mGy per hour (or 10 R per hour, defined by the National Council on Radiation Protection and Measurements [NCRP] as *dangerous radiation zone*). An aerosol RDD deposits radioactive material both in the vicinity of the explosion and at a long distance of about 50 blocks, and therefore could affect a rather large number of people (approximately 50,000), but the doses that would affect members of the public are expected to be small.
SOURCE: Modified slide from presentation by Dr. Stephen Musolino (Brookhaven National Laboratory).

5. An RDD detonation is likely to occur in highly populated areas with the intent to cause disruption and panic, and therefore could affect a rather large number of people (approximately 50,000). However, with the possible exceptions of fragments becoming embedded in a person's body, the doses to members of the public are expected to be small. Dr. Musolino said that an RDD in New York City will be detected rapidly because every firehouse and thousands of police officers are equipped with radiation detectors and thus response to the radiological incident can start within minutes. To the contrary, in other cities in the United States, responses will likely take longer depending on local resources.

1.3.3 Radiation Dose Reconstruction

Dr. John Till (Risk Assessment Corporation) said that radiation dose reconstruction is a fundamental step in assessing the impacts of nuclear and radiological incidents and the associated need for long-term health

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monitoring of the affected populations. Information derived from dose reconstruction includes

- Level of exposure of the affected populations
- Pathways of immediate exposure and immediate dose mitigation strategies
- Specific organs exposed and the risk of disease
- Potential pathways of long-term exposure and long-term mitigation strategies
- Feasibility of biodosimetry

He made a distinction between population-based dose reconstruction and individual dose assessment.

Population-Based Dose Reconstruction

Since the 1980s, dose reconstruction has been applied to studying large populations exposed to nuclear weapons fallout (Till et al., 1995, 2018) and later to populations exposed to nuclear accidents. Dr. Till said that each of these dose reconstruction efforts was unique in terms of the source term (quantity of radionuclides released to the environment and the chemical and physical form), the environmental transport of radionuclides, the scenarios of exposure, and the resulting estimated doses and uncertainties (Till et al., 2014).

He added that gathering the data for dose reconstruction is challenging and time consuming. Every dose reconstruction has information gaps due to incomplete, insufficient, or undocumented data, or due to data accessibility issues. As a result, dose reconstruction experts have to use mathematical modeling to fill in the data gaps and face the challenge of communicating the resulting uncertainties in the doses assigned to the populations.

Individual Dose Assessment

Dr. David Brenner (Columbia University) talked about individual dose assessment through biodosimetry. He defined biodosimetry as the use of radiation-induced biomarkers in blood, urine, or other accessible tissues to assess personal radiation exposure. He explained that in addition to generating individual dose estimates, perhaps the biggest advantage of biodosimetry is that it takes into account an individual's biological response to radiation and therefore can identify those exposed individuals who are radiation-sensitive and presumably in need of a higher level of medical intervention.

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The oldest and most studied biodosimetric approach measures DNA damage (e.g., chromosome aberrations or micronuclei) that can then be related to the delivered radiation dose. Until recently, this type of assay was only performed manually, typically in cytogenetic laboratories. According to Drs. Brenner and Iddins, this manual approach would not be suitable to reconstruct doses of a large number of survivors from a large-scale radiological incident, such as an IND, because it is labor intensive, at least in its standard manifestation. In addition, it has a limited dose range where it is practical for large-scale use, typically 500 mGy–5 Gy.

Although there are a number of cytogenetic laboratories around the world that could jointly provide biodosimetric services following a nuclear or radiological incident, Dr. Brenner estimated that the overall capacity using this approach would still be less than 10,000 samples per month, and the logistics of transferring the samples are challenging.

The Biomedical Advanced Research and Development Authority and the National Institute of Allergy and Infectious Diseases conduct and support research in biodosimetry. For example, researchers at Columbia University, with support from these two agencies, developed a completely automated, ultra-high throughput biodosimetric platform called RABiT (Rapid Automated Biodosimetry Tool), which fully automates both sample preparation and image analysis. The RABiT automates two mature, but currently manual, biodosimetry assays (micronucleus and dicentrics). A single RABiT machine can estimate whole-body, partial-body, or neutron doses of 1–10 Gy with a throughput of more than 6,000 samples per day (Garty et al., 2016).

Information on other biodosimetric tools that were not discussed at the workshop can be found at the Radiation Emergency Medical Management webpage at https://www.remm.nlm.gov/biodosimetry_refs.htm.

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2

Planning for a Radiation Registry

Several workshop participants noted that most of the efforts to prepare for a nuclear or radiological incident are focused on activities that take place days or weeks following an incident and pointed to several guidance documents as well as planning and training tools issued by federal agencies to support these early response activities (DHS-FEMA, 2010, 2016a; HHS-ASPR, 2016, 2017; HHS-CDC, 2014). However, little guidance, a few tools, and no exercises focus on preparing for the long-term recovery (months or years) after an incident. Dr. Armin Ansari (CDC) said that, as a consequence, there is little understanding within the emergency management community and in particular among those organizations that will be involved in recovery operations about what the "perfect" recovery plan would look like and what it takes to get the long-term recovery work done.

Dr. Kevin Yeskey (ASPR) and others added that there are fundamental gaps in the nation's plans for recovery. One of those gaps is the lack of federal laws to support recovery operations. For example, the Robert T. Stafford Disaster Relief and Emergency Assistance Act (the Stafford Act), which is the main law designed to bring federal assistance to state and local governments, only applies to response to a disaster and not to recovery. As a consequence, available federally appropriated funds to plan for recovery-related issues are insufficient. Although CDC states that a registry needs to be established as early as possible after a radiation emergency,[1] no laws

[1] See Public Health Preparedness Capabilities at https://www.cdc.gov/nceh/radiation/emergencies/publichealthpreparedness.htm.

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exist that allow for immediate follow-up of the populations affected by a nuclear or radiological incident including the setup of a radiation registry.

Experience from past public health emergencies shows that congressional authorization and appropriation and construction of codes and statutes to set up and operate a public health surveillance system such as a registry takes approximately 1–2 years. Dr. Jonathan Fielding (UCLA) noted that the delay between an emergency and mobilization of action can compromise public health surveillance. For example, delays in congressional supplemental appropriations hampered HHS's ability to control the Ebola epidemic abroad and combat domestic cases of the disease (HHS, 2016).

Workshop participants offered for consideration a list of important pre-planning activities, that if addressed can help the emergency management community create a coherent and executable plan for setting up a radiation registry. The proposed activities were

1. Engaging stakeholders
2. Defining the purpose of a registry
3. Agreeing on roles and responsibilities
4. Linking immediate response to long-term follow-up
5. Implementing radiation dose threshold as an inclusion criterion
6. Screening for disease
7. Preparing for long-term communications

Discussions around these activities were informed by expert opinions of the workshop participants and experiences and lessons to be learned from setting up registries in the past (radiation and other) in the United States and elsewhere. Some basic information on the purpose and operation of the registries discussed at the workshop is presented in Table 2.1.

Many workshop participants recognized that the list of pre-planning activities identified by workshop participants is not exhaustive and that ultimately, an exercise focusing on long-term recovery that includes setting up a radiation registry would reveal additional gaps and planning needs.

2.1 ENGAGING STAKEHOLDERS

Dr. Daniel Sosin (CDC) noted that the sooner pre-planning for a radiation registry starts, the more time there is to appropriately identify the key stakeholders who need to be involved in decisions about setting up and maintaining a radiation registry. These stakeholders would be anyone with a mission, interest, influence, and expectations related to the purpose and outcomes of a radiation registry. Bringing the key stakeholders together early in the process, before there is an urgent need to set up the registry,

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TABLE 2.1 Summary of Radiation and Non-Radiation Registries Described at the Workshop

Title	**Studies of the Atomic Bombing Survivors of Hiroshima and Nagasaki**
Primary purpose(s)	Research
Event: Baseline: Follow-up:	1945 1946/1950 Ongoing; commitment for follow-up until extinction of survivors
Managed by: Sponsored by:	Radiation Effects Research Foundation (RERF) Department of Energy (United States) and Ministry of Health, Labour and Welfare (Japan)
Populations studied (size)	a. Residents of Hiroshima and Nagasaki at the time of the bombings (120,000) b. Children of the atomic bombing survivors (77,000) c. Exposed fetuses (3,600)
Dose above a threshold level as an inclusion criterion?	No
Major contributions	Understanding of health effects of radiation; fundamental information for radiation risk assessment and radiation protection standards worldwide
Workshop presenter	Dr. Eric Grant, RERF

continued

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TABLE 2.1 Continued

Title	**Chernobyl State Registry**
Primary purpose(s)	Public health surveillance
Event: Baseline: Follow-up:	1986 1986 Ongoing
Managed by:	Republican Research Center for Radiation Medicine and Human Ecology
Sponsored by:	Ministry of Health of Republic of Belarus
Populations studied (~total number of eligible people/ participation rate)	a. Persons who participated in the liquidation of the Chernobyl accident (100,000/55%) b. Persons who evacuated affected areas in 1986 (13,000/33%) c. Persons living or working in the areas of primary and subsequent resettlement, as well as those who were resettled or who left these areas after the accident on their own (140,000/40%) d. Children of persons in groups a–c, except for children belonging to groups b or c (28,000/71%) e. People living or working in areas with the right of resettlement and of periodic radiation monitoring, as well as residents of other settlements, where the average equivalent radiation dose exceeds 1 millisievert per year (540,000/71%) f. Persons who participated in the liquidation or are affected by the accidents and their consequences at other nuclear facilities of civil or military purposes (1,200/35%) g. Persons affected by the Chernobyl accident who are not assigned to other groups of primary accounting (3,500/40%)
Exposure above a threshold level as an inclusion criterion?	Only for group e
Major contributions	Information on doses to the exposed populations
Workshop presenter	Dr. Andrei Cheshyk, Republican Research Center for Radiation Medicine and Human Ecology, Belarus

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TABLE 2.1 Continued

Title	**Fukushima Health Management Survey**
Primary purpose(s)	Public health surveillance; research
Event: Baseline: Follow-up:	2011 2011 30 years
Managed by: Sponsored by:	Fukushima Medical University Fukushima Prefectural Government
Populations studied (~total number of eligible people/ participation rate)	a. Basic Survey of all individuals in Fukushima (2,060,000/27%) b. Thyroid ultrasound examination of all children aged ≤18 years (381,000/57%) c. Comprehensive health check-up of all residents of the municipalities that ordered evacuation (210,000/21%) d. Mental Health and Lifestyle Survey of all residents of the municipalities that ordered evacuation (210,000/20%) e. Pregnancy and Birth Survey of all women in Fukushima prefecture after the accident (16,000/52%)
Exposure above a threshold level as an inclusion criterion?	No
Major contributions	Concerns of over-diagnosis following thyroid screening; magnitude of mental health effects following the accident and needed resources for individual support
Workshop presenter	Dr. Koichi Tanigawa, Fukushima Medical University

continued

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TABLE 2.1 Continued

Title	**Goiânia Registry**
Primary purpose(s)	Medical follow-up of those exposed to the accident; medical examinations and compensation
Event: Baseline:	1987 1987
Managed by: Sponsored by: Follow-up:	Centro de Assistencia aos Radioacidentados (CARA) Government of State of Goiás Ongoing
Populations studied	a. Sub-cohort G1: 56 individuals who received radiation absorbed doses above 0.2 gray (Gy) (estimated by unstable chromosomal aberrations) and/or had incorporation of Cs-137 activity above 1.85 gigabecquerel (GBq), which is equal to half of the annual limit of intake for workers adopted by the Brazilian Regulatory Authority (Comissao Nacional de Energia Nuclear). The patients who developed acute radiation syndrome are included in this sub-cohort b. Sub-cohort G2: 103 individuals who received radiation absorbed doses ranging from 0.05–0.2 Gy (estimated by unstable chromosomal aberrations) and/or had incorporation of Cs-137 activity below 1.85 GBq c. Sub-cohort G3: 1,075 professionals who dealt with contaminated material or patients internally and externally exposed to Cs-137 and also neighboring population of contaminated areas. There is no dosimetry for this group
Exposure above a threshold level as an inclusion criterion?	Yes
Major contributions	Source of data for epidemiological and biomarker studies; understanding efficacy of Prussian Blue in decorporation of cesium
Workshop presenter	Dr. Dunstana Melo, Melohill Technology

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TABLE 2.1 Continued

Title	**World Trade Center Health Registry**
Primary purpose(s)	Public health surveillance; research
Event: Baseline: Follow-up:	2001 2003 Ongoing
Managed by: Sponsored by:	New York City Department of Health and Mental Hygiene National Institute for Occupational Safety and Health
Populations studied	Rescue/recovery workers and volunteers at the site (9/11/01–6/30/02) and people who lived, worked, went to school, or were passersby in lower Manhattan (71,000)
Exposure above a threshold level as an inclusion criterion?	No
Major contributions	Important contribution to the literature on respiratory and mental health conditions of enrollees; link affected participants to services
Workshop presenter	Dr. Mark Farfel, New York City Department of Health and Mental Hygiene

Title	**a. Gulf Coast Child and Family Health Study** **b. Sandy Child and Family Health Study** **c. Gulf Coast Population Impact Project/Resilient Children Youth and Communities Project**
Primary purpose(s)	Research
Event: Baseline: Follow-up:	a. 2005, b. 2012, c. 2010 a. 2006, b. 2014, c. 2012 a. Completed, b. completed, c. completed
Managed by: Sponsored by:	Columbia University and collaborators a. Children's Health Fund, b. State of New Jersey, c. Baton Rouge Area Foundation
Populations studied	a. 1,079 households in Louisiana and Mississippi recruited within 1 year of Hurricane Katrina; sample representative of 60,000–100,000 displaced and/or heavily impacted Katrina survivors b. 1,000 residents living in or near the coastal areas of New Jersey most directly exposed to the storm c. 655 families living in spill-affected areas of South Louisiana
Exposure above a threshold level as an inclusion criterion?	N/A
Major contributions	One of few population studies on the topics; use of novel sampling methodologies
Workshop presenter	Mr. Jonathan Sury, Columbia University

continued

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TABLE 2.1 Continued

Title	**Vegas Strong Resiliency Center**
Primary purpose(s)	Social recognition of the tragedy; link victims and families to resources
Event: Baseline:	October 1, 2017 May 31, 2017
Managed by: Sponsored by: Follow-up:	Legal Aid Center of Southern Nevada In-kind contributions of local and state agencies and direct financial support through federal and state of Nevada grant funding sources 4 years post-event
Populations studied	Anyone affected by the Route 91 Harvest music festival attack including survivors, family members of victims, responders, and those who witnessed the incident or tried to assist victims.
Exposure above a threshold level as an inclusion criterion?	N/A
Major contributions	Victim advocacy and support; free resources, including counseling and spiritual care referrals; technical assistance with applying for online services; free legal services
Workshop presenter	Jeff Quinn, Southern Nevada Health District
Title	**U.S. Zika Pregnancy and Infant Registry**
Primary purpose(s)	Public health surveillance/access to health care
Event (outbreak): Baseline:	2015 2016
Managed by: Sponsored by:	CDC CDC
Populations studied	7,400 completed pregnancies with laboratory evidence of possible Zika virus infection from December 1, 2015, to March 31, 2018, in U.S. states and territories
Exposure above a threshold level as an inclusion criterion?	N/A. Positive blood or urine test that confirms Zika infection was required
Major contributions	Understanding burden of disease; update clinical guidance for caring for families affected by Zika virus; developed a standard approach to surveillance of emerging threats to mothers and babies using longitudinal-linked mother–baby data
Workshop presenter	Dr. Peggy Honein, CDC

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is essential to build trust, discuss scientific and sociopolitical challenges that relate to setting up a radiation registry, and identify issues of possible disagreement that would require time to resolve.

A number of workshop participants including Dr. Mark Farfel (New York City Department of Health and Mental Hygiene), Mr. Eddie Olivarez (Hidalgo County Health and Human Services Department, Edinburg, Texas), Dr. Monica Schoch-Spana (Johns Hopkins Bloomberg School of Public Health), Ms. Vivi Siegel (CDC), Dr. Daniel Sosin (CDC), and Mr. Jonathan Sury (Columbia University) drew on lessons to be learned from setting up registries in the United States and provided their opinions on key stakeholders that need to be engaged early in planning for a radiation registry. Those included

- Federal government agencies with public health responsibilities
- State, local, and tribal government offices with public health responsibilities
- Partner organizations such as
  - Association of State and Territorial Health Officials
  - National Alliance for Radiation Readiness
  - National Association of County & City Health Officials (NACCHO)
  - Radiation Injury Treatment Network (RITN) (see Sidebar 2.1)
- Local and community leaders
- Political and elected officials
- Contractors likely to be called on to supplement existing resources
- Public information officers and other communicators
- Members of the public
- The international radiation protection community

There was a general agreement that identifying and engaging with stakeholders is an iterative process that evolves throughout the development of a radiation registry. That is because additional groups who are affected by the incident might not be identified during early planning. For example, Dr. Farfel noted that in the case of the World Trade Center Health Registry, which was created to assess the physical and mental effects of the 9/11 attacks in New York City (Farfel et al., 2008; Gargano et al., 2018; Perlman et al., 2011), labor unions and local community stakeholders were engaged after the registry's inception. These groups raised concerns that lower Manhattan was open for business prematurely following 9/11, potentially exposing residents and workers to hazards in the home, in their offices, and in the ambient environment. Members of these groups participated in advisory boards for the World Trade Center Health Registry and provided input on the type and scope of data collected.

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2.2 DEFINING THE PURPOSE OF A REGISTRY

Perhaps the first question stakeholders will need to address if a nuclear or radiological incident occurs is whether to set up a registry for long-term health monitoring of the affected populations. As there have been few incidents involving releases of radiation, the very nature of a nuclear or radiological incident alone may warrant strong consideration to create a registry. The incident will likely be the first of its kind and the potential to learn about its impact by creating a registry of the affected populations will be high. Additional obvious requirements for a radiation registry discussed at the workshop were that such a registry focuses on the well-being of the affected populations and benefits these populations, the research community,[2] health care providers, and others. However, many workshop participants recognized that the decision to set up a radiation registry would involve additional considerations such as available resources, socio-political influences, and public concerns.

Dr. Robert Ursano (Uniformed Services University F. Edward Hébert School of Medicine), Mr. Jack Hearmann (ASPR), and others delivered a consistent message that the need for a radiation registry depends on how the affected populations *perceive* the risk they incurred following their exposure to radiation and not the actual risk. Experience with previous radiation incidents has demonstrated that psychological impacts affect the plans for population monitoring. Dr. Ursano used the plot of the psychological reactions to disaster with time cited in DeWolfe (2000) (see Figure 2.1) to demonstrate that reactions of members of the public to a disaster, including a nuclear or radiological incident, vary according to the phase of the disaster and with time during recovery. Therefore, public reactions and acceptance of a radiation registry will likely depend on when it is introduced and certainly on how it is communicated by the planners.

Experts who were involved in setting up registries recognized that a registry is most useful when designed for a specific purpose. Therefore, if the decision is made that a registry is warranted, Dr. Sosin noted that the purpose of the registry will need to be clearly defined. This purpose defines who to enroll; methods to reach out to eligible individuals; identifying appropriate comparison groups; what data need to be collected; the consent, authorization, and legal requirements that govern the registry; and the resources needed including personnel and funding. Dr. Betsy Kagey (Georgia Department of Public Health) noted that irrespective of the

[2] The National Institutes of Health's Disaster Research Response Program provides a framework for research on the medical and public health aspects of disasters and public health emergencies. See https://dr2.nlm.nih.gov for information.

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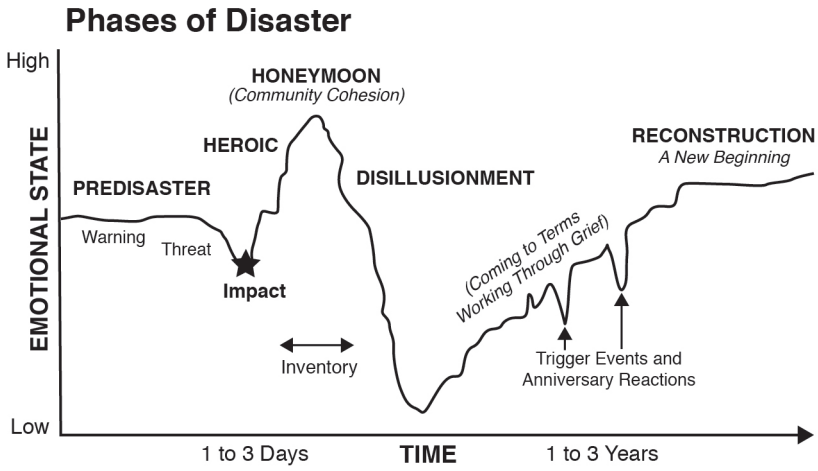


FIGURE 2.1 Psychological reactions to disaster with time.
NOTES: Reactions of members of the public to a disaster including a nuclear or radiological incident vary according to the phase of the disaster and with time during recovery. Dr. Robert Ursano (Uniformed Services University F. Edward Hébert School of Medicine) used the plot to demonstrate that public reactions and acceptance of a radiation registry will likely depend on when it is introduced and how it is communicated by the planners.
SOURCES: Adapted from Zunin and Myers as cited in DeWolfe, 2000.

purpose, a radiation registry would likely be a long-term commitment, and implementation costs are likely to be in the millions of dollars annually.[3]

Dr. Sosin, Dr. Schoch-Spana, and others contributed to the list of potential purposes of a radiation registry. Those were

- Medical monitoring of those who exhibited clinical symptoms related to ARS
- Public health monitoring of those affected[4]
- Access to health care for those affected
- Research on radiation health effects
- Financial compensation for victims
- Social recognition of the tragedy
- Outreach to those affected such as updates on new scientific and medical developments or new programs or policies relevant to the incident

[3] Two presenters shared annual costs for their registries: the Fukushima Health Management Survey costs $20–$30 million per year and the World Trade Center Health Registry costs about $7 million per year.

[4] See Chapter 1 for the three distinct groups of members of the public that may require health monitoring following a nuclear or radiological incident through a radiation registry.

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Depending on the purpose, some registries may require only a listing of affected individuals and their contact information while others may require a repository of information that includes various demographic characteristics of the affected populations, exposure data, outcomes, and perhaps biological sample collection.

Radiation registries with research as their main focus are likely the most demanding in terms of data collection. Dr. Eric Grant (Radiation Effects Research Foundation [RERF]) described the processes to enroll and retain participants in the Japanese atomic bombing survivor studies. These studies are still ongoing with bi-national U.S.–Japan support, more than 70 years after the bombings. Dr. Grant also described the massive efforts to reconstruct radiation doses to the survivors by interviewing and administering mail survey questionnaires. Studies of the atomic bombing survivors continue to make important contributions to understanding the health effects of radiation and provide fundamental information for radiation risk assessment and radiation protection standards worldwide.

Dr. Sosin noted that it is possible that a radiation registry is set up to serve one goal (e.g., public health monitoring) and its goal is expanded over time. He cautioned, however, that not all purposes are compatible and raised concerns that the social and political issues involved in financial compensation for victims could interfere or complicate the public health monitoring purpose of a registry.

2.3 AGREEING ON ROLES AND RESPONSIBILITIES

Advance agreement among stakeholders on the roles and responsibilities for setting up a radiation registry would help plan for a framework to which everyone subscribes. This common framework would alleviate confusion, duplicative or conflicting efforts, and competition for available resources that are expected to be scarce, especially following a mass casualty incident that also poses a threat to national security.

The question of "who is in charge?" was raised a number of times during the workshop. Two high-level officials from HHS (Drs. Yeskey and Sosin) acknowledged that currently the roles and responsibilities for setting up long-term health monitoring following a nuclear or radiological incident are ill-defined. Dr. Kevin Yeskey (ASPR) described his agency's focus on life-saving medical responses happening during the first days to weeks following an incident and on assisting with transitioning to recovery. Dr. Sosin (CDC) expressed his hope that the workshop would help his agency understand the emergency management community's views on CDC's role in setting up and maintaining a radiation registry.

Based on the discussions at the workshop, it became obvious that the state and local public health community expects CDC to have a central

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role in setting up a radiation registry. Four different approaches for CDC's involvement were discussed at the workshop:

1. CDC, with input from stakeholders, would develop the framework for setting up a radiation registry, but its implementation is the responsibility of the state or local health authorities. Workshop participants discussed that the framework developed by CDC and others would include guidance, training material, templates of pre-drafted Institutional Review Board documents, Health Insurance Portability and Accountability Act (HIPAA) privacy and other confidentiality requirements, and data share agreements for setting up and operating a radiation registry. One advantage of this approach might be that it ensures some level of consistency in the setup of the registry. A second advantage is that the states and local jurisdictions affected by the incident lead the registry's implementation using optimal approaches for the specific communities. One participant added that a third party like a university or a research organization could provide additional support to the state or local public health department tasked with operating the registry. Dr. Andrew Pickett (Pennsylvania Department of Health) compared elements of this approach to the Emergency System for Advance Registration of Volunteer Health Professionals, a federal program created to support states and territories in establishing standardized volunteer registration programs for disasters and public health and medical emergencies.
2. CDC, with input from stakeholders, would develop a radiation registry template and then transfer it to the state or local health authorities to set up and operate the registry. Dr. Kagey argued in favor of this model because in her view the federal government has more resources including access to funding to initiate the registry at a time when the state and local agencies are likely still in the process of responding to the incident or in early stages of recovery. She compared elements of this model to the disaster medical assistance team. A drawback of this approach is that there may be multiple registries operated by different state or local health authorities for a single incident, and there will likely be inconsistencies among those registries that complicate communication of results and other activities.
3. CDC, with input from stakeholders, would set up and operate the radiation registry. The main argument in favor of this approach was that a major nuclear or radiological incident such as an IND detonation would likely have multi-jurisdictional, statewide, or even multi-statewide consequences as potentially millions of

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displaced persons will seek assistance to address their health needs from anywhere in the United States. CDC can ensure that information received from all affected states and local jurisdictions are treated consistently and in a coordinated manner.

4. A fourth approach, which to some extent is a hybrid of those described above, was utilized by the U.S. Zika Pregnancy and Infant Registry. However, its potential applicability to a radiation registry was not explicitly discussed at the workshop. Dr. Peggy Honein (CDC), who described the Zika registry, said that CDC provided the framework for data collection and data agreements to the state and local health authorities, but the state and local health authorities performed the data collection. Then these authorities transferred the data back to CDC, which maintained a centralized registry and was responsible for reporting the adverse outcomes of Zika infections. Decisions on how the data were used and reported were made collaboratively through working groups that included federal, state, and local health partners.

Dr. Meghan McGinty (Johns Hopkins Bloomberg School of Public Health), who served as the deputy director of the Big Cities Health Coalition at NACCHO until 2018, noted that the support for one approach versus another will depend on state and local capabilities, and these differ considerably across the United States. She added that it is likely that state and local public health departments that have the resources and expertise may seek relative autonomy in setting up and maintaining the radiation registry, possibly with some federal support. However, state and local health departments that do not have the resources would rely on the federal government to set up and maintain the radiation registry.

Indeed, the New York City Department of Health and Mental Hygiene, one of the largest public health agencies in the United States, took the lead in 2002 in setting up and maintaining the World Trade Center Health Registry with initial financial and administrative support from the Federal Emergency Management Agency (FEMA), the Environmental Protection Agency (EPA), and ATSDR. The registry is now operated solely by the New York City Department of Health and Mental Hygiene with funding from the National Institute for Occupational Safety and Health. Dr. Farfel recognized the importance of collaborating with ATSDR to set up the registry because of the agency's statutory mandate to perform functions such as health surveillance and registries. ATSDR, among other tasks, helped secure a contractor who assisted with creating the initial survey and then the database of potential registrants.

Ms. Tess Konen noted that the Minnesota Department of Health is well prepared to respond to public health emergencies and that public health

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experts including injury and chronic disease epidemiologists are involved in the state's emergency preparedness program. However, the department does not have experts in tracking psychological effects following a disaster. The Minnesota Department of Health would therefore turn to the federal government for support with that task. Mr. Pickett noted that only recently have public health experts become involved in the emergency preparedness program of the Pennsylvania Department of Health despite the state's history with responding to the Three Mile Island nuclear power plant accident in 1979.

Dr. Sosin recognized that the United States has a history of government reorganization and changes to agency structures, roles, and responsibilities following major incidents. For example, after 9/11, Congress introduced homeland security legislation and approved a new cabinet-level department, the Department of Homeland Security (DHS), in 2002. After Hurricane Katrina, Congress introduced the Pandemic and All-Hazards Preparedness Act and created ASPR in 2006. Although Dr. Sosin did not explicitly discuss this, similar changes to the federal government could happen following an IND to enhance response and recovery efforts, and, therefore, roles and responsibilities for a radiation registry might need reassessing.

2.4 LINKING IMMEDIATE RESPONSE TO LONG-TERM FOLLOW-UP

Following a large-scale, mass casualty nuclear or radiological incident, such as an IND detonation, the highest priority is to care for those who are critically injured. First responders who include personnel from the police, fire brigades, and health services will be the first to arrive and provide assistance at the scene of the incident, which could still be a high-threat environment. Mr. John Koerner (ASPR) noted that implementing a strategy to appropriately triage those exposed to high levels of radiation following an IND detonation will be challenging because of the large number of exposed populations. The Exposure And Symptom Triage tool was developed to enable rapid prioritization for appropriate treatment and transport (Hick et al., 2018).

Community Reception Centers (CRCs) or other triage locations are typically established by local and state authorities within 24 hours or so after the incident and are expected to be operating for several days or weeks. These are the locations where a large portion of those affected by the incident will report and be screened for radiation contamination and exposure.

Ms. Angela Leek (Iowa Department of Public Health) and others identified the following goals of CRCs:

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SIDEBAR 2.1
Radiation Injury Treatment Network (RITN)

RITN was established in 2006 with the vision of providing a resource to help with the surge of casualties suffering from hematopoietic acute radiation syndrome (ARS) as a result of an improvised nuclear device (IND) to hospitals and cancer centers. Mr. Cullen Case, Jr., noted that facilities are selected to be part of the RITN network because of their expertise in bone marrow transplant, hematology, and oncology and because they are familiar with the needs of patients who are exposed to high levels of ionizing radiation in preparation for hematopoietic stem cell transplantation. The resulting complications of these patients can be directly correlated to the care needed for a radiation casualty who is suffering from ARS resulting from exposure to ionizing radiation following an IND.

RITN's nationwide network consists of 74 hospitals and cancer centers and has the capacity to accept and care for 63,000 individuals with ARS. Mr. Case noted that in the event of an IND, hospitals and cancer centers in distant cities will be activated in recognition that communities proximal to the incident will be overwhelmed, requiring that facilities far from the incident need to be prepared for the influx of evacuees who will require medical care. RITN facilities in the city that the incident occurs in will not be activated because it is expected that they will be using all of their resources to respond to the incident. Individuals are transferred to the distant hospitals and cancer centers by the federally coordinated National Disaster Medical System.

RITN is funded by the U.S. Office of Naval Research and coordinates with the Office of the Assistant Secretary for Preparedness and Response.

- Triage incoming patients and victims to the appropriate care.
- In case of an IND, integrate patients into RITN for specialized treatment (see Sidebar 2.1).
- Identify people who may need further evaluation or need to be followed and evaluated for potential benefits from countermeasures.
- Identify people who are contaminated externally or internally and need to be decontaminated and those who are exposed.
- Collect information of potentially affected populations for possible inclusion in a radiation registry.

A number of workshop participants felt strongly that it is not possible to set up a radiation registry at the same time first responders and CRC staff are dealing with life-saving tasks because it may impact their ability to perform these tasks. Instead, those workshop participants discussed the need for planning in advance for the handoff of information collected during the first few critical days of the incident to registry planners. Three areas of planning were discussed:

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1. Capturing basic information early
2. Screening for radiation contamination and assessing exposure
3. Considering data systems needs

These three topics are discussed in the following sections.

2.4.1 Capturing Basic Information Early

Two tools aimed to assist with the initial information collection for long-term health monitoring were described at the workshop.

The first was the Rapid Response Registry (to be replaced by Epi CASE [Contact Assessment Symptom Exposure]), a tool developed by ATSDR to help local and state public health and disaster management agencies register responders and other persons exposed to hazards including nuclear agents from a disaster. This ATSDR tool involves completing a two-page form that can be distributed on paper or electronically and requires 5 minutes or less to collect basic information, such as demographics (e.g., name, age, sex, home address), health information, exposure information, immediate health and safety needs, and health insurance information.

According to the ATSDR website (ATSDR, 2015) for mass casualty events, four critical fields are sufficient to establish an official registry record and require only about 90 seconds to complete for each registrant. These are the registrant's name, sex, home address, and telephone numbers. One participant argued that pregnancy status also needs to be included in the list of critical fields collected. This type of quick collection of basic information was referred to as "rostering" at the workshop. People who are rostered can be contacted when the community begins to recover and a registry is being set up. At that point, detailed information on the affected populations can be collected through surveys and interviews.

The second tool was the Community Reception Center Electronic Data Collection Tool (CRC eTool). This tool is intended for use at CRCs, and is designed to collect, analyze, visualize, and securely exchange population monitoring data including demographics, radiation contamination measurements, radiation exposure assessment, and health outcomes (HHS-CDC, 2018).

Ms. Leek noted that it is important to communicate with members of the public to keep track of where they were during an incident and also to record personal behavior information following the incident. This information, together with measurements of internal or external contamination performed at CRCs or other triage locations and maps of radiation levels in the contaminated areas, can assist with assessing individual exposures. However, it was evident from the discussions at the workshop that in the case of mass casualty or large-scale incidents, it is unlikely that detailed

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exposure information will be collected and assessed soon after an incident. Instead, exposure information will most likely be collected through questionnaires or interviews and assessed later in the recovery phase.

Indeed, it was months after the Fukushima accident, when residents who agreed to participate in the Fukushima Health Management Survey were asked to provide information on their location and movements for the first 4 months following the accident and to identify activities that could have impacted their external exposure. This information was compared to maps of radiation levels in the contaminated areas to develop dose estimates. According to Dr. Koichi Tanigawa (Fukushima Medical University), at that point recollection among participants was faded and the likelihood of recall bias was high. The issue of recall bias was also discussed by Mr. Sury for assessing exposures to populations enrolled in the *Deepwater Horizon* Oil Spill Study 2 years after the incident.

Mr. Richard Kozub (Middlesex County Office of Health Services, New Jersey) supported the collection of only a few critical fields at CRCs because of the limited time that those who staff the centers will have with each affected individual following a large nuclear or radiological incident. He noted that during the 2017 Gotham Shield Exercise, his office operated a CRC to monitor potentially exposed individuals, decontaminate those exposed, and subsequently register people for follow-up monitoring, medical assessment, or medical management. For the exercise, the goal was to screen 7 million people. It was estimated that it would take 6 months to process that many individuals, if detailed information was collected. That throughput speed was not acceptable by the exercise planners.

Mr. John Koerner (ASPR) cautioned that although a portion of the affected population will report to the CRCs, others may report to local hospitals and medical centers in the vicinity of the incident or to these types of facilities further away. He said that similar to first responders, the burden of setting up a registry cannot be passed on to the health care providers either. Instead, health care providers can be informed that there are a few critical fields that are going to be useful and be prepared to collect and transfer that information to the registry planners.

Mr. Koerner's comment also raised the issue of transferability of information from a medical or health care center to the registry. One of the lessons learned from the 2017 Las Vegas shooting at the Route 91 Harvest music festival was that transfer of information from health care providers to registry planners warrants pre-planning to ensure compliance with HIPAA. Mr. Jeff Quinn (Southern Nevada Health District) said that due to the high volume of injured citizens following the shootings, local available emergency medical services resources were quickly depleted and the majority of injured (approximately 800 people) were either self-transported or transported by private citizens to hospitals throughout the valley. Hospitals had

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no notice of the shooting before the injured started arriving and patient tracking through the Multi-Agency Coordination Center was compromised because hospitals were hesitant to provide the requested information in fear of violating HIPAA. A report (ASTHO, 2018) recommended developing a template of essential elements of shareable information that would detail information that can and should be shared among coalition and community response partners.

2.4.2 Screening for Radiation Contamination and Assessing Exposure

Following a nuclear or radiological incident, CRCs and other triage locations will be offering screening for radiation contamination (external or internal), an initial assessment of exposure, and guidance for decontamination. These services are critical for planning for long-term population monitoring as they provide information about the number of contaminated or exposed individuals as well as the level of contamination or exposure. Therefore, they not only inform initial projections about the impact of the incident and its acute and long-term health effects in the community as a whole but also they provide the first evaluation of the effect of the incident on an individual's health. Contaminated or exposed individuals might be particularly interested in participating in a radiation registry, when this is established, to receive a detailed dose assessment and an assessment of risk to develop disease later in life. For these reasons, a number of workshop participants cautioned that special attention is needed in setting the criterion for screening for radiation contamination and assessing exposure.

Guidance documents from FEMA (DHS-FEMA, 1995, 2002), the National Council on Radiation and Measurements (NCRP, 2005, 2008, 2010), IAEA (2005, 2006, 2011), the Conference of Radiation Control Program (CRCPD, 2006), and EPA (1992, 2013) describe factors to consider in deciding on a contamination screening criterion. Both EPA and NCRP state that the skin decontamination objective is to reduce the level to less than two times the level of background radiation.

CDC does not recommend setting a pre-determined, fixed screening criterion for radiation contamination to be applied to all people for all incidents under all circumstances (HHS-CDC, 2014). However, some workshop participants argued that without uniform standards for screening for contamination across the United States, the response effort may falter, and therefore, some pre-planning and additional guidance is warranted to ensure consistency and avoid confusion in the case of an incident. Ms. Leek made the point that without additional guidance, jurisdictions that establish CRCs will be setting different screening criteria for radiation contamination for those impacted by the same incident. The criteria they set will be based on the experience of those who perform the screening, the type of radiation

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detection equipment used, and the number of people that they are expected to screen. Mr. Kozub and Dr. Kagey echoed the need for more specific federal guidance and argued in favor of incident-dependent but consistent screening criteria for radiation contamination across states so that affected populations feel they receive consistent messaging and treatment. Many recognized that the screening criterion for emergency workers might be different from that of members of the public.

The screening criterion for radiation contamination will define survey measurement readings that indicate levels where decontamination is warranted.[5] Dr. Kozub noted that decontaminating those exposed is a resource intensive activity but suggested that the overall plans for decontamination following a nuclear or radiological incident remain flexible. He said it is likely that the number of people who will request to be decontaminated regardless of evidence of contamination will be more than anticipated. He reflected on the experience following the 9/11 terrorist attacks when New Jersey's Middlesex County Office of Health Services was supporting New York with decontaminating individuals exposed to dust or dust clouds from the collapsing buildings. Although the instructions that were given to his office were to decontaminate the people that were obviously exposed, responders ended up decontaminating anyone who requested it.

2.4.3 Data Systems Considerations

Workshop participants also discussed the handoff of information from those involved in early response to an incident to those involved in recovery including the registry planners. This handoff raises at least two issues related to data systems that would benefit from pre-planning.

1. Systems compatibility for merging information collected by different entities.
2. Leveraging existing systems to build a radiation registry.

For (1), some workshop participants suggested that forethought be given to how the initial information (likely just rostering information) collected using different tools and systems by emergency responders, CRCs, medical providers, and others is transferred to the agency responsible for setting up the radiation registry months or years after the incident. A lesson to be learned from responses to past disasters such as Hurricane Sandy was the importance of different response entities having compatible systems to

[5] There might be cases where decontamination occurs without survey measurements or an established contamination criterion to ensure prompt exposure reduction of potentially contaminated individuals.

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collect information. Dr. Kozub said that in anticipation of and following the hurricane, the American Red Cross, the local jurisdictions, and Federal Medical Stations coordinated by ASPR were collecting information on affected residents using different systems. As a result, state officials who were ultimately responsible for evaluating the overall effects of the hurricane spent weeks hand-entering all of the data into a centralized system because it was not possible to electronically merge the information collected using incompatible systems. Dr. Sosin recognized that the issue of incompatible data systems also exists at the federal level, and that departments with significant responder roles including the Department of Defense, DHS, the Department of State, and HHS lack consistency when gathering information. Therefore, the ability within the federal government to integrate and share information effectively is compromised.

For (2), the time and resources needed to build a registry and collect and process the data can be substantial. Workshop participants therefore noted that pre-planning would also help in adopting existing public health system frameworks, including the processes for data collection and linking to existing data sources to reduce the burden on staff and participants. Without providing details, Dr. Sosin noted that a lesson learned from the response to three public health emergencies, H1N1, Ebola, and Zika, was the need to leverage, scale, and build on the systems that already exist.

2.5 IMPLEMENTING RADIATION DOSE THRESHOLD AS A REGISTRY INCLUSION CRITERION

Much of the discussion at the workshop was around the appropriateness of establishing a dose threshold as an eligibility criterion for the radiation registry. Choosing a threshold reflects the option to be more inclusive (lower threshold) or to be more resource-efficient (higher threshold) in monitoring the affected populations.

Implementing a radiation dose threshold as an inclusion criterion for a registry implies that a radiation dose is estimated by the registry planners using a common protocol and assigned to the affected members of the public. According to Dr. Till, achieving that requires extensive work to create a central repository of data supporting individual radiation dose assessment that is web accessible; integrate technical methods for radiation dose assessment with source, transport, and exposure scenario information; and implement new techniques and creative approaches to accelerate and facilitate estimates of dose. The assigned doses will likely be uncertain, especially if individual dose assessment happens 1–2 years after the incident, which is when the radiation registry is expected to be set up.

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2.5.1 Existing Guidance

There is little international and no national guidance on the use of a radiation dose threshold for long-term population monitoring. The IAEA's General Safety Requirements (GSR) Part 7[6] and the Triage Monitoring and Treatment (TMT) handbook authored by a consortium of European radiation protection organizations and WHO (Rojas-Palma et al., 2009) propose that those exposed to a 100 millisievert (mSv) or higher dose to the whole body are included in a radiation registry. Dr. Eduardo Herrera, who represented the IAEA, noted that the guideline is based on scientific evidence for potential increase in cancer incidence and mortality that derives primarily from the atomic bombing survivor studies. When asked whether the IAEA guideline had been informed by non-scientific considerations or whether it had been audience tested with emergency responders, public health professionals, or members of the public, he responded that it had not.

2.5.2 Practice with Other Registries

The three radiation registries presented at the workshop whose main purpose was research and/or public health surveillance did not have a dose threshold criterion for eligibility of participants. Instead, geographic location of exposure defined eligibility. More specifically, experts involved with setting up or analyzing data from these registries noted that:

- The Life Span Study (LSS), which investigates the lifelong health effects of the atomic bombing survivors in Hiroshima and Nagasaki, identified through the national census individuals who were residents in Hiroshima and Nagasaki at the time of the bombings. About 120,000 individuals were selected to participate in the LSS, of which 94,000 were atomic bombing survivors and 27,000 unexposed individuals.
- The Chernobyl State Registry categorizes participants based on whether they participated in clean-up operations; were residents who were evacuated from the 30-kilometer zone during the first 2 weeks after the accident; or were residents of the contaminated areas or children of those people.
- The Fukushima Health Management Survey included anyone living in Fukushima Prefecture at the time of the accident including officials registered in Fukushima and individuals who temporarily visited the prefecture.

[6] See https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1467_web.pdf.

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Similarly, exposure did not define eligibility to non-radiation registries with research/public health surveillance purposes described at the workshop. For example, the World Trade Center Health Registry relied on recognizable streets and boundaries to determine eligibility for the registry. Dr. Farfel noted that the registry was criticized, particularly by community residents and labor unions, for having boundaries that were too restrictive.

In contrast to the research/public health registries described above, the registry established following the 1987 radioactive contamination accident in Goiânia, Brazil,[7] used a tiered dose approach to define eligibility (see Table 2.1 for more information). The primary purpose of that registry was medical follow-up of those exposed to radiation from the accident and provided medical examination as well as monthly compensation that varies depending on the dose received.[8] Dr. Luiz Bertelli (Los Alamos National Laboratory) described extensive efforts and approaches to estimating individual doses for those affected by the accident and to assessing the appropriateness of administering Prussian blue[9] and its efficacy in decorporation of cesium.

2.5.3 Other Considerations

Dr. Sosin argued that the decision about what threshold (if any) is appropriate following an incident in the United States will be a political decision driven by social factors and only partly informed by scientific evidence about radiation health effects. He emphasized the need for preplanning to balance the scientific with political and social considerations.

Some workshop participants recognized that attempting to be "all inclusive" may be the best approach but others argued that the all-inclusive approach will add cost but not value, resulting in overly burdensome data collection that can compromise the quality of the radiation registry. Dr. Ursano noted that a threshold as an eligibility criterion may work for predicting disease such as cancer but might not address the stress-related psychological effects of the incident, which may occur independently of the dose. Therefore, a threshold as an eligibility criterion may not work for making the community feel safe. He added that if a radiation dose threshold is implemented as an inclusion criterion for a registry, it needs to meet both the community's need to feel safe and the registry planners' goals and available resources.

[7] A Cs-137 medical teletherapy source was stolen, removed from its shield, and ruptured (IAEA, 1988, 1998).

[8] Verbal communication between Dr. Ourania Kosti (the National Academies) and Dr. Mel Dunstana (Melohill Technology LLC).

[9] Prussian blue is a drug that can help remove radioactive cesium and thallium from the body.

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In response to the different opinions on the appropriateness of a radiation dose threshold as an eligibility criterion for a radiation registry, Dr. Sosin proposed a tiered approach for data collection based on the dose received by the affected populations. Based on this approach, all individuals with high and moderate doses are enrolled in the radiation registry but only a sample of those who received low doses is included in the registry. He explained that the sample of the populations who received low doses can confirm that the risks are indeed low or provide new knowledge about the impacts of low radiation doses that may warrant a better designed study to fully examine them. Novel methods for identifying representative samples of a larger population were employed by Mr. Jonathan Sury (Columbia University) and colleagues to examine the physical and psychological effects of Hurricanes Katrina and Sandy and the *Deepwater Horizon* oil spill.

Given that an IND detonation and other radiological incidents would likely affect many states, workshop participants found that having consistent eligibility criteria for all affected is essential. Ms. Leek expressed her opinion that setting a universal threshold as an eligibility criterion for a radiation registry is unrealistic because the acceptability of radiation differs from state to state and from city to city. Dr. John Till (Risk Assessment Corporation) was optimistic that universal (but perhaps incident specific) criteria for inclusion in a registry could be set. He offered as examples the agreement within the radiation protection community in setting thresholds for administering countermeasures to members of the public and in defining acceptable dose to an emergency responder.

2.6 SCREENING FOR DISEASE

Populations affected by a nuclear or radiological incident will likely be encouraged by their health care providers to follow the screening recommendations of the U.S. Preventive Services Task Force for the general population to detect disease at an early stage and provide a better health outcome than if the disease were diagnosed at a later stage. The decision to perform additional screening, beyond what is recommended for the general population, could be an individual decision considering the person's specific radiation dose estimate. Some additional screening could be offered by the radiation registry.

2.6.1 Screening for Cancer

A radiation registry could pay special attention to diseases recognized as being associated with radiation exposure, for example, certain types of leukemia and thyroid, breast, and colon cancers, to name a few.

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Dr. Steven Woolf (Virginia Commonwealth University) stated that decisions about a radiation registry's screening policy following a nuclear or radiological incident begin with the core principles of screening, which apply to any condition (see Sidebar 2.2). In addition to balancing scientific evidence in relation to these principles, other considerations affect screening policies including costs of implementation, available resources, public expectations, and ethical and legal factors.

Experience from the Fukushima Daiichi Nuclear Power Plant accident demonstrated the challenges with decisions for screening of those affected. Dr. Tanigawa said that following the accident, thyroid ultrasound examination was offered to children aged 18 or younger to reassure members of the public that the doses received were low,[10] and therefore, the health risks from the doses received were also low. However, the examination revealed an unexpectedly large number of thyroid cancers among children screened (200 cases to date) that could not be explained by the relatively low doses received. The screening findings caused public anxiety about the health effects of radiation and raised concerns within the scientific and medical community about over-diagnosis following thyroid screening.[11]

Dr. Kayo Togawa (International Agency for Research on Cancer [IARC]) noted that the concerns about over-diagnosis led IARC to convene a multi-disciplinary expert group to develop recommendations on long-term strategies for thyroid health monitoring after a nuclear accident. The expert group recommended against population thyroid screening after a nuclear accident but also that consideration be given to establishing a long-term thyroid monitoring program for higher-risk individuals (defined as those exposed in utero or during childhood or adolescence with a thyroid dose of 100–500 mGy or more) after a nuclear accident (IARC, 2018).[12]

2.6.2 Screening for Psychological Effects

A number of workshop participants pointed to decades of research and real-world experience that show that the public fears exposure to radiation more than any other environmental hazard and that situations involving radioactive materials have a remarkable capacity to produce widespread fear, a profound sense of vulnerability, and a continuing sense of alarm and

[10] Dr. Tanigawa reported that the maximum, mean, and median values of estimated external radiation doses for the first 4 months after the accident were 25, 0.8, and 0.6 mSv, respectively.

[11] Dr. Kayo Togawa (IARC) explained that screening has the potential to identify benign thyroid nodules and thyroid cancers that will remain indolent as well as those that will become clinically significant.

[12] See http://publications.iarc.fr/Book-And-Report-Series/Iarc-Technical-Publications/Thyroid-Health-Monitoring-After-Nuclear-Accidents-2018.

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SIDEBAR 2.2
Key Principles of Screening

Dr. Steven Woolf listed four principal considerations for judging the effectiveness of cancer screening with the ultimate goal of understanding whether patients and populations experience better outcomes with screening than without it. These principles are described in more detail elsewhere (IOM and NRC, 2003) and are

1. The burden of suffering, which is the frequency with which cancer occurs in the population and its attendant health effects.
2. The accuracy and reliability of the screening test in detecting cancer and minimizing inaccurate test results.
3. The effectiveness of early detection, including the incremental benefit of detecting and treating cancer at an earlier stage.
4. The harms of screening, both from the testing process and from the incremental harms from evaluation and treatments that follow.

Dr. Woolf added that recommendations for or against population screening interventions are driven by the relative strength of the available scientific evidence in relation to these principles but judgments about the strength of the evidence are often subjective or the evidence is insufficient to recommend for or against screening. Studies show that guideline panels composed of specialists and leading investigators, who hold the most content expertise on the target condition but also have experience with skewed patient populations and potential conflicts of interest, produce different recommendations than panels composed of generalists with expertise in the critical appraisal of evidence but no personal stake in the outcomes. The U.S. Preventive Services Task Force is comprised primarily of generalists to avoid such biases. The task force has developed grading systems and rules of evidence for screening that have been used for decades.

dread. For these reasons, perception of risk from radiation is high (Becker, 2007; Slovic, 2001).

Dr. Ursano said that following a nuclear or radiological incident, some people will experience complete disruption of their lives, loss of friends or family members, or loss of jobs and social ties. Although most people are resilient and with time will recover from the tragedy, some will develop distress symptoms, changes in health behaviors, and psychiatric illness such as posttraumatic stress disorder, depression, anxiety, and increased alcohol and tobacco use. Exposure (or perception of exposure) to radiation contributes to the deterioration of one's mental health. Following nuclear plant accidents (including Chernobyl, Fukushima, and Three Mile Island), there was also increased reporting of multiple idiopathic physical symptoms and multiple unexplained physical symptoms at emergency rooms and primary care facilities. Reporting of mental health symptoms was not dependent on

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radiation dose received but on whether a person thought that he or she was exposed to radiation.

Dr. Tanigawa noted that the psychological effects of the Fukushima accident were beyond those anticipated. To mitigate these effects, the Fukushima Medical University launched telephone hotlines with clinical psychologists and other specialists who offered counseling to those who showed evidence of mental health deterioration based on responses to the mental health questionnaire of the Fukushima Medical Survey (Kumagai and Tanigawa, 2018). In 2012, the prefectural government established a dedicated center, the Fukushima Mental Health Care Center, to help cope with the prevalence of psychological effects.

Dr. Ursano noted that following a large-scale nuclear or radiological incident in the United States, available resources for large numbers of affected individuals may be limited, and Internet-based resources and treatments may expand care, although with decreased efficacy. He also noted that special programs for addressing the psychological effects of an incident on children not only have positive impacts on children's well-being but on the well-being of the community as a whole because they provide some needed reassurance that the community's future is being taken care of.

2.7 PREPARING FOR LONG-TERM COMMUNICATIONS

A common theme among the presenters and panelists was the importance of communications and public engagement at different stages of a response to a nuclear or radiological incident. Similar to other aspects of preparing for a nuclear or radiological incident, a series of tools is available to help with providing early, credible, and consistent information to the public.[13] However, risk communicators including Ms. Vivi Siegel (CDC) and Dr. Brooke Rogers (King's College London) noted gaps in planning for communications during the long-term recovery from an incident including the content of messages and who communicates those messages. Ms. Siegel explained that these gaps are to some extent expected because experts cannot predict future situations and what the communication needs will be. However, she argued that the responder and recovery community can anticipate concerns about long-term health effects including psychological effects within the affected communities and can plan for those.

[13] Ms. Jennifer Wieder (EPA) informed the workshop participants that communication resources from different federal agencies are listed on EPA's website under Protective Action Guide Public Communication Resources. See https://www.epa.gov/radiation/pag-public-communication-resources.

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2.7.1 Pre-Event Communication

Ms. Jennifer Wieder (EPA) said that successful public communication about long-term health monitoring following a nuclear or radiological emergency will be determined by the ability of the communicators to build and maintain public trust from the start of the emergency. Trust-building within communities needs to start early in the response. Ideally, understanding who the community trusts needs to happen before an emergency occurs, at a time when the public is more likely to hear and understand the messages, compared to during an emergency, which is a high-stress situation. She presented a number of lessons learned from EPA's experience in communicating with the public and building trust:

1. Emotional concerns need to be addressed before providing facts.
2. Comparisons of risks need to be chosen carefully.
3. Repeating the same message is not effective; provide additional information or context around it, or change the wording to help people understand the message better.
4. Empathy is important for trust building. Acknowledge people's feelings even if scientific evidence related to risks from their exposure indicates that the feelings are unwarranted.

2.7.2 During-Event Communication

During the early response to an event, much of the communication is one way, and it involves the government or the agency responding to the incident, explaining what the incident is, and what one needs to do to be safe. However, communication during the first few hours of an event might be disrupted by damage to infrastructure including to cell towers and landlines, and slowed satellite communication due to extensive use.

Ms. Siegel said that communicators have done a good job of anticipating through research and audience testing many of the questions that they will receive from members of the public in the immediate aftermath and have pre-planned messages that can address these concerns. For example, the government has developed early guidance messages on social media for nuclear detonation, and they can be found in the ESF #15 Standard Operating Procedures guidelines (DHS-FEMA, 2016c). The public's reaction to this messaging can impact the effectiveness of emergency response plans because members of the public can act or not act as advised depending on whether they trust the messenger.

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2.7.3 Communication During Recovery

Communication during a long-term situation such as recovery from a nuclear or radiological incident involves maintaining trust and building a long-term relationship with the affected populations. Communication experts present at the workshop said that there will be a need for continuing adjustment of the messages based on the evolving situation and the affected populations' needs. In contrast to communication during the early response phase of an incident, communication during recovery is two way, and input and feedback from those affected is crucial.

The following communication experts offered opinions on the pre-planning needs for messaging related to the radiation registry:

- Mr. Tamer Hadi (New York City Department of Health and Mental Hygiene)
- Mr. Eddie Olivarez (Hidalgo County Health and Human Services Department, Edinburg, Texas)
- Dr. Brooke Rogers (King's College London)
- Dr. Monica Schoch-Spana (Johns Hopkins Bloomberg School of Public Health)
- Ms. Vivi Siegel (CDC)
- Ms. Jessica Wieder (EPA)

The rapporteur distilled 10 key considerations for pre-planning long-term communications about a radiation registry from the experts' presentations and comments. These are described in the following sections.

Develop Relationships in the Affected Communities

Every community is different, and understanding the characteristics of those affected is an essential first step to help ensure that a registry runs smoothly and efficiently. Specific groups within a community may require a particular communication tool, message, or strategy. Such groups can include vulnerable populations, those with disabilities, pregnant women, individuals whose first language is not English, and undocumented immigrants. Verbal and written communications about the radiation registry need to be appropriately designed to meet the language, cultural, and other needs of the affected communities.

Communicate Clearly the Purpose of the Registry

Registry planners need to communicate the purpose of the registry and what incentives (for example, free health care or financial compensation)

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or links to resources are provided to participants. Similarly, it is important to communicate to participants as they join the registry and throughout the process information on who governs the registry, what health information is recorded, and what happens if something occurs along the way, for example, if a participant is diagnosed with cancer. By clearly articulating this information to those who are considering enrolling and periodically to those enrolled, the chance of setting clear expectations is increased.

Explain Eligibility for the Registry

If participation in the registry is not open to anyone interested but instead is determined by a set of inclusion and exclusion criteria, people who do not meet these criteria but are concerned about the effect of the nuclear or radiological incident to their health will feel that their concerns are neglected and will likely express their dissatisfaction to the registry planners. Their feelings may be intensified if participation at the registry is linked to resources such as health care coverage or financial compensation. On the other hand, there may be people who are eligible for participation but are concerned about the implications of being part of the registry such as "radiation stigma," a social issue prevalent among Fukushima evacuees (NRC, 2014).

Make Complex Radiation Terms and Measurements Easily Understood by Members of the Public

Communicating eligibility for a radiation registry will likely require explaining the health impacts of different levels of exposure to radiation, how these exposures are determined, and the associated uncertainties. This task is complicated by disagreement within the radiation community about health risks at low doses of radiation and the use of different units by experts (for example, international system versus conventional units) to describe dose (NASEM, 2017). These issues may give the appearance of inconsistent public messaging and ultimately may lead to loss of trust in those who deliver it.

Explain Data Confidentiality and Data Security

Participants will need to know how the data collected are being stored and whether they are accessible to others. Participants will also likely have questions about how biological samples such as blood components and urine are being used if they are collected.

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Communicate Findings of the Registry

Registry participants will want to know what the researchers found to feel that their contributions are appreciated and to use the information to make informed decisions about their health. Findings can be disseminated through reports, scientific articles, and other means.

Prepare to Deal with Emotion

For radiation registry participants, concerns about radiation will likely constitute only a part of the overall devastation caused by the incident, especially if the incident was large scale. As noted earlier, it is likely that some people will experience complete disruption of their lives, loss of friends or family members, or loss of jobs and social ties. For them, the registry might be a way to deal with the impact of the incident to their lives and registry planners need to show empathy to them and consider making resources available to the affected populations. Special recognition of the incident's impacts during anniversaries is important to maintain a trusted relationship with the enrollees.

Prepare to Be Viewed as the Overall Incident Communicator

Experience with the World Trade Center Health Registry and other registries shows that registry communicators are perceived as communicators for the incident overall. This is because years after the incident, the initial communicators have moved on to different tasks, but the registry operators are committed to a long-term activity. Therefore, they are often asked questions about the incident that are unrelated to the registry they operate. Ms. Siegel suggested that registry operators accept how the public views them and prepare to direct people to the various resources for the incident.

Establish Social Media Presence and Build Awareness of Social Media Influences

Mr. Tamer Hadi spoke about the resistance of emergency management organizations, until recently, to embrace the use of social media as a means to communicate messages but also to monitor messages and understand what members of the public, press, and others think about the way in which the agencies communicate messages. Others pointed out that if the organization that operates the registry is not present in social media, then other actors outside the organization will fill the gap, and the lack of message coherence could undermine the radiation registry's effectiveness. Dr. Schoch-Spana noted today's trend for laypersons to more readily turn to

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one another to share and interpret health experiences via social media as opposed to turning to the experts for information.

The New York City Department of Health and Mental Hygiene has successfully used a social media monitoring team during public health emergency responses including the response to Ebola and Legionnaires' disease to understand what others think about the department's response and use the feedback to help strengthen future communication (Hadi and Fleshler, 2016; Hadi et al., 2017). Mr. Hadi said that the concepts and implementations used by the department can be applied by any agency interested in social media monitoring. Agencies that do not have the capability to develop social media monitoring teams in-house can use a virtual operations support team.

Plan for Succession of Registry Communicators

Given the long-term commitment of a radiation registry (likely decades), there will be turnover in staff who manage the registry and communicate about the registry. Effective succession plans will help ensure the continuity of trust between the registry operators and the enrollees, and eliminate to the extent possible feelings of uneasiness and uncertainty among those enrolled during transitions.

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Appendix A

Workshop Agenda

DAY 1: Tuesday, March 12, 2019

8:30 AM **Plenary Session: Setting the Stage**
Moderated by Jonathan Fielding, University of California, Los Angeles (UCLA), Fielding School of Public Health

Call to Order and Welcome (10')
Jonathan Fielding, UCLA Fielding School of Public Health

About the Study Request (15')
Armin Ansari, Centers for Disease Control and Prevention (CDC)

The Need to Prepare for Population Monitoring (15')
Kevin Yeskey, Office of the Assistant Secretary for Preparedness and Response (ASPR)

Environmental Consequences and Dose Impacts of Radioactive Material Following a Nuclear or Radiological Incident (15')
Stephen Musolino, Brookhaven National Laboratory

Radiation Dose Reconstruction (15')
John Till, Risk Assessment Corporation

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Biodosimetry Tools to Support Long-Term Health Monitoring After a Large-Scale Radiological Event (15')
David Brenner, Columbia University

10:00 AM **Questions and Discussion for Plenary Session**

10:20 AM **Break**

10:35 AM **Session 1: Existing Radiation Registries and Population Monitoring**
Moderated by Betsy Kagey, Georgia Department of Public Health

Follow-Up of the Atomic Bombing Survivors (15')
Eric Grant, Radiation Effects Research Foundation, Hiroshima

The Chernobyl State Registry (15')
Andrei Cheshyk, Republican Research Center for Radiation Medicine and Human Ecology, Belarus

Dosimetry During the Radiological Accident in Goiânia (15')
Luiz Bertelli, Los Alamos National Laboratory

The Fukushima Health Management Survey (15')
Koichi Tanigawa, Fukushima Medical University

11:40 AM **Questions and Discussion for Session 1**

12:00 PM **Lunch**
Speakers and session moderators please proceed to the E Street Conference Room for buffet lunch.

All other participants can purchase lunch at the refectory on the 3rd floor.

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1:00 PM **Session 2: Health Screening**
Moderated by Tener Veenema, Johns Hopkins University School of Nursing

Radiation Screening/Decontamination (10')
Angela Leek, Iowa Department of Public Health

Medical Management of Radiation Incidents (15')
Carol Iddins, Radiation Emergency Assistance Center/ Training Site

The Principles of Screening (15')
Steven Woolf, Virginia Commonwealth University

Long-Term Strategies for Thyroid Health Monitoring After Nuclear Accidents (15')
Kayo Togawa, International Agency for Research on Cancer (IARC)

Mental Health Screening (15')
Robert Ursano, Uniformed Services University F. Edward Hébert School of Medicine

Health Care Resources (15')
Cullen Case, Jr., Radiation Injury Treatment Network

2:35 PM **Questions and Discussion for Session 2**

3:00 PM **Break**

3:20 PM **Session 3: Lessons Learned from Setting Up Population Monitoring Registries**
Moderated by Lorna Thorpe, New York University (NYU) Langone Health

The World Trade Center Health Registry (15')
Mark Farfel, New York City (NYC) Department of Health and Mental Hygiene

Katrina, Sandy, and *Deepwater Horizon* (15')
Jonathan Sury, Columbia University

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The Las Vegas Mass Shooting and Patient Tracking Registry (15')
Jeff Quinn, Southern Nevada Health District

U.S. Zika Pregnancy and Infant Registry (15')
Peggy Honein, CDC

4:30 PM **Questions and Discussion for Session 3**

5:00 PM **Day 1 Closing Remarks**
Lorna Thorpe, NYU Langone Health

5:15 PM **Adjourn Day 1**

DAY 2: Wednesday, March 13, 2019

8:00 AM **Welcome Remarks**
Jonathan Fielding, UCLA Fielding School of Public Health

8:05 AM **Session 4: Operational Considerations for Setting Up and Maintaining a Radiation Registry**
Moderated by Meghan McGinty, Johns Hopkins Bloomberg School of Public Health

PANELISTS

International Perspectives
Eduardo Herrera, International Atomic Energy Agency

Federal Perspectives
Daniel Sosin, CDC
John Koerner, ASPR
Oleg Muravov, Agency for Toxic Substances and Disease Registry

State and Territorial Perspectives
Tess Konen, Minnesota Department of Health
Jennifer Beggs, National Alliance for Radiation Readiness
Betsy Kagey, Georgia Department of Public Health
Andrew Pickett, Pennsylvania Department of Health

Local Perspectives
Richard Kozub, Middlesex County Office of Health Services

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9:50 AM **Break**

10:05 AM **Session 5: Communications**
Moderated by Brooke Rogers, King's College London

Communicating About the Event and What to Do (15')
Jessica Wieder, Environmental Protection Agency

Considerations for Long-Term Communications Planning: What About the Non-Immediate Aftermath? (15')
Vivi Siegel, CDC

Setting Expectations: How Enrollees and Epidemiologists May View the Role of a Radiation Registry Differently (15')
Monica Schoch-Spana, Johns Hopkins Bloomberg School of Public Health

Communicating Inclusion and Exclusion Criteria for a Registry (15')
Eddie Olivarez, Hidalgo County Health and Human Services Department, Edinburg, Texas

Communicating Health Monitoring Following the Salisbury Nerve Agent Attack (15')
Brooke Rogers, King's College London

Social Media Monitoring (15')
Tamer Hadi, NYC Department of Health and Mental Hygiene

11:40 AM **Questions and Discussion for Session 5**

12:05 PM **Key Themes That Emerged During the Workshop**
Jonathan Fielding, UCLA Fielding School of Public Health

12:20 PM **General Discussion**

12:35 PM **Closing Remarks**
Jonathan Fielding, UCLA Fielding School of Public Health

12:40 PM **Adjourn Day 2**

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Appendix B

Committee Member, Presenter, and Staff Member Biographies

Armin Ansari, PhD, *presenter*, is the radiological assessment team lead at the Centers for Disease Control and Prevention. He received his BS and PhD degrees in radiation biophysics from the University of Kansas and completed his postdoctoral research at Oak Ridge and Los Alamos National Laboratories. He has led the development of key national guidance documents including guides for population monitoring and operation of public shelters after radiation emergencies. 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 a member of the U.S. delegation to the United Nations Scientific Committee on the Effects of Atomic Radiation.

Jennifer C. Beggs, MPH, *panelist*, represents the Council of State and Territorial Epidemiologists on the Executive Board of the National Alliance for Radiation Readiness. She has worked for the Michigan Department of Health and Human Services (MDHHS) for 16 years and is the emergency preparedness epidemiologist for the State of Michigan. Her current areas of focus include planning and response for biological, chemical, radiological, and natural disaster incidents. She serves as the lead for the EPIDESK Unit position in the MDHHS Community Health Emergency Coordination Center and has responded to such incidents as severe acute respiratory syndrome, 2009 influenza pandemic, Middle East respiratory syndrome, *Embridge* oil spill, Ebola, Flint water contamination, and hepatitis A outbreak. Ms. Beggs is a graduate of Michigan State University with a BS in

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human biology and the University of Michigan with an MPH. She is a subcommittee member and workshop planner for the Council of State and Territorial Epidemiologists–Disaster Epidemiology Subcommittee.

Luiz Bertelli, *presenter*, worked in internal dosimetry modeling and interpretation of monitoring of radiation workers in Brazil for 18 years. He was responsible for calculating all internal doses and evaluating initial efficacy of Prussian Blue for all age groups due to the Goiânia radioactive accident. He worked as an internal dosimetrist at the Argonne National Laboratory for 1.5 years and has worked at the Los Alamos National Laboratory as an Internal Dosimetry Team member since October 2003. He has been a member of the Task Group on Dose Calculations of the International Commission on Radiological Protection since 1995, a member of the International Commission on Radiological Protection Committee 2 from 2013 to 2017, and is currently a member of the National Council on Radiation Protection and Measurements.

David Brenner, *presenter*, is the director of the Columbia University Center for Radiological Research, which is the oldest and largest radiation biology center in the United States. He is also principal investigator of the Center for High-Throughput Minimally-Invasive Radiation Biodosimetry, a multi-institute consortium to develop high-throughput biodosimetry technology to rapidly test individual radiation exposure after a radiological incident. He is also director of the Columbia Radiological Research Accelerator Facility, which is a national facility dedicated to probing the mechanisms of radiation induced cancer. Mr. Brenner's research focuses on mechanistic models for the effects of ionizing radiation on living systems. He divides his research time between the effects of high doses of ionizing radiation (relating to radiation therapy) and the effects of low doses of radiation (relating to radiological, environmental, and occupational exposures). At low doses, he was the first to quantify the potential risks associated with the rapidly increasing usage of computerized tomography scans in the United States. At high doses, his proposal to use large-fraction radiotherapy for prostate cancer (hypofractionation) is increasingly being used in clinics. He is a recipient of the Failla gold medal, the annual award given by the Radiation Research Society for contributions to radiation research.

Cullen Case, Jr., *presenter*, is the program manager for the Radiation Injury Treatment Network, where he leads the preparedness activities of 73 hospitals for the medical surge from a radiological incident. He has additional responsibilities for the National Marrow Donor Program (NMDP) to ensure organizational preparedness; lead crisis response, business continuity, and emergency communications; and exercise all related plans for

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the NMDP. He has experience leading technical teams in Silicon Valley, teaching computer-aided design, providing engineering design services, and was a logistics officer in the U.S. Army. While in the U.S. Army he managed the logistical response to Hurricanes Bertha and Fran in North Carolina (1996) and Hurricane Mitch in Nicaragua (1998). Mr. Cullen has an Executive Master of Public Administration, a BS in industrial engineering, is a Certified Emergency Manager, a Certified Business Continuity Professional, a Certified Healthcare Emergency Professional, a Stanford Certified Project Manager, and a Minnesota Certified Emergency Manager.

Andrei Cheshyk, PhD, *presenter*, is the head of the Department of the State Register of Belorussian Persons Exposed to Radiation due to the Chernobyl Accident of Belarus in The Republican Research Centre for Radiation Medicine and Human Ecology. The main directions of scientific activity are collection and analysis of medical and dosimetry information on people affected by the Chernobyl disaster, public health and health care of the health of the population residing in the areas affected by the Chernobyl accident, scientific and epidemiological analysis of health indicators of the population affected by the Chernobyl accident, and the study of the structure, nature, dynamics, morbidity and disability trends, and outcomes of the diseases within the population affected by the Chernobyl accident.

Mark Farfel, ScD, *presenter*, has served as the director of the World Trade Center (WTC) Health Registry in the Division of Epidemiology, New York City Department of Health, since 2005. He has overseen the expansion of the scope and comprehensiveness of the Registry's intramural and collaborative extramural research. He has also guided efforts to encourage Registry enrollees to seek 9/11-related health care through the federal WTC Health Program. Prior to joining the Registry, he served for 18 years on the faculty of the Johns Hopkins Bloomberg School of Public Health conducting epidemiological and applied research focused on urban environmental health issues. He also received his doctoral degree from the Johns Hopkins Bloomberg School of Public Health.

Jonathan E. Fielding, MPH, MBA, MD, *committee chair and session moderator*, is a professor of health policy and management and pediatrics at the University of California, Los Angeles (UCLA), Fielding School of Public Health. His areas of expertise include the development of preventive services guidelines and priorities, prevention economics and financing, evidence-based public health methods and practice, and health promotion for children, adults, and families in community, clinical, and occupational settings. As the founding co-director of the UCLA Center for Health Enhancement, he helped develop the first comprehensive university-based center to focus

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on clinical and worksite prevention opportunities. Dr. Fielding served as director of public health and health officer for Los Angeles County for more than 16 years where he was responsible for the full range of public health activities for more than 10 million county residents. Dr. Fielding's awards include the Porter Prize, given for his national impact on improving the lives of Americans; The Milton and Ruth Roemer Prize for achievements in local public health; the Sedgwick Medal for contributions to the field of public health; and elected membership in the National Academy of Medicine. He received an MD, an MA, and an MPH from Harvard University and an MBA from the Wharton School of Business Administration.

Eric Grant, PhD, *presenter*, is the associate chief of research at the Radiation Effects Research Foundation (RERF) in Hiroshima and Nagasaki, Japan. Dr. Grant was originally trained in engineering and holds a BSEE from the University of Michigan. Dr. Grant earned his PhD in epidemiology from the University of Washington and has worked as a research scientist at RERF for many years. His primary research interests include cancer incidence, indirect effects, and trans-generational effects of radiation exposure. Dr. Grant was the program co-chair for the 2018 Conference on Radiation and Health in Chicago, Illinois, and was recently nominated to be a member of the National Council on Radiation Protection and Measurements.

Tamer Hadi, *presenter*, is the director of strategic technology for the Office of Emergency Preparedness and Response at the New York City Department of Health and Mental Hygiene, where he is responsible for managing technology projects that aim to improve the agency's ability to prepare for, respond to, and recover from emergencies. In 2012, Mr. Hadi was responsible for the creation and development of a social media monitoring team that has been integrated into the independence care system (ICS) structure of the agency and used during every emergency response. Over the past 12 years, Mr. Hadi has served as the ICS liaison officer for several agency responses including H1N1, Hurricane Sandy, Ebola, Legionnaires' outbreaks, and Zika. Mr. Hadi has a master's degree in bioinformatics from New York University and a BS in biology from the University at Buffalo.

Eduardo Herrera, PhD, *panelist*, is a medical doctor and specialist in nuclear medicine. He has been working since 2012 in the Incident and Emergency Centre at the International Atomic Energy Agency (IAEA) as the medical emergency preparedness specialist, and is an expert in radiopathology and topics related to medical management of internal contamination, internal dosimetry, biological dosimetry, and occupational medicine. Dr. Herrera is the author of several IAEA publications and training materials related to the medical management of persons involved in nuclear and

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radiological emergencies. He has been technical officer for more than 23 regional and national projects under the IAEA Technical Cooperation. He is also responsible for the medical preparedness and response activities in the IAEA for radiological and nuclear emergencies. Dr. Herrera is an international expert and coordinator of trainings and workshops and international meetings for more than 120 member states, with more than 1,000 health care professionals trained. He is also the leader of eight international IAEA Missions in the medical field and does important work with stakeholders and international networks.

Margaret (Peggy) Honein, PhD, MPH, *panelist*, is an epidemiologist and the director of the Centers for Disease Control and Prevention's (CDC's) Division of Congenital and Developmental Disorders. Her research interests include congenital infections, substance exposure and medication use during pregnancy, and long-term outcomes associated with birth defects and infant disorders. Dr. Honein served as the co-lead for the Pregnancy and Birth Defects Task Force for 20 months during CDC's Emergency Zika Response; in this capacity, she developed and directed work to advance understanding of and mitigate the impact of Zika virus infection during pregnancy.

Carol Iddins, PhD, *presenter*, is the director of the Radiation Emergency Assistance Center/Training Site (REAC/TS), a Department of Energy emergency response asset for radiological/nuclear (R/N) incidents. She routinely consults on calls regarding radiation exposures; evaluates and participates in R/N exercises; and consults on cases involving cutaneous radiation injuries. Dr. Iddins has been deployed overseas to examine and consult on patients with radiation injuries secondary to radiotherapy overdose errors for the International Atomic Energy/Pan American Health Organization Radiation Assistance Network. She has been at REAC/TS since 2009 and has become a nationally and globally known subject-matter expert in the medical management of radiological injuries and incidents. Dr. Iddins is a fellow of the American Academy of Disaster Medicine with 25 years of experience in civilian and military medicine and is a decorated U.S. Air Force Veteran.

Betsy T. Kagey, PhD, MSPH, *committee member, session moderator, and panelist*, is the academic and special projects liaison at the Georgia Department of Public Health's Office of Emergency Preparedness and Response. The primary focus of her current work is on emergency preparedness planning for vulnerable populations and developing guidance for Georgia's public health response to radiation incidents. Dr. Kagey is a member of the Council for State and Territorial Epidemiologists's (CSTE's) environmental and disaster epidemiology workgroups and she is CSTE's representative on

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the National Alliance for Radiation Readiness. Dr. Kagey is a member and past president of the Society for Environmental Geochemistry and Health. Dr. Kagey received a BS in chemistry from Carnegie Mellon University, an MSPH in environmental epidemiology from the University of North Carolina Gillings School of Global Public Health, and a PhD in environmental health and toxicology from the State University of New York School of Public Health.

John Koerner, MPH, *panelist*, is chemical, biological, radiological, nuclear, and explosive (CBRNE) advisor in the Department of Health and Human Services' Office of the Assistant Secretary for Preparedness and Response for matters related to national medical preparedness and response to CBRNE incidents. In that role, Mr. Koerner leads the development of innovative, evidence-based interventions and guidance to support the nation's medical and public health response to catastrophic disasters and terrorist incidents. He is broadly published and an internationally recognized expert in medical preparedness and response to radiation and other CBRNE incidents. He is a combat veteran and serves as board member and triage chief during medical missions for a charitable organization. He received his MPH from the Johns Hopkins Bloomberg School of Public Health and is a board certified industrial hygienist. He has spent more than two decades operating, researching, and advising in the field of medical and public health response to terrorism.

Tess Konen, *panelist*, graduated from the University of Michigan School of Public Health with a master's degree in occupational environmental epidemiology. She completed a Council of State and Territorial Epidemiologists (CSTE)/Centers for Disease Control and Prevention Epidemiology Fellowship at the Minnesota Department of Health in the Minnesota Tracking program. Currently, she is an environmental epidemiologist in the Minnesota Tracking program focusing on acute poisonings surveillance, climate change indicators, and disaster epidemiology. She is the chair of the CSTE Disaster Epidemiology Subcommittee and works on post-disaster, long-term surveillance planning.

Ourania (Rania) Kosti, PhD, MSc, *staff member*, is a senior program officer at the National Academies of Sciences, Engineering, and Medicine's Nuclear and Radiation Studies Board (NRSB). Dr. Kosti's interests within the NRSB focus on radiation health effects, and she is the principal investigator for the National Academies' Radiation Effects Research Foundation Program that supports studies of the atomic bombing survivors in Japan. Prior to her current appointment, she was a postdoctoral fellow at the Lombardi Comprehensive Cancer Center at Georgetown University Hospital in Washington, DC, where she conducted research on biomarker

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development for early cancer detection using case-control epidemiological study designs. She focused primarily on prostate, breast, and liver cancers and on trying to identify those individuals who are at high risk of developing malignancies. Dr. Kosti also trained at the National Cancer Institute (2005–2007). She received a BSc in biochemistry from the University of Surrey, United Kingdom, an MSc in molecular medicine from the University College London, and a PhD in molecular endocrinology from St. Bartholomew's Hospital in London, United Kingdom.

Richard F. Kozub, *panelist*, currently serves as the management specialist for the Middlesex County, New Jersey, Office of Health Services Special Operations Unit. He oversees the County Health's emergency preparedness operations, Medical Needs Shelters operations, and Radiation Response program, and oversees coordinating equipment and logistics for disaster response operations. Mr. Kozub serves as the medical reserve corps coordinator for the county. He has been an adjunct faculty member at Rutgers University for 34 years and is an instructor for the New Jersey State Police Hazmat Program. He is also a member of the Northern New Jersey Urban Area Security Initiative Program. Prior to his current position he was the chief of the County Hazardous Materials Unit from 1979–2002. He has also been a member of his hometown volunteer fire department for 35 years, serving in all officer positions.

Angela Leek, MS, *presenter*, is the bureau chief for Radiological Health at the Iowa Department of Public Health, where she is responsible for all aspects of radiation protection in Iowa, including programs with oversight of radioactive materials, radiation machines, and radon. She is also responsible for coordinating dose assessment and providing technical advice, control, and tracking for public and worker doses and protection throughout radiation emergency response. In addition to her responsibilities in Iowa, she is also active in supporting the development and implementation of the Radiological Operations Support Specialist program. Ms. Leek currently serves as Iowa's state liaison officer to the Nuclear Regulatory Commission, serves on the Conference of Radiation Control Program Board of Directors, is a voting member for the Organization of Agreement States, and is councilor for the North Central Chapter of the Health Physics Society. She earned an MS in radiation health physics from Oregon State University.

Meghan McGinty, PhD, MPH, MBA, *committee member and session moderator*, is a faculty associate in health policy and management at the Johns Hopkins Bloomberg School of Public Health. Her research examines public health preparedness and response to disasters, allocation of scarce resources during emergencies, risk management and communication, and resilience.

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Prior to joining Hopkins, Dr. McGinty served as the deputy director of the Big Cities Health Coalition at the National Association of County & City Health Officials. In this role, she convened leaders of America's largest metropolitan health departments to exchange strategies and jointly address issues to promote and protect the health and safety of the 55 million people they serve. Over the course of her career, Dr. McGinty has prepared for, responded to, and conducted research to improve national resilience to disasters and public health emergencies. She served as director of continuity of operations planning at the New York City Department of Health and Mental Hygiene, where she was responsible for developing plans to sustain essential public health services in the event of a disaster. She also supported preparedness and response initiatives of the U.S. National Response Team, the Environmental Protection Agency, the U.S. Coast Guard, the Federal Emergency Management Agency, and the U.S. Public Health Service. She has responded to disasters including Hurricanes Katrina and Rita and the 2009 H1N1 pandemic. Dr. McGinty is committed to improving the nation's collective ability to learn from prior disasters. To this end, she has served on the National Institute of Environmental Health Sciences' Best Practices Working Group for the development of special considerations for Institutional Review Board review of disaster and emergency-related public health research, and is a member of the National Health Security Preparedness Index's Advisory Panel for the development of local measures. Dr. McGinty earned an MPH and a PhD from the Johns Hopkins Bloomberg School of Public Health, an MBA from the Johns Hopkins Carey Business School, and a BA from Georgetown University.

Oleg I. Muravov, PhD, MD, *panelist*, is medical epidemiologist at the Agency for Toxic Substances and Disease Registry (ATSDR). Dr. Muravov has expertise and 33 years of experience in planning, managing, and supervising epidemiological, public health surveillance, and registry programs, including congressionally mandated national surveillance programs and research, analytical, and applied health surveillance programs. He was a visiting scientist/senior science fellow with ATSDR (1992–2006) and a senior epidemiologist with the Chernobyl nuclear plant response (1986–1992). He served as the principal investigator (PI) for 24 epidemiological studies investigating adverse health outcomes related to exposure to various toxic agents and radiation; he is a member of the National Amyotrophic Lateral Sclerosis (ALS) Registry; a member of the National Multiple Sclerosis Prevalence Workgroup; program lead for the ATSDR Rapid Response Registry (https://www.atsdr.cdc.gov/rapidresponse), a subject-matter expert assisting state and local health/disaster agencies with post-disaster surveillance and registries; and PI for the multi-state ALS/Multiple Sclerosis prevalence studies grants and contracts. He earned his MD at the Ukrainian

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State Medical University, Kiev, Russia (1983), and a PhD in epidemiology at the USSR Academy of Medical Sciences, National Center for Preventive Medicine, Moscow, Russia (1992).

Stephen V. Musolino, PhD, MS, *committee member and presenter*, is a scientist in the Nonproliferation and National Security department at the Department of Energy's (DOE's) Brookhaven National Laboratory (BNL). With more than 30 years of experience in health physics, his current research interests are in nonproliferation, counterterrorism, and planning for response to the consequences of radiological and nuclear terrorism. Since 1981, he has been part of the DOE Radiological Assistance Program as a team captain/team scientist and has been involved in developing radiological emergency response plans and procedures, as well as participating in a wide range of radiological and nuclear exercises and field deployments. During the Fukushima crisis, he was deployed in Japan as an assessment scientist with the DOE response team that was measuring the environmental consequences of the radioactive material released from the damaged nuclear power plants. He is a member of the National Council on Radiation Protection and Measurements (NCRP) and served on the scientific committee that developed NCRP Report No. 165, Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers. He also co-chaired the committee for Report No. 179, Guidance for Emergency Reponses Dosimetry. Dr. Musolino was a member of the team with the Department of Homeland Security that published *Radiological Dispersal Device (RDD) Response Guidance Planning for the First 100 Minutes*. Earlier in his career at BNL he was a member of the Marshall Islands Radiological Safety Program and participated in numerous field missions to monitor the populations living on islands affected by nuclear testing. Dr. Musolino earned a BS in engineering technology from Buffalo State College, an MS in nuclear engineering from Polytechnic Institute of New York University, a PhD in health physics from the Georgia Institute of Technology, and is certified by the American Board of Health Physics.

Eduardo "Eddie" Olivarez, *presenter*, has been involved in health care for more than 30 years. In addition, he has a background in psychiatric and drug addictions treatment, thereby encouraging an improved community. Mr. Olivarez's primary objective is to promote healthier lifestyles and promote stronger families. He has been a hospital administrator and has overseen each aspect of operating a successful inpatient and outpatient facility. He has also led a private nonprofit drug treatment and prevention organization that provided services across the Rio Grande Valley. He is currently the chief administrative officer of Hidalgo County Health and Human Services and is responsible for the implementation of various public health

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and human services programs in indigent health care, preventative health care, environmental health, infectious diseases and prevention, and homeland security preparedness and response. He is a U.S. Public Health Service Primary Care Policy fellow from the Department of Health and Human Services. He served as the president of the U.S./Mexico Border Health Association representing all 10 bi-national states on the U.S./Mexican Border, and past president of the Texas Association of Local Health Officials. He is a chairman of Texas Department of State Health Services Preparedness Coordinating Council, which oversees public health homeland security, in addition to serving on several boards and committees focusing on public health needs.

Andrew "Andy" Pickett, MS, *panelist*, is currently the director of the Bureau of Public Health Preparedness with the Pennsylvania Department of Health, having been appointed to the position in April 2015. In this role, he oversees the implementation of the Public Health Emergency Preparedness and Hospital Preparedness Program federal cooperative agreements, and manages public health and medical preparedness and response efforts across the commonwealth. Previously, he worked for 7 years in local public health preparedness for the City of Detroit and in county emergency management. Academically, he holds a BS in geographic information science from Central Michigan University and an MS in technology studies with a concentration in public safety and emergency management from Eastern Michigan University. He has also participated in the Executive Leaders Program through the Center for Homeland Defense and Security at the Naval Postgraduate School.

Jeff Quinn, MPH, *presenter*, is the public health preparedness manager with the Southern Nevada Health District in Las Vegas, Nevada. The Office of Public Health Preparedness is responsible for managing multiple federal cooperative agreements, sub-granted to local health authorities from the State of Nevada. Mr. Quinn served in the Clark County Multi-Agency Coordination Center immediately following the October 1, 2017, mass casualty incident in Emergency Support Function #8 and provided support to health care systems through the Medical Surge Area Command in the weeks following this incident. Mr. Quinn most recently served as the chair for the Southern Nevada Healthcare Preparedness Coalition. He is also an active member of Southern Nevada's Type 3 Incident Management Team, Vegas Strong Resiliency Center-Responder Support Working Group, and The Nevada Emergency Preparedness Association.

Brooke Rogers, PhD, *committee member, presenter, and session moderator*, is a professor of Behavioural Science and Security in the Department of War

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Studies at King's College London. She is a social psychologist interested in risk and crisis communication, perceptions of risk, and health outcomes in response to extreme events. The majority of her projects investigate public and practitioner responses to chemical, biological, radiological, or nuclear (CBRN) terrorist incidents. She is the chair of the Cabinet Office Behavioural Science Expert Group for the National Risk Assessment and National Security Risk Assessment. She maintains membership on various working groups and committees including the UK Government's Scientific Advisory Group for Emergencies; the Cabinet Office Community Resilience Programme Steering Group; the Home Office Science Advisory Council; the Home Office, Office for Security and Counter Terrorism Science, Technology, Analysis and Research Programme Challenge Board; the Cabinet Office Community Resilience Programme Steering Group; the Cabinet Office Practitioner Guidance Advisory Group; and Public Health England's Emergency Response Development Group's Psychosocial and Behavioural Issues Sub-Group. She has also been involved in teaching and training for the North Atlantic Treaty Organization, the International Atomic Energy Agency, Home Office, Metropolitan Police, Police National CBRN Centre, Department of Homeland Security, and others. Professor Rogers has a BA (cum laude) in psychology from Rollins College in Winter Park, Florida, and a PhD in psychology from Royal Holloway University, University of London.

Monica Schoch-Spana, PhD, *presenter*, a medical anthropologist, is a senior scholar with the Johns Hopkins Center for Health Security and a faculty member in the Department of Environmental Health and Engineering at the Johns Hopkins Bloomberg School of Public Health. Her research and policy interests include community resilience to disasters, crisis and emergency risk communication, and public engagement in policy making. Working in the field of public health emergency preparedness for the past 20 years, Dr. Schoch-Spana has led research, education, and advocacy efforts to encourage authorities to enlist the public's contributions in epidemic and disaster management. National advisory roles include serving on the Homeland Security Subcommittee of the Board of Scientific Counselors for the Environmental Protection Agency; the Resilient America Roundtable of the National Academies of Sciences, Engineering, and Medicine; and the National Research Council's Committee on Increasing National Resilience to Hazards and Disasters. She received her PhD in cultural anthropology from Johns Hopkins University.

Vivi Siegel, MPH, *presenter*, is the acting associate director for communications for the Centers for Disease Control and Prevention's (CDC's) Division of Environmental Health Science and Practice in the National Center for

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Environmental Health. Her focus is on using risk communication principles to help stakeholders understand and deal with health uncertainties surrounding environmental events and exposures, and to take actions to protect themselves and others. She helps lead CDC communications responses for natural, chemical, and radiological emergencies, including the 2011 Fukushima response and 2017 national Gotham Shield exercise, and recently, Hurricanes Harvey, Irma, Maria, Florence, and Michael. She holds a BS in journalism from Northwestern University in Evanston, Illinois, and an MPH in environmental toxicology from the University of Alabama at Birmingham.

Daniel Sosin, MD, MS, *panelist*, is the deputy director and chief medical officer for the Office of Public Health Preparedness and Response (OPHPR) at the Centers for Disease Control and Prevention (CDC). In his current role, Dr. Sosin is the lead science advisor and provides scientific representation for preparedness on behalf of the OPHPR Director and CDC. He serves as a liaison to CDC programs and external partners and assures strategy and program coordination for OPHPR in medical and public health preparedness and response. He is board certified in preventive medicine and internal medicine and a fellow of the American College of Physicians. He received his MD from the Yale University School of Medicine, his master's degree in epidemiology from the University of Washington School of Public Health, and his BS in biology from the University of Michigan.

Jonathan Sury, *presenter*, is a project director for Field Operations and Communications at the National Center for Disaster Preparedness (NCDP), Earth Institute, Columbia University. He has a keen interest in geographic information systems (GISs) and their use in disaster preparedness and recovery. He has more than 10 years of experience in qualitative and quantitative research with significant experience field research and study design, implementation, management, and data architecture and analysis. He has been responsible for mobile solutions deployment, management, and data flow on more than eight waves of cohort studies. He has led NCDP's use of GISs in combination with wireless data collection methods utilizing centralized server applications in both offline and online scenarios.

Koichi Tanigawa, *presenter*, is the vice president of Fukushima Medical University and the director at Fukushima Global Medical Science Center. He is a graduate of Faculty of Medicine, Kyushu University in 1982, and trained in emergency and critical care medicine in Fukuoka, Japan, and Pittsburgh, Pennsylvania. Professor Tanigawa has been contributing to the development of the Japan's radiation emergency medical system when he was professor and chair of the Department of Emergency and Critical Care

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Medicine at Hiroshima University. In response to the 2011 earthquake, tsunami, and nuclear crisis, Professor Tanigawa led a radiation emergency medical team dispatched to Fukushima, and later became vice president of Fukushima Medical University. He reported the important issues learned from the Fukushima Accident in *The Lancet*, and edited a book titled *Radiation Disaster Medicine* (Springer, 2013).

Lorna Thorpe, PhD, MPH, *committee member and session moderator*, is a professor of epidemiology, the director of the Division of Epidemiology, as well as the chair of strategy and planning in the Department of Population Health at New York University (NYU). Dr. Thorpe is a leading expert in population health surveillance and performing population-based studies. Her current research focuses on the intersection between epidemiology and policy, particularly with respect to chronic disease prevention and management and improving modern forms of public health surveillance. Before coming to NYU School of Medicine, she served as chair of the Department of Epidemiology and Biostatistics at the City University of New York's School of Public Health for 7 years. Prior to that, Dr. Thorpe spent 9 years at the New York City Department of Health and Mental Hygiene, including 5 years as deputy commissioner of epidemiology. In her time at the Health Department, Dr. Thorpe led the growth of the Epidemiology Division and oversaw a large portfolio of innovative scientific studies aimed at understanding the health of New York City residents. She also supervised birth and death registration, injury surveillance, epidemiologic consultancies throughout the agency, public health training, and workforce development. Dr. Thorpe serves as chair of the steering committee for the Centers for Disease Control and Prevention (CDC)-funded Prevention Research Center Network, which includes 26 academic institutions around the nation. She has served on National Academies of Sciences, Engineering, and Medicine committees and as an advisor to CDC on population health surveillance issues. Dr. Thorpe completed a BA at Johns Hopkins University, an MPH at the University of Michigan, and a PhD in epidemiology at the University of Illinois at Chicago.

John E. Till, PhD, *presenter*, is the president of Risk Assessment Corporation (RAC), a research and development organization focusing on environmental risk analysis and dose reconstruction. Dr. Till is a graduate of the U.S. Naval Academy and served in the U.S. Navy Nuclear Submarine Program, retiring as a rear admiral in the U.S. Naval Reserve. He has published widely in the open literature, editing the first textbook on radiological risk assessment published by the U.S. Nuclear Regulatory Commission in 1983 followed by an updated version in 2008, *Radiological Risk Assessment and Environmental Analysis*, published by Oxford University Press. He was

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the recipient of the E.O. Lawrence Award from the Department of Energy (DOE) in the field of Environmental Science and Technology in 1995 and presented the Lauriston S. Taylor Lecture at the annual meeting of the National Council on Radiation Protection and Measurements in 2013. Dr. Till and the RAC team have performed historical dose reconstructions at 12 former or current DOE sites as well as other facilities where radionuclides have been released to the environment and raised public concerns.

Kayo Togawa, PhD, MPH, *presenter*, is an epidemiologist in the Section of Environment and Radiation at the International Agency for Research on Cancer (IARC), the World Health Organization's specialized cancer research agency. Her current work primarily involves the coordination of the Thyroid Monitoring after Nuclear Accidents project, where an international, multidisciplinary expert group convened by IARC developed recommendations on long-term thyroid health monitoring after nuclear accidents. Dr. Togawa also works on research projects at IARC, such as the consortium of agricultural cohort studies and the African Breast Cancer–Disparities in Outcomes study. Her current research interests are in occupational cancer epidemiology and early detection of cancer. Dr. Togawa received an MPH and a PhD in epidemiology from the University of Southern California.

Robert Ursano, PhD, *presenter*, is a professor of psychiatry and neuroscience at the Uniformed Services University F. Edward Hébert of Medicine and the founding director of the Center for the Study of Traumatic Stress. Dr. Ursano completed 20 years of service in the U.S. Air Force medical corps. He is a distinguished life fellow of the American Psychiatric Association. He has received the Department of Defense Humanitarian Service Award, the Lifetime Achievement Award of the International Traumatic Stress Society, the William C. Menninger Memorial Award of the American College of Physicians, and the American Psychological Association's (APA's) Bruno Lima Award in Disaster Psychiatry. He is the senior editor of the *Textbook of Disaster Psychiatry* and was the first chairman of the APA's Committee on Psychiatric Dimensions of Disaster. His work focuses on the interface of psychiatry and public health in times of disaster and terrorism.

Tener Goodwin Veenema, PhD, MPH, MS, RN, FAAN, *committee member and session moderator*, is a professor of nursing and public health at the Johns Hopkins University School of Nursing and the Johns Hopkins Bloomberg School of Public Health. As an internationally recognized expert in disaster nursing and public health emergency preparedness, she has served as senior scientist to the Department of Health and Human Services' Office of Human Services Emergency Preparedness and Response, Department of Homeland Security, Federal Emergency Management Agency,

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and the Veterans Affairs Emergency Management Evaluation Center. An accomplished researcher, Dr. Veenema is a member of the American Red Cross National Scientific Advisory Board and is an elected fellow in the American Academy of Nursing, the National Academies of Practice, and the Royal College of Surgeons Faculty of Nursing and Midwifery, Dublin, Ireland. She is the editor of *Disaster Nursing and Emergency Preparedness for Chemical, Biological and Radiological Terrorism and Other Hazards,* 4th edition, the leading textbook in the field. Dr. Veenema was awarded the Florence Nightingale Medal of Honor (International Red Crescent, 2013), the highest international award in nursing, for her professional service in disasters and public health emergencies and was the recipient of a Fulbright U.S. Scholar Award (2017). She served as the National Academy of Medicine (NAM) 2018 Distinguished Nurse Scholar-in-Residence and has been a member of several NAM committees including the Centers for Disease Control and Prevention (CDC) Standing Committee for the Strategic National Stockpile, the CDC Committee on Evidence-Based Practices for Public Health Emergency Preparedness and Response, and the CDC/National Institute for Occupational Safety and Health Committee on the Use of Elastomeric Respirators in Health Care. Dr. Veenema received master's degrees in nursing administration (1992), pediatrics (1993), and public health (1999), and a PhD in health services research and policy (2001) from the University of Rochester School of Medicine and Dentistry.

Jessica Wieder, *presenter*, is the director of the Center for Radiation Information and Outreach at the Environmental Protection Agency (EPA). She has worked in the field of radiation communication for 14 years and serves as the senior public information officer for EPA's Radiological Emergency Response Team. Ms. Wieder leads the United States Nuclear/Radiological Communication Working Group and is a member of the National Council on Radiation Protection and Measurements.

Steven H. Woolf, MD, MPH, *presenter*, is the director emeritus of the Center on Society and Health at Virginia Commonwealth University, where he is a professor of family medicine and population health. He holds the C. Kenneth and Dianne Wright Distinguished Chair in Population Health and Health Equity. Dr. Woolf has edited three books. Over a period of 16 years in his early career, Dr. Woolf served as scientific advisor to, and a member of, the U.S. Preventive Services Task Force. He is author of *Health Promotion and Disease Prevention in Clinical Practice* and has published more than 200 articles in a career that has focused on raising public awareness about the social, economic, and environmental conditions that shape health and produce inequities. Dr. Woolf was elected to the National Academy of Medicine in 2001.

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Kevin Yeskey, MD, *presenter*, currently serves as the principal deputy assistant secretary to the Assistant Secretary for Preparedness and Response at the Department of Health and Human Services (HHS). The office leads the nation in preventing, responding to, and recovering from the adverse health effects of man-made and naturally occurring disaster and public health emergencies. Dr. Yeskey spent more than 24 years as a physician in the U.S. Public Health Service (USPHS) and retired as CAPTAIN. In his USPHS career, he served in various agencies in HHS, including the Indian Health Service, Health Resources and Services Administration, and Centers for Disease Control and Prevention. From 2007 to 2012, he was the deputy assistant secretary for preparedness and response and the director of the Office of Preparedness and Emergency Operations. From 1986 to 1999, Dr. Yeskey was a member of the HHS Disaster Medical Assistance Team of the National Disaster Medical System (NDMS), serving as the Team Commander from 1993–1999. He was the chief medical officer for the NDMS program from 1998–1999. Dr. Yeskey also served as the Medical Policy Advisor to Federal Emergency Management Agency Operations prior to retiring from the USPHS. Dr. Yeskey received his bachelor's degree from Brown University and his MD from the Uniformed Services University of the Health Sciences. He has been board certified in emergency medicine for more than 30 years.

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NRC to Hold Public Meeting to Discuss Oversight Activities at San Onofre Nuclear Generating Station

The Nuclear Regulatory Commission will hold a public meeting on Aug. 20 to discuss the status of fuel loading operations at the San Onofre Nuclear Generating Station. The San Clemente, Calif., plant is owned by Southern California Edison and permanently shut down in 2013.

The "town hall" style meeting, to be held at the San Juan Capistrano Community Center, 25925 Camino Del Avion, will run from 7-8:30 p.m. NRC staff will update the public on ongoing inspection activities, then seek questions and comments from members of the public on spent fuel storage related issues.

Fuel loading operations were suspended following an Aug. 3, 2018, incident involving a loaded spent fuel storage canister that was misaligned and became stuck on a flange while being lowered into a storage vault. Information about the incident and NRC's response is available on the NRC website.

Edison resumed fuel loading operations last month after the NRC determined operations could be safely resumed following extensive corrective actions by the company.