Discussion Guide

*For public health decision-making in a nuclear/radiological response*

CDC

# Primer on Nuclear/Radiological Preparedness and Response Basics

This section is intended to be used as a fact sheet for participants in the discussion-based activity .

## Radiation Basics

### What is Electromagnetic Radiation?[1]

Electromagnetic radiation is energy that comes from a source and travels through space and matter. This energy has an electric field and a magnetic field associated with it and has wave-like properties. You could also call radiation "electromagnetic waves." There is a wide range of electromagnetic radiation in nature. Visible light is one example. Radiation with the highest energy includes forms like ultraviolet radiation, x-rays, and gamma rays.

### Contamination vs. Exposure[2]

Radioactive contamination occurs when radioactive material is deposited on or in an object or a person. Radioactive materials released into the environment can cause air, water, surfaces, soil, plants, buildings, people, or animals to become contaminated. A contaminated person has radioactive materials on or inside their body.

Radioactive materials give off a form of energy that travels in waves or particles. This energy is called radiation. When a person is exposed to radiation, the energy penetrates the body. For example, when a person has an x-ray, they are exposed to radiation.

### Acute Radiation Syndrome[3]

Acute Radiation Syndrome (ARS) is sometimes known as radiation toxicity or radiation sickness. ARS is an acute illness caused by irradiation of the entire body, or most of the body, by a high dose of penetrating radiation in a very short period, usually a matter of minutes.

**The required conditions for ARS are**

- **The radiation dose must be large** (i.e., greater than 0.7 Gray [Gy][1, 2] or 70 rads).

---

[1] From Radiation and Your Health by CDC

[2] From What Causes Contamination versus Exposure by CDC

[3] From Acute Radiation Syndrome: Information for Clinicians by CDC

- **The dose usually must be external** (i.e., the source of radiation is outside of the patient's body).
- **The radiation must be penetrating** (i.e., able to reach the internal organs).
- **The entire body** (or a significant portion of it) must have received the dose[3].
- **The dose must have been delivered in a short time** (usually a matter of minutes).

## Treatments[4]

There are select treatments and agents that can help limit or treat the health effects of certain types of radiation in a radiological or nuclear emergency.

### *Medical Countermeasures for Internal Contamination*

During a radiological or nuclear emergency, radioactive materials may be released into the air and then breathed into the lungs, or they may get into the body through open wounds. Radioactive materials can also contaminate the local food supply and water and get into the body through eating or drinking. This is called internal contamination**.**

Removing internal contamination from the body will help reduce the risk for health effects. Small amounts of internal contamination may not need treatment.

Depending on the type of radioactive material involved, some medical treatments are available for limiting or removing internal contamination. These treatments include

- **Potassium Iodide (KI)** – KI is an iodine compound that is not radioactive and can be used to help block one type of radioactive material, radioactive iodine (I-131), from being absorbed by the thyroid.
- **Prussian Blue** – Prussian blue is a pill that can help remove radioactive cesium and thallium from people's bodies.
- **Diethylenetriamine pentaacetate (DTPA)** – DTPA is a medicine that can bind to radioactive plutonium, americium, and curium to decrease the amount of time it takes to get radioactive plutonium, americium, and curium out of the body. DTPA cannot bind all of the radioactive plutonium, americium, and curium that might get into a person's body after a radiation emergency. DTPA cannot prevent radioactive plutonium, americium, and curium from entering the body.

Medical professionals will determine if treatments are needed.

### *Medical Countermeasures for Radiation Exposure*

During a radiation emergency, a person who is exposed to a very high dose of radiation over a very short time may experience bone marrow suppression, meaning the marrow produces fewer blood cells. This bone marrow suppression occurs with ARS. Medications that speed up blood cell

[4] From Treatment of Radiation Exposure and Contamination by CDC

production, including colony stimulating factors (CSFs), may help the body heal and protect from infections. Medical professionals will determine if treatments are needed.

Figrastim is one type of FDA-approved CSF that has been used successfully for cancer patients. It has been used to stimulate the growth of the white blood cells, making patients less vulnerable to infections. It is expected to help patients who have bone marrow damage from very high doses of radiation in much the same way. There are other FDA-approved CSFs. Learn more at Emergency Department: Evaluation and Management of Affected Patients.

## Tools and Assets

### Radiation Hazard Scale[5]

CDC developed the Radiation Hazard Scale (Figure 1 below) as a tool for communicating radiation risk in emergencies. This tool

- Provides a frame of reference for relative hazards of radiation
- Conveys meaning without using radiation measurements or units that are unfamiliar to people
- Is designed for use ***only*** in radiation emergencies and is applicable for short-term exposure durations, for example, over a period of several days
- Is best used when accompanied with protective action recommendations or instructions
- Has been audience tested with public information officers, emergency management and public health professionals, and members of the public

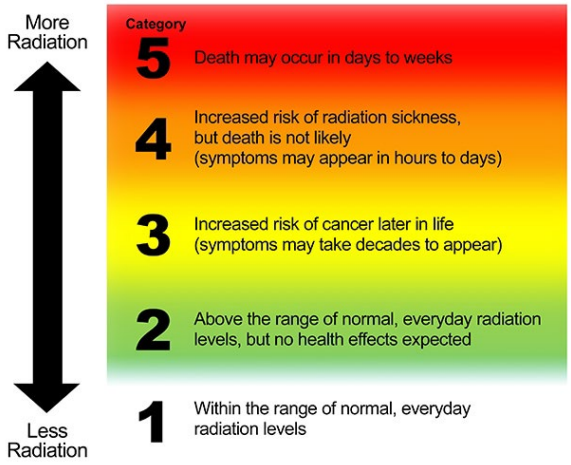


**Figure 1. Radiation Hazard Scale**

[5] From Radiation Hazard Scale by CDC

## Radiological Emergency Preparedness Program (REPP)

As of 2021, the United States has 58 operating commercial nuclear power plants in 29 states that produce ~20% of the nation's power. Nearly three million people live within 10 miles of an operating nuclear power plant.

The U.S. Federal Emergency Management Agency (FEMA) established the Radiological Emergency Preparedness Program (REPP) to ensure the health and safety of people living around these power plants in the event of an accident. The REPP[6]

- Educates the residents in the neighboring communities about what they need to do to prepare for the possibility of a nuclear power plant accident, which would emit dangerous levels of radiation
- Coordinates the national effort to provide state, local, and tribal governments with planning, training, and exercise guidance and policies to increase their capability to prevent, protect against, mitigate the effects of, respond to, and recover from commercial nuclear power plant incidents
- Evaluates the emergency plans and level of preparedness of state, local, and tribal governments, applicants, and licensees to respond to a nuclear accident within the emergency planning zones surrounding, and outside and beyond the boundaries of, a nuclear power plant

## Radiation Injury Treatment Network[7]

The Radiation Injury Treatment Network (RITN) is a national network of medical centers with expertise in the management of bone marrow failure. They work with partners from other medical specialties to assist with managing ARS and its health-related consequences. It is important to note that RITN hospitals are not first responders nor are they decontamination facilities.

# Nuclear/Radiological Emergency Response Phases

Protective action decision-making can be divided into three action phases that are common to all nuclear/radiological incidents: early, intermediate, and late. These phases represent non-precise periods in which response officials make public health protection decisions. Protective actions taken in these three phases have three objectives (see Figure 2):

1. Life safety
2. Risk mitigation
3. Recovery

---

[6] From About the Radiological Emergency Preparedness Program by FEMA

[7] From About RITN℠ by RITN

CDC developed a 3-day Applied Course for Public Health Decision-Making in a Radiation Emergency. The purpose of this course is to offer beyond-the-basics training and development in response to radiation emergencies, and, as part of the course, response is broken into three phases with an emphasis on the overlapping nature of response activities and functions throughout the response.

## Early – Days to Weeks[8]

Also called the Plume or Emergency Phase, the Early Phase occurs at the beginning of a nuclear/radiological incident involving a release of radioactive material into the atmosphere. Protective actions are taken to reduce possible exposure, but doses may accrue in this phase from deposition and inhalation of radioactive material. The principal protective actions in the Early Phase are

### *Life Safety*

- Sheltering in place
- Seeking early medical care
- Search and rescue
- Using public shelters

### *Risk Mitigation*

- Firefighting
- Critical infrastructure protection
- Evacuation
- Population monitoring

Note that some actions will continue through the Intermediate or Late Phases.

## Intermediate – Weeks to Months

The Intermediate Phase begins after the source of the radioactive release has been brought under control and reliable environmental measurements are available. Doses may accrue in this phase from deposition, re-suspension, and ingestion of radioactive material. Protective actions in the Intermediate Phase are

### *Life Safety*

- Dose assessment
- Radiation exposure care

[8] Adapted from Radiological Incident Phases by Wisconsin Emergency Management

***Risk Mitigation***

- Dose reconstruction

***Recovery***

- Fatality management
- Re-entry

Note that some actions will continue through the Late Phase.

### Late – Months to Years

The Late Phase begins when actions are taken to reduce radiation levels in the environment to acceptable levels that will allow inhabitants unrestricted use of the areas. The principal protective actions in the Late Phase are

***Risk Mitigation***

- Relocation
- Food/water safety

***Recovery***

- Return
- Long-term surveillance
- Cleanup

## Important Concepts

Two concepts that may be discussed during a discussion-based activity are population monitoring and community reception centers (CRCs).

### Population Monitoring[9]

Population monitoring is a process that begins soon after a radiation incident is reported and continues until all potentially affected people have been monitored and evaluated for the following:

- Needed medical treatment
- The presence of radioactive contamination on the body or clothing (external contamination)
- The intake of radioactive materials into the body (internal contamination)
- The removal of external or internal contamination (decontamination)

---

[9] From Population Monitoring in Radiation Emergencies, A Guide for State and Local Public Health Planners by CDC

- The radiation dose received and the resulting health risk from the exposure
- Long-term health effects

The population to be monitored includes the people in the affected community. In addition, pets may also be included because many people consider them part of their families and will include them in their decision-making process (e.g., does the shelter allow pets?).

To conduct population monitoring, specific instruments are used to survey for radioactive contamination on the body. This is also referred to as monitoring or screening for external contamination. Other instruments and laboratory tests may be needed to determine if and how much radioactive material has been taken into the body, which is referred to as internal contamination. Additional assessments may be needed to determine total radiation dose to an individual or to a population. This is referred to as radiation dose assessment.

### Community Reception Centers[10]

CRCs are locations where public health personnel and response partners conduct population monitoring following a radiation emergency. CRCs are expected to be opened 24 to 48 hours after a radiological or nuclear incident. They would be located outside of the affected area to service the people living in that community and the displaced population arriving there. The basic services provided at a CRC include the following:

- Screening people for radioactive contamination
- Assisting people with washing or decontamination
- Registering people for long-term follow-up

## The Role of Public Health in Radiation/Nuclear Emergencies[11]

In a nuclear/radiological event, a public health agency has the following responsibilities:

- Conducting population monitoring
- Initiating health surveillance and epidemiological investigations for workers and the public
- Coordinating the distribution of medical resources/countermeasures
- Communicating guidance regarding the use of crisis standards of care and managing scarce resources

A public health agency has 15 major capabilities that are necessary during a radiation emergency. These capabilities are described below.

---

[10] From Community Reception Center (CRC) Overview Video by CDC

[11] From Public Health Emergency Preparedness and Response Capabilities by CDC

## Public Health Laboratory Testing

Biological specimens can provide a powerful diagnostic tool for assessment of internal contamination and radiation exposure. Public health and hospital laboratories may be needed to analyze blood samples (complete blood count with differential white cell count). Collection of urine or blood specimens for analysis may take place in a hospital or other medical facility or in the field at a CRC as part of the population monitoring process.

## Public Health Surveillance and Epidemiological Investigation

State and local agencies should establish a registry as early as possible after a radiation emergency. This registry will be used for short-term medical follow-up or long-term health monitoring of affected people. The long-term monitoring process involves observing and recording any health effects that could be related to radiation exposure. Establishing the registry is part of population monitoring operations.

## Community Preparedness

Making pre-event information about radiation emergencies available to community partners and the public will enhance community preparedness. For example, all-hazards awareness training could incorporate protective action messages for radiation emergencies, such as the “get inside, stay inside, and stay tuned” message.

## Community Recovery

Recovery from a radiation emergency could take a long time. There may be ongoing environmental cleanup and a need to assist those who may have been contaminated by or exposed to radioactive material. Addressing the psychological impact of radiation disasters will also be a key part of recovery efforts.

## Medical Countermeasure Dispensing

There are some medical treatments available for limiting or removing internal contamination, These treatments only work for certain types of radioactive materials. There are also medical treatments for people that received a high dose of external radiation and could develop or have developed Acute Radiation Syndrome (ARS). Medical professionals will have to determine if treatments are needed. For treatment to be effective, it must be administered quickly to have the best chance at mitigating adverse health effects.

## Medical Materiel Management and Distribution

In addition to medical countermeasures, there may be other medical materiel needs following a radiation emergency related to burns, trauma injuries, or other scenario-specific needs.

## Non-pharmaceutical Interventions

Non-pharmaceutical interventions, such as getting inside a building, taking a shower or changing clothes, and sheltering-in-place, can be very effective in reducing the potential health effects of a radiation

emergency. Population-monitoring operations and public information are two examples of how non-pharmaceutical interventions could be implemented.

## Emergency Operations Coordination

The Nuclear Radiological Incident Annex to the Response and Recovery Federal Interagency Operation Plan (a part of the National Response Framework) outlines the response activities for a radiation emergency. It includes coordinating with emergency support functions (ESFs) to provide guidance regarding health and safety precautions and conducting medical response operations.

## Emergency Public Information and Warning

Effective and timely communication will play a vital role during a radiation emergency. Communication after a radiation event must address the public's concerns using simple and concise messages. Radiation is an unfamiliar hazard to many, and understanding the threat, as well as knowing and communicating what protective measures to take, will be a challenge for communicators.

## Information Sharing

Sharing information regarding health and safety is especially important after a radiation emergency. Many response agencies will need information regarding safe operational areas, responder precautions, and the status of healthcare infrastructure. For some types of radiation emergencies, law enforcement agencies may require assistance and collaboration with health and medical agencies to assist in investigations and evidence collection.

## Fatality Management

Depending on the scale of the radiation emergency, an event could result in radioactively contaminated decedents through surface contamination, internal contamination, or shrapnel on or in decedents' bodies. Assisting in fatality management operations would include coordinating proper and safe recovery and handling of contaminated decedents.

## Mass Care

Mass care operations, including public sheltering, during a radiation emergency will present unique needs that require additional guidelines for shelter operations. Decontamination, registration and tracking, and risk communication are areas of mass care that may require specialized planning and training.

## Medical Surge

Managing medical surge in a radiation emergency will include facility preparation, surge capacity, healthcare provider safety, patient decontamination, triage, and the medical management of life-threatening injuries. Life-saving medical care should never be postponed because of concerns about contamination.

### Volunteer Management

Following a radiation emergency, volunteers may be called upon to assist with various response activities, including population monitoring. Volunteers may assist with entering registry information, directing people to additional services, or providing other support services. Some volunteers may have a radiation background and could assist with screening or other more technical tasks.

### Responder Safety and Health

Protocols to protect responder safety and health will depend on the responder's role in the response to a radiation emergency. Safety officers will be able to provide specific worker protections and precautions based on the situation. These could include barrier protection methods, such as N-95 respirators and gloves, as well as using radiation monitoring equipment, such as dosimeters or radiation detection instruments.

## Public Health Response Mechanisms

### Public Health and Medical Services

ESF #8 – Public Health and Medical Services provides the mechanism for coordinated federal assistance to supplement state, tribal, local, and territorial resources in response to a public health and medical disaster, potential or actual incidents requiring a coordinated federal response, and/or during a developing potential health and medical emergency. The U.S. Department of Health and Human Services (HHS) is designated as the ESF #8 Coordinator.

ESF #8 functions include, but are not limited to, the following:

- Public health
- Medical surge support, including patient movement
- Behavioral health services
- Mass fatality management
- Veterinary, medical, and public health services

### Public Health Authority

- The Secretary of HHS possesses the authority to safeguard public health and welfare, to declare a public health emergency, and to prepare for and respond to public health emergencies (Public Health Service Act, 42 U.S.C. §§ 201 et seq.).
- The Public Health Service Act (PHSA), as amended by the Pandemic and All-Hazards Preparedness Reauthorization Act (Public Law No. 113-5), serves as the cornerstone of HHS legal authority for responding to public health emergencies (Public Health Service Act, 42 U.S.C. §§ 201 et seq.).

- The Project BioShield Act amended the PHSA to grant flexible authorities expediting and enhancing the research, development, procurement, and stockpiling of medical countermeasures for chemical, biological, radiological, and nuclear (CBRN) threats (Public Law 108-276 as amended at 21 U.S.C. § 360bbb-3; 42 U.S.C. §§ 247d-6a, 247d-6b).