Radiological Dispersal Device (RDD) Immediate Response Guidance

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Science and Technology

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National Urban Security Technology Laboratory

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July 2025

The **National Urban Security Technology Laboratory (NUSTL)** is a federal laboratory that provides testing and evaluation services and products to the national first responder community. The Laboratory's mission is to test, evaluate and analyze homeland security capabilities while serving as a technical authority to first responder, state, and local entities protecting our cities. NUSTL services and products help first responders prepare, protect and respond to homeland security threats. As a federal government-owned, government-operated lab, NUSTL uniquely provides independent technology evaluations and assessments for first responders, thereby enabling informed acquisition and deployment decisions, and helping to ensure that responders have the best technology available to use in homeland security missions.

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Publication Notice

Why Plan for the Immediate Response?

The immediate response to an explosive radiological dispersal device (RDD) encompasses the first minutes and hours after the detonation. This is the most critical timeframe of the response, as it presents the greatest opportunity to maximize lifesaving and protect the public from potentially harmful radiation exposure. However, it is also unlikely that, during the first minutes and hours, there will be substantial on-scene support from the state or federal government. Instead, it will be local response agencies – especially first responders and emergency managers – who must initiate, execute, and manage the incident, relying on their own assets, equipment, and training.

Because the immediate response is such a critical phase, this document uses a **notional 100-minute timeline** to provide technical recommendations on when certain field operations, public messaging, and response coordination should occur. 100 minutes was chosen as a guidance framework knowing how important the first minutes would be to get a lot of response actions complete. Planners should use the 100-minute timeframe presented in this document as a starting point, and adjust the timeframe as needed during their planning discussions to reflect the resources, expertise, and readiness of their community to manage the immediate response to an RDD.

A timeline is an essential tool for emergency planners because many of the public safety recommendations presented in this guidance are time-sensitive and it is important for local agencies to plan for both **how** the operation is conducted and **when** it must be completed to have the desired impact. A successful local RDD response plan will include an achievable, detailed timeline of how and when response actions should be coordinated and executed. Some of these actions (e.g., recognizing that a radiation hazard exists) will be completed quickly, while others (e.g., screening the population for contamination) will likely only be initiated during the first minutes and hours of the response and might not be completed for days or even weeks.

If the Tactics or technical objectives described in this guidance are not achievable in your jurisdiction, use this document to identify operational gaps. Discussing those gaps with state, regional, and federal partners will help you document the support you require during a radiological response and the process for requesting assistance.

Ask for Support Writing your Jurisdiction's RDD Plan

Local jurisdictions should contact state agencies with core capabilities in emergency response and radiological protection to initiate and coordinate emergency response planning and operations. Below are some recommended points of contact that may be available to support the development of local RDD response plans:

- Federal Bureau of Investigation (FBI) Field Office – Weapons of Mass Destruction (WMD) Coordinator
- Federal Emergency Management Agency (FEMA) – Office of Emerging Threats Coordinator
- Department of Energy National Nuclear Security Administration (DOE/NNSA) – Radiological Assistance Program (RAP) Regional Program Manager

- Environmental Protection Agency (EPA) – Regional On-Scene Coordinator (OSC)
- National Guard Weapons of Mass Destruction-Civil Support Team (WMD-CST)
- Radiological Operations Support Specialist (ROSS)

Contact Information

Please send comments or questions on this document to the National Urban Security Technology Laboratory (New York, NY) at NUSTL@hq.dhs.gov.

Summary of Changes

This 2025 RDD Immediate Response Guidance is the first substantial update to the 2017 RDD 100 Minute Guidance. Listed below are the summary of changes made and represented in this guidance. As part of the process to update the original guidance, NUSTL engaged with various stakeholders to understand needed points of clarification and other updates required.

Date	Summary of Changes
2025	**Title:** Changed from "RDD Response Guidance: Planning for the First 100 Minutes" to the "RDD Immediate Response Guidance," to de-emphasize a literal, rigid interpretation of the "100-minute timeline." However, the 100-minute timeline concept is still included as a notional framework to help planners understand when certain actions, tactics, and missions are most effective and how they are sequenced. **Introduction:** Added information in the Introduction about radiation units to help readers understand that during a radiation emergency, making a distinction between dose, exposure, and equivalent dose is not necessary. **Tactic 4 (and throughout):** Updated public messaging templates in Tactics 4, 6, and 9 and Annex 2 to include additional messages and align with other existing guidance. Specific updates include, but are not limited to, instructions to put HVAC system(s) on recirculate mode or, if it pulls in air from the outside, to turn it off; and added messages about evacuation, looking for loved ones, consuming food, water, and medicine, helping others shelter, and decontamination. **Tactic 6:** Added Table 4: Radiation Hazard Zones to align with other radiological emergency response guidance. **Tactic 7:** Updated the definition for "crime scene" and added information about secondary devices and a summary table of the various areas and zones that might be established by law enforcement and/or emergency response agencies, including the Detonation Point, Detonation Site, Crime Scene, Dangerous Radiation Zone, Hot Zone, and Shelter-in-Place Zone.

Date	Summary of Changes
	Tactic 8: Made minor revisions to the graphics depicting the steps to conduct the 10-Point Monitoring Survey. Further clarified that responders should rely on radiation measurements, rather than prevailing or observed wind direction, when determining the direction of contamination spread. **Tactic 10:** Added information about dry decontamination of people who were in the Hot Zone, without slowing down the evacuation. Added information about beginning to establish Community Reception Centers so that equipment, supplies, and personnel can be mobilized. **Annex 4:** Significantly expanded this annex to more fully describe the data assessment process and how information collected while carrying out Tactics 1, 2, 7, and 8 can be used by the Data Analyst. **Annex 8:** Removed the original RDD Initial Report Form and replaced it with a new Frequently Asked Questions list to addresses topics in the guidance (e.g., isotope identification, wind direction) that often required further explanation. **Throughout:** Updated units of measure for distances and radiation measurements to consistently include U.S. customary units followed by metric units in both the guidance and corresponding graphics.

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INTRODUCTION

This science-based "Radiological Dispersal Device (RDD) Immediate Response Guidance" (hereinafter, the "Immediate Response Guidance") delineates Missions and Tactics that should be executed by first responders and local response agencies in the first minutes and hours of a response to an outdoor explosive RDD detonation[1], based on realistic estimates of the possible consequences. It also includes recommendations for equipment requirements, including personal protective equipment (PPE), and public messaging. As described on page 5, this document uses a **notional 100-minute timeline** to help planners understand how the Missions and Tactics can be sequenced to accomplish the most important tasks quickly and accurately, thus setting the stage for a successful response.

The first minutes and hours of a response to an RDD detonation are critical as this period sets the stage for how the overall response will be executed. First responders will be tasked with multiple activities, such as confirming a radiological release, conducting lifesaving rescue operations, issuing protective actions, and characterizing the scene. Several of these activities must take place within the first few minutes of responders arriving on scene. **The response will take place at the local level in the early phase and beyond**, as other state and federal assets and specialized teams arrive on scene to support the response. This document provides actionable guidance and additional tools in annexes that can be used to plan an effective response to an RDD that protects first responders and the public and establishes interagency coordination and integration of state and federal assets. The information presented here is based on research and extensive experiments conducted by the U.S. Department of Energy (DOE) National Laboratories.

The Tactics described in this document are presented using a response timeline of 0 to 100 minutes. **This timeline is notional**: it may not be realistic for all jurisdictions and will depend on staffing, equipment, location-specific policies and procedures, and the actual RDD scenario encountered. However, the Missions and Tactics in this guidance are placed on a timeline to show when their execution will yield the most effective response. **Local jurisdictions that opt to use the Immediate Response Guidance should modify the timeline to fit their personnel, equipment, and other resources to meet the health and safety requirements of their jurisdiction**.

As presented, the guidance assumes a single RDD detonation, though it is also applicable to scenarios involving more than one explosion. If a second RDD detonates near the first, for example, then radiological measurements and boundaries can be adjusted as needed, noting that overlapping plumes might lead to localized "hot spots" in places experiencing deposition from multiple RDDs. If a second detonation occurs far away from the first, the Missions and Tactics outlined in this document can be applied to each RDD site as if they were separate incidents.

[1] An RDD is defined as the combination of radioactive material and the means (whether active or passive) to disperse the material with malicious intent; fission reactions (i.e., a nuclear explosion) do NOT occur in the RDD or its dispersed material.

Operational Safety: Explosives and Other Risks

The scene of an RDD incident is simultaneously the scene of an explosion, a crime scene, and a radiological area, affected by contamination, radiation, or both. Incident command may be engaged with multiple agencies and faced with competing priorities, each with their attendant risks and benefits (e.g., simultaneously performing triage and treatment of injured, conducting radiation surveys in contaminated areas, maintaining responder exposures as low as reasonably achievable (ALARA), and preserving the integrity of the crime scene). Incident command must balance these competing priorities and risks to determine whether the work to be done justifies the risk(s) involved, which may include but not be limited to:

- Risks to responders and the public from secondary devices and/or secondary incidents
- Risks to responders and the public from downed or ruptured utility lines, unstable structures, fires, hazardous weather, and other explosion-related hazards
- Risks to responders and the public from radiation and radioactivity
- Risks to the public from injuries they may have incurred
- Risks to the investigation from disturbing the crime scene and/or evidence.

Radiation Units

Since radiation is not routinely encountered by first responders and uses a specialized terminology, first responders are frequently unfamiliar with the units shown on their radiation instruments. Further, radiation safety professionals distinguish between "dose," "equivalent dose," and "exposure," each of which has a precise scientific meaning and is expressed in a separate set of units. These distinctions can be confusing but, during a radiological emergency response, they are unnecessary. For beta and gamma radiation, all three sets of units are very close to the same value. These units are:

- **roentgen** (R) is the most common unit of measurement for US emergency response equipment. Displayed as mR or mR/hr where 1,000 milli-roentgen (mR) = 1 roentgen (R).
- **rad** (r) is a unit frequently used in radiation safety and expressed in mr or mr/hr where 1000 milli-rad (mr) = 1 rad (r).
- **rem** is a unit that measures the biological damage caused by exposure to radiation and is usually displayed as mrem or mrem/hr where 1000 mrem = 1 rem.

For external gamma radiation, the following approximation can be used:

$$1\ \mathrm{R} \approx 1\ \mathrm{rad} \approx 1\ \mathrm{rem}$$

Because the most common unit of measurement for US emergency response equipment is the roentgen (R), it is used in the Immediate Response Guidance, followed by SI units in paratheses. To convert US units into SI units:

1 rem = 10 mSv	1 rad = 10 mGy
100 rem = 1 Sievert (Sv)	100 rad = 1 Gray (Gy)

Structure of the Immediate Response Guidance

To make it accessible and applicable to response planners, emergency managers, public health officials, and first responders, the Immediate Response Guidance is organized into "Missions" (strategic, big picture, overall response concepts) and "Tactics" (on the ground, operational response actions). There are five time-phased Missions: Recognize, Inform, Initiate, Measure and Map, and Evacuate and Monitor. Ten Tactics are grouped under the Missions (see Figure 1) to give more focus to individual operational areas. For each Tactic, guidance is provided for activities in the field and/or in an Incident Command Post (ICP) or an Emergency Operations Center (EOC) (see Table 1). Within each Tactic, the Immediate Response Guidance identifies the objective and then provides several recommendations for execution. While the Tactics are numbered, **this is not to imply they will be sequential**. Missions and Tactics overlap on the response timeline.

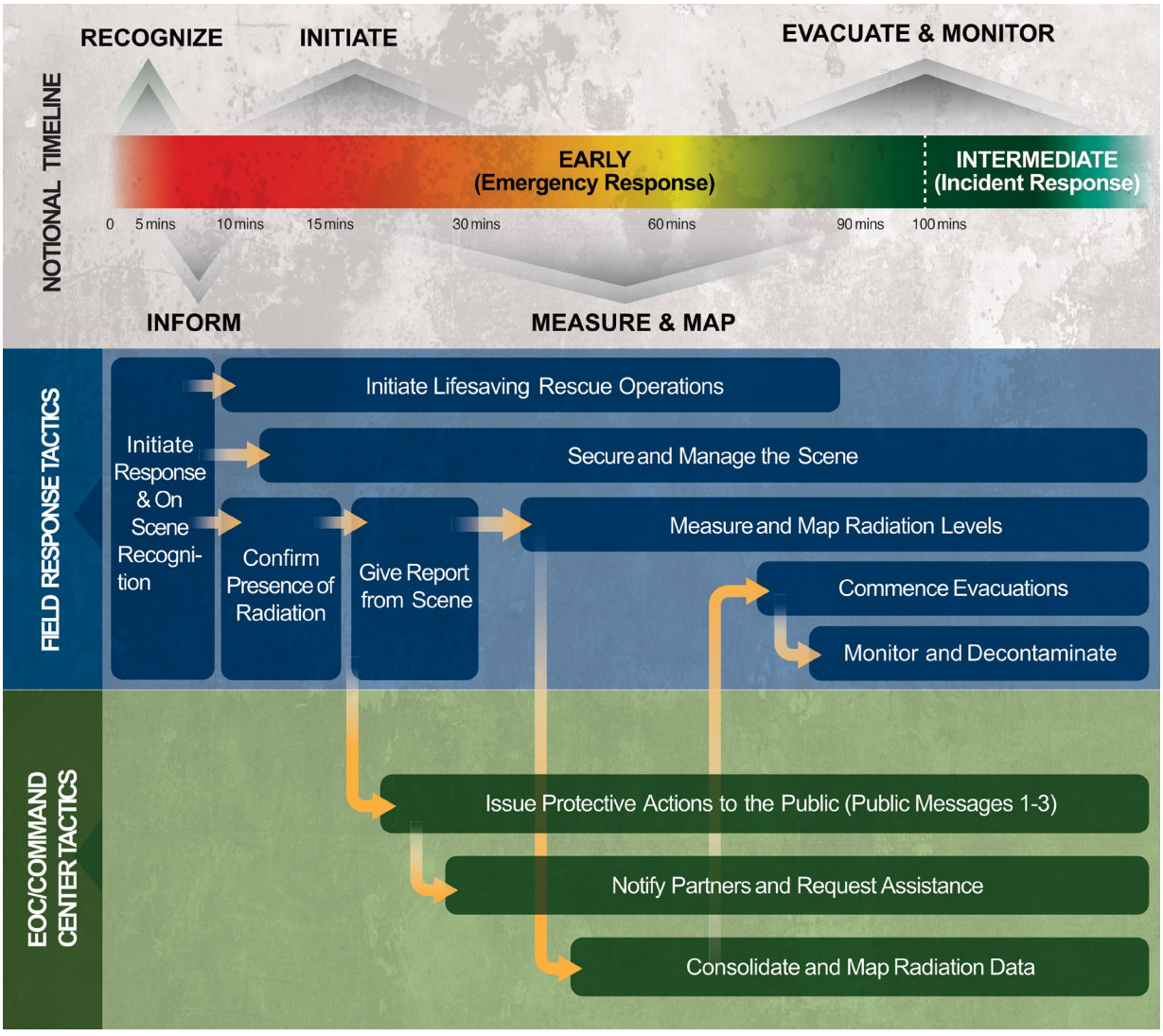


Figure 1 Time-Phased Missions and Tactics

The Immediate Response Guidance also includes references to CBRNResponder, a software platform developed by the Federal Emergency Management Agency (FEMA), the Department of Energy National Nuclear Security Administration (DOE/NNSA), and the Environmental Protection Agency (EPA). CBRNResponder can be used to collect and map radiological data and help responders execute specific Tactics. If CBRNResponder can be used to execute specific actions, they are noted using gray callout boxes titled "CBRNResponder Action" throughout the document and are detailed further in Annex 5 (p.60).

This is intended to be a flexible guidance document. Individual jurisdictions will use it differently based on their preferred approach to RDD response planning and their level of available resources (e.g., by making adjustments for specific agency roles, staffing, equipment, technical capability). This guidance is meant to be a tool customized by its readers to meet their needs: cut and paste the guidance text into your local RDD response plan and associated procedures, change text that does not work for your jurisdiction, and leverage the information included here in interagency RDD response preparedness discussions.

After the Immediate Response to an RDD

The RDD Immediate Response Guidance should be the starting point for jurisdictions that want to develop an RDD response capability: it describes the missions and tactics first responders should execute during the first minutes and hours after an RDD detonation.

However, the emergency does not end after the immediate response. A separate guidance describes how to plan for the days, weeks, months, and years that follow a radiological incident. **"Planning Guidance for Responding to and Recovering from Radiological Dispersal Device (RDD) Incidents: After the Initial Response" picks up where this guidance leaves off and provides planners with a framework that covers response and long-term recovery**.

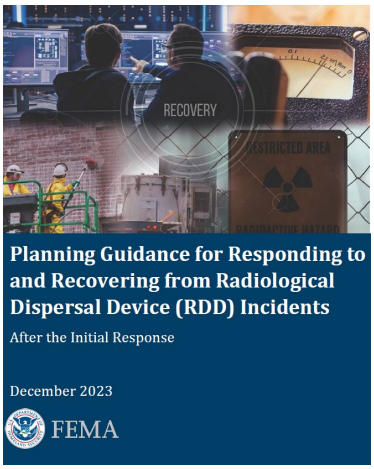


Figure 2 Guidance for *After* the Initial Response

- "Planning Guidance for Responding to and Recovering From RDD Incidents" is available here: www.fema.gov/sites/default/files/documents/fema_rd-planning-guidance-for-responding-to-and-recovering-from-radiological-dispersal-device-rdd-incidents.pdf

Table 1 Summary of Missions and Tactics

MISSION (notional elapsed time until mission and tactics initiated)	**Tactic**	**Activities**	
		Field Response	**EOC/Command Center**
RECOGNIZE that radiation is present at scene of explosion. **(0–5 minutes)**	**1. Initiate Response & On-scene Recognition (p. 8)**	First responders are equipped with radiation detection equipment that is in continuous use when responding to an explosion.	
	2. Confirm the Presence of Radiation (p. 8)	After an initial indication that radiation is present, first responders take at least two readings, in at least two different locations, with at least two separate radiation detection instruments (can be the same or different model/type) to confirm that elevated radiation levels above background are present in the vicinity of the explosion.	
INFORM responders and the public of the initial default Hot Zone and Shelter-in-Place Zone and notify local, state and federal authorities to request assistance. **(5–10 minutes)**	**3. Report from the Scene (p. 9)**	Incident Commander or a designated official on scene notifies command center(s), including the EOC (if already activated), that the explosion was from an RDD and informs emergency personnel arriving on scene that radiation is present.	
	4. Issue Protective Actions to the Public (p. 10)		Emergency management issues pre-approved **Public Message #1** (p.10) with immediate shelter-in-place instructions.
	5. Notify Partners and Request Assistance (p. 12)		Emergency management notifies local, state, FEMA and other federal partners that an RDD has detonated and requests assistance.

Table 1 Summary of Missions and Tactics (cont.)

Mission	Tactic	Activities	
		Field Response	**EOC/Command Center**
INITIATE a multiagency response, with agencies conducting lifesaving rescue operations and securing and managing the scene, without waiting for radiation monitoring to begin. **(5–40 minutes)**	**6. Initiate Lifesaving Rescue Operations (p. 15)**	First responders initiate lifesaving rescue operations, including search and rescue, fire suppression, and medical triage and treatment. These operations also occur in the Hot Zone **and are not delayed** because of the presence of radiation.	Emergency management issues preapproved **Public Message #2** (p. 16), that lifesaving rescue operations are taking place with instructions to seek shelter in a structurally sound building.
	7. Secure and Manage the Scene (p. 18)	First responders establish initial public safety boundaries, such as the Hot Zone boundary. Law enforcement clears the scene of secondary devices, designates the area surrounding the Detonation Point a crime scene, and initiates coordination with the Federal Bureau of Investigation (FBI) and other investigative agencies. Tactic 7 activities happen concurrently with the lifesaving rescue operations described in Tactic 6 (p. 15).	
MEASURE & MAP radiation levels at the Detonation Site, in the Near Field, and in the direction of contamination spread to initially characterize and visualize the extent of the radiological contamination. **(15–90 minutes)**	**8. Measure and Map Radiation Levels (p. 22)**	Incident Command assembles three Radiological Monitoring Teams, if resources permit, in two sequential phases, to conduct an initial characterization of radiological contamination, locate non-uniform high radiation areas, and provide radiological measurements for mapping.	The EOC consolidates and maps field data to visualize the extent of contamination and to support analyst's decision making on hazard boundaries and refining protective actions.

Table 1 Summary of Missions and Tactics (cont.)

Mission	Tactic	Activities	
		Field Response	**EOC/Command Center**
EVACUATE & MONITOR populations from impacted areas and begin to identify locations to open community reception centers (CRCs) for screening and population monitoring. **(>70 minutes)**	**9. Commence Evacuations (p. 34)**	First responders establish evacuation routes based on radiological measurements taken in the field to avoid evacuating populations through heavily contaminated areas. Since people should be sheltering in place, evacuations during the immediate response should prioritize populations who do not have access to adequate shelter or are in danger due to non-radiological hazards. Phased evacuations of affected areas may take time to plan and conduct safely and might not begin for 24 hours or more.	Emergency management organizes a press conference with updates on the response, evacuation and self-decontamination instructions (Public Message #3, p. 35).
	10. Monitor and Decontaminate (p. 36)	First responders perform quick screening and dry decontamination of individuals at designated Hot Zone exits to the extent practical, and without unduly slowing down self-evacuation. Since people are expected to self-evacuate the affected area and self-decontaminate when they reach their destination, priority should be given to life saving and stabilizing the scene. Community Reception Centers (CRCs) are unlikely to be established within 12–24 hours following an RDD.	Emergency management should choose from a list of already-identified CRC locations or begin to identify possible locations to open CRCs. Once CRC locations are determined, mobilizing equipment, supplies, and personnel to these locations should begin.

RDD Response Plan Trigger: An explosion is reported in your jurisdiction

MISSION: RECOGNIZE that radiation is present at the scene of an explosion.

Tactic 1: Initiate Response & On-scene Recognition

Guidance: First responders are equipped with radiation detection equipment that is in continuous use when responding to an explosion.

- Use of radiation detectors provides first responders with situational awareness to promptly reveal the presence of radiation and associated hazards during a response.

Tactic 2: Confirm the Presence of Radiation

Guidance: After an initial indication that radiation is present, first responders take at least two readings, in at least two different locations, with at least two separate radiation detection instruments (which can be the same or different model/type) to confirm that elevated radiation levels above background are present in the vicinity of the explosion.

- A single radiation detection alarm could be the result of a false positive caused by a benign source or an equipment malfunction and should not be the trigger to activate the jurisdiction's RDD response plan and procedures. Following the "two readings, two locations, two instruments" rule can help avoid the misidentification of an RDD.
- The two readings should be taken at different locations a minimum of ~50 feet (ft), ~15 meters (m), apart from each other at a height of ~3 ft (~1 m) above the ground. No specific points are required when selecting the two locations.
- Each of the two measured exposure rates or count rates should be greater than approximately three to five times the natural background at that location to signify the presence of elevated radioactivity levels.
- The two separate pieces of radiation detection equipment, such as a personal radiation detector, do not need to have extended range capability. Two off-scale instruments with elevated readings would be considered adequate to confirm. First responders should know how their instrument reacts in an over-range condition.[2]
- It is critical that agencies document and understand normal background radiation levels in their jurisdiction and how background levels read on the specific instruments that they use.[3] The response criteria for identifying contaminated areas might rely on knowledge of area-specific background radiation. For that reason, routine operational use of detection instrumentation and trainings should be used to increase knowledge of and map background. A mapping effort can reveal areas where elevated background radiation may regularly occur (e.g., areas near buildings with large amounts of granite).

[2] See the "Using Preventative Radiological Nuclear Detection Equipment for Consequence Management Missions" job aids, which includes a guide to help responders understand the capabilities of their equipment: www.dhs.gov/publication/st-frg-using-preventative-radiological-nuclear-detection-equipment-consequence
[3] Technical guidance on how to design a background radiation survey can be found at: https://www.dhs.gov/science-and-technology/publication/st-wide-area-background-radiation-survey

MISSION: INFORM responders and the public of the initial default Hot Zone and Shelter-in-Place Zone and notify local, state, and federal authorities to request assistance.

Tactic 3: Report from the Scene

Guidance: Incident Commander or a designated official on scene notifies command center(s), including the EOC (if already activated), that the explosion was from an RDD and informs emergency personnel arriving on scene that radiation is present.

- Make notifications from the scene to:
  - 24-hour emergency watch (or command center)/emergency management agency;
  - Response unit dispatch;
  - Agency headquarters; and/or
  - Hospitals and Emergency Medical Services (EMS).
- The initial notification should include the following information:
  - Reported by, Agency/Unit, time;
  - Location of detonation;
  - At least two initial radiation readings and measurement locations (taken in Tactic 2) as well as, if possible, typical background readings for the area. For each location include radiation reading, unit of measure, location description or GPS latitude/longitude, and name of person who made the measurement;
  - Direction that smoke from the explosion traveled (if observed);
  - Estimated number of casualties;
  - Extent of observable physical damage to buildings and broken windows; and
  - Fires or other on-scene hazards resulting from the explosion.
- Emergency personnel arriving on scene should follow recommendations for PPE outlined in Tactic 6 (p. 15) and Annex 3 (p. 52) before initiating any operations.
- Responding EMS and receiving hospitals begin to prepare to receive and treat casualties that may be radiologically contaminated to ensure proper treatment and protection of staff and other response infrastructure.
- Incident Command Post (ICP) or EOC initiates the creation of an incident data map by plotting the location of the explosion and the two initial measurements. This incident data map can be created in any geospatial information system (GIS) or mapping software that a jurisdiction chooses for information sharing and data management. One tool that can be used to complete this mapping is FEMA's CBRNResponder. Real-time information sharing among responding agencies and the Incident Command is critical to the overall safety of responders and public. This data map will populate while protective action zones are established and additional radiological measurements are collected and posted. Tips for using CBRNResponder are highlighted throughout the Immediate Response Guidance in gray call out boxes. More detailed information can be found in Annex 5: CBRNResponder Integration (p. 60).

CBRNResponder Action: Create an Event

After an initial report from the scene that the explosion involves radiation, the ICP or EOC creates an event in CBRNResponder and includes the following points:
- Location of detonation
- Two initial radiation readings and locations of measurements

Tactic 4: Issue Protective Actions to the Public

Guidance: Emergency management issues pre-approved public messaging with immediate shelter-in-place instructions.

- The immediate release of Public Message #1, a general instruction to seek shelter in a structurally sound building, will minimize the public's exposure to radiological hazards and contamination. This initial message can be generic and can be immediately issued for all reports of an explosion. If the presence of radiation cannot be confirmed immediately, at a minimum the initial public messaging should state that an explosion has occurred and direct the public to move inside to avoid potential smoke and falling debris.
- Seeking shelter in an unsafe structure (e.g., a building that is not structurally sound or that is on fire) may pose a greater risk than receiving radiation exposure. People sheltering in a building that puts them at risk should relocate to a stable structure; this should be done along a path that minimizes radiation exposure and avoids other risks (e.g., downed power lines and/or ruptured utility lines).When radiation has been confirmed at the scene, emergency management can release Public Message #1a that includes information about radioactive particles. The initial Shelter-in-Place Zone for public radiation safety should be ~1600 ft (500 m) in all directions (see Figure 3).
- Use all available communication methods, including Wireless Emergency Alerts (WEA) and reverse notification systems, to disseminate the message as quickly as possible without waiting to schedule a press conference.

Public Message #1: Response Units Arrive on Scene to Assess the Hazard

An explosion has occurred at [Location]. Emergency personnel are on scene. If you are near [Location], immediately move inside the nearest structurally sound building, close the windows and doors, and stay inside until further instruction. If your HVAC system pulls air in from the outside, put it on recirculate mode or turn it off. If you cannot get inside a building, place a dry cloth or other facial covering (e.g., mask) over your nose and mouth and quickly move away from the area. Please stay clear of [Location].

Public Message #1a: Radiation is Confirmed at Scene of Explosion

An explosion has occurred at [Location]. Radioactive particles may be in the smoke and on the ground. If you are near [Location] immediately move inside the nearest structurally sound building, close the windows and doors, and stay inside until further instruction. If your HVAC system pulls air in from the outside, put it on recirculate mode or turn it off. If you cannot get inside a building, place a dry cloth or other facial covering (e.g., mask) over your nose and mouth and quickly move away from the area. Please stay clear of [Location].

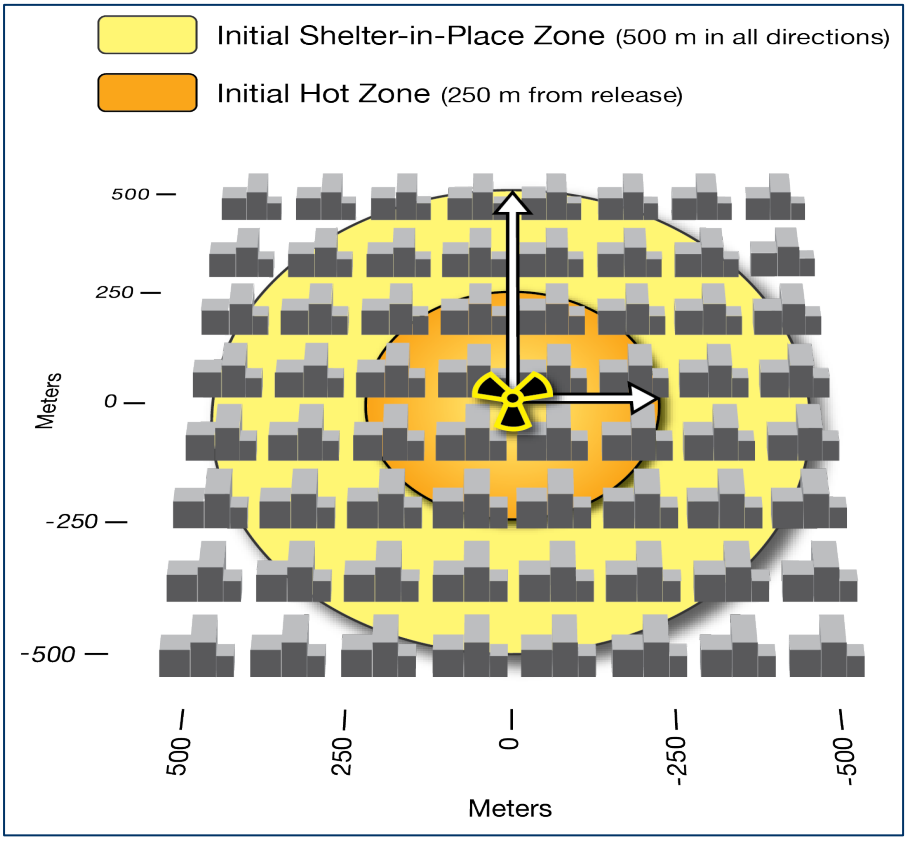


Figure 3 Initial Hot and Shelter-in-Place Zones with Unknown Direction of Contamination

- Individual jurisdictions must determine the best way to define the shelter-in-place boundaries. In some instances, asking whole neighborhoods to shelter-in-place simplifies messaging; in other instances, specific street boundaries may be provided. The overall intent is to reach as many people as quickly as possible that are within the Shelter-in-Place Zone radius of ~1600 ft (500 m) to instruct them to move inside a structurally sound building and to stay inside.[4]
- Heating, ventilation, and air conditioning systems (HVAC) that pull in outside air should either be put on recirculate mode or turned off to prevent airborne contamination, if present, from entering buildings where people are sheltering. However, turning off HVAC systems for a prolonged period during intense cold or heat could present health risks to occupants. Consider the totality of hazards when providing shelter-in-place guidance to the public, especially if instructing people to shelter inside for an extended duration.
- See Annex 2: Public Messaging (p. 41) for information on Public Message #1 and #1a.

[4] Note regarding distances: The distances in this guidance (e.g., distances for initial boundaries and in the 10-point monitoring plan) are based on scientific studies that produced results as approximate values given in metric units. The metric units for distance in this document have been converted into US units and rounded up or down to the nearest convenient number. Actual impacts of an RDD, such as the amount and extent of contamination spread, are highly dependent on the circumstances of the incident (weather, amount of radioactive material, explosive yield, terrain, etc.). When responding to an actual event, use the distances provided here as a starting point and adjust as appropriate for the specific conditions encountered.

Tactic 5: Notify Partners and Request Assistance

Guidance: Emergency management notifies local, state, FEMA, and other federal partners that an RDD has detonated and requests assistance.

- Emergency management leverages existing protocols and procedures to notify local officials, county/state emergency management, FEMA, and other federal partners that an RDD was detonated in their jurisdiction.
- Emergency management may leverage pre-scripted mission assignments for pre-identified gaps in local response operations to facilitate the arrival of resources.
- All support requests should be routed through official channels, typically from local to state to FEMA's Regional Response Coordination Center (RRCC), which will send the request to the National Response Coordination Center (NRCC).
- Table 2 outlines radiological support teams/assets that may be requested. Making contact with these specialized state and federal teams during pre-incident planning will help facilitate their integration into the RDD response.
- The majority of state and federal assets will not be on the scene during the first few hours, but delaying the request for assistance will slow their arrival. Assets and teams that do not require physically being on scene will begin supporting immediately (for example, the Consequence Management Home Team (CMHT) and the Interagency Modeling Atmospheric and Assessment Center (IMAAC)). Some assets may deploy on their own authority without an official request.
- If possible, share the incident data map with local, state, and federal agencies that may support the incident so that all agencies supporting the response have the same common operating picture.
- Any local information (e.g., meteorological, radiological, land use) that can be provided to IMAAC will improve the quality of their models and assessments of impacts.

CBRNResponder Action:
Share Event with Partners

Share the RDD event with agencies who are responding in the field and who may support the incident through modeling and other analysis so that all agencies supporting the response have the same common operating picture. This will also allow agencies to aggregate and consolidate data from all agencies collecting radiological data in the field. It is recommended to pre-establish CBRNResponder partnerships to better facilitate this process during an actual incident.

Table 2 Assets/Team and Capabilities to Request[5]

	Assets/Team		Capability to Request
State/Local	Local/county/state hazardous materials (hazmat) teams		Incident characterization and assessment, largely conducted by personnel in the field.
	State radiation control officials/radiation specialists		
	Department of Defense (DOD) CBRN Response Enterprise: National Guard Teams	Weapons of Mass Destruction – Civil Support Team (WMD-CST)	There are 57 CSTs, with at least one per state or territory, consisting of 22 full time national guard personnel. CSTs provide identification and assessment of threats and hazards and advise and assist civil authorities on CBRN response.
		CBRNE Enhanced Response Force Packages (CERFPs)	Command and control for incoming National Guard assets with capabilities in assessment, search and extraction, decontamination, emergency medical, security and logistics support.
		Homeland Response Force (HRF)	
	Radiological Operations Support Specialist (ROSS)		A radiological/nuclear incident subject matter expert (SME) that acts as a state and local resource to assist emergency managers and first responders in navigating the unique challenges of radiological incidents and emergencies.
Federal	Interagency Modeling Atmospheric and Assessment Center (IMAAC)		Request atmospheric dispersion modeling and hazard predictions.
	DOE/NNSA	Nuclear Emergency Support Team (NEST) via the DOE/NNSA Emergency Operations Center[6]	NEST provides field-deployed and remote technical support to the nation's countering weapons of mass destruction (WMD) operations, including preventive nuclear and radiological detection (PNRD) and threat-based nuclear search; public health and safety missions, including radiological consequence management; and responses to U.S. nuclear weapon accidents and incidents. NEST has access to the following capabilities, and more: • Aerial Measuring System (AMS) • Consequence Management Home Team (CMHT) • Radiation Emergency Assistance Center/Training Site (REAC/TS) • Radiological Assistance Program (RAP)

[5] Table 2 describes the early phase federal assets and capabilities that are available for state and local responders to request; for a more complete list of the federal assets and capabilities that may respond to a radiological emergency and additional information on how to access those assets, please see the "Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plan." www.fema.gov/sites/default/files/documents/fema_incident-annex_nuclear-radiological.pdf

[6] https://www.energy.gov/nnsa/emergency-management

Federal (Continued)	EPA, U.S. Department of Agriculture (USDA), Food and Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC)	The Advisory Team for Environment, Food and Health (A-Team) via the EPA Emergency Operations Center[7]	Coordinated advice and recommendations on environmental, food, health, and animal health matters.
	Department of Homeland Security (DHS)	Federal Emergency Management Agency (FEMA) by region	FEMA may be called upon to provide lead or supplemental operational coordination for consequence management support for complex and/or large-scale incidents.
	Federal On-Scene Coordinators (OSCs) for oil and hazardous materials consequence management: EPA, DOE, DOD, DHS (U.S. Coast Guard (USCG))		Coordinate the on-scene tactical response to oil and hazardous materials incidents. Actions include assessment of the extent and nature of environmental contamination; assessment of environmental cleanup options; and implementation of environmental remediation, including decontaminating buildings and structures, and management of wastes. For nuclear/radiological incidents, USCG provides the federal OSC for incidents in certain areas of the coastal zone, and EPA provides the federal OSC for incidents in the inland zone and in other areas of the coastal zone.
	U.S. Department of Justice (DOJ)	Federal Bureau of Investigation (FBI)	The FBI OSC is responsible for leading and coordinating the federal operational law enforcement response and investigative activities necessary to resolve terrorist incidents and preserving evidence for subsequent criminal prosecution. Additionally, the FBI OSC has primary responsibility to conduct, direct, and oversee crime scenes, including those involving WMD, its security, and evidence management through all phases of the response.

[7] https://www.epa.gov/advisory-team/how-activate

MISSION: INITIATE a multiagency response, with agencies conducting lifesaving rescue operations and securing and managing the scene, without waiting for radiation monitoring to begin.

Tactic 6: Initiate Lifesaving Rescue Operations

Guidance: First responders initiate lifesaving rescue operations, including search and rescue, fire suppression, and medical triage and treatment. These operations also occur in the Hot Zone[8] and **are not delayed because of the presence of radiation**. Emergency management issues preapproved Public Message #2 (p. 16) that lifesaving rescue operations are taking place with instructions to seek shelter in a structurally sound building.

- Search and rescue, fire suppression, medical triage and treatment, and other lifesaving rescue operations must take priority over conducting radiological measurements or decontamination.
- Upon arrival, first responders should wear appropriate PPE to reduce intake of airborne radioactivity and mitigate skin and eye contamination. **However, the unavailability of PPE for radiological protection should not prevent responders from taking prompt action to save a life**. See Annex 3: PPE Recommendations (p. 52) for more information.
- Until all hazards on scene are identified, responders should wear PPE that is protective for all potential non-radiological hazards at the site of an explosion.
- **Radiation monitoring equipment, while desirable to understand exposures for responders, is not required to begin lifesaving rescue operations.** Occupancy (stay) times should be minimized and managed by supervisors to ensure responder safety and to ensure responders are keeping exposures as low as reasonably achievable (the ALARA principle).

PPE Recommendations (see Annex 3)
Recommendations in this publication do not address protection against non-radioactive airborne contaminants or other hazards on scene.

Respiratory Protection: To reduce the inhalation of airborne radioactivity, first responders should follow situation-specific guidelines:

- If on or near the scene at the time of detonation and without respiratory protection, use improvised protection such as a mask or dry cloth over the mouth and nose and evacuate the area.
- If arriving on scene within the first 15 minutes, wear a positive-pressure self-contained breathing apparatus (SCBA). If it is not practical to wear a positive-pressure SCBA (such as when driving), wear a full-face air purifying respirator with a P-100 or HEPA filter.
- If arriving on scene after 15 minutes, wear a half- or full-face respirator or N95 air purifying respirator.

Protection from Surface Contamination: If on or near the scene at the time of detonation, first responders should wear a regular duty uniform, goggles and gloves to minimize exposure to skin and eyes. Level A Hazardous Material suits are unnecessary for protection from radioactive contamination.

[8] This guidance adopts the National Council on Radiation Protection and Measurements definitions for radiation zones. Specifically, the "Hot Zone" > 10 mR/hr (0.1 mGy/hr) and the "Dangerous Radiation Zone" > 10 R/hr (0.1 Gy/hr) (NCRP 2010).

  - If occupancy times are minimized until additional radiation instruments are brought to the scene, the risk of acute radiation exposure can be reduced. For example, the existence of a Dangerous Radiation Zone greater than 10 R/hr (0.1 Gy/hr) is unlikely, but possible, over a wide area. At an exposure rate of 10 R/hr (0.1 Gy/hr), first responders can work for up to 30 minutes and keep their doses below 5 rem (50 mGy).[9] It would be unlikely that a responder would receive a dose higher than the EPA Protective Action Guidance for lifesaving rescue operations during the early phase, which is 25 rem (250 mGy).
  - Radiation monitoring should begin as soon as dosimeters and/or radiation detectors arrive at the scene.
  - If electronic dosimeters such as a personal emergency radiation detectors or passive integrating dosimeters are not available, integrated exposures can be estimated from exposure rate meters and occupancy times.
  - A retrospective dose reconstruction can determine the dose to be assigned following the early phase.
- Approximately 15 minutes after the initial detonation, the concentrations of airborne radioactivity (if produced) that could result in acute exposures will dissipate and the remaining inhalation hazard would be from resuspension of contamination and dust from the ground.
- In addition to understanding which radiation hazard zone they are to enter and its restrictions (see Table 3), first responders should be alert for any possible hot spots or localized high radiation levels due to partially dispersed or non-dispersed radioactive sources. These elevated areas or hot spots may also be due to remnants, fragments, or pieces of the explosive device.
- One potential unique exposure risk is that a high-activity radioactive fragment becomes embedded in a person. If not identified during triage, this type of wound could be a source of prolonged exposure to the patient and to the responder(s) treating the person. Such fragments should be removed by a medical professional at the earliest opportunity, then placed in a container that is kept at least 30 ft (~10 m) from any work areas.
- If practical, conduct rapid, field-expedient casualty decontamination and contamination control measures, such as clothing removal and/or wrapping casualties in sheets or other available material, to limit the spread of and potential ongoing exposure to contamination.
- Emergency management issues Public Message #2 that includes information about the radiological hazard and reiterates the message to seek shelter in a structurally sound building. See Annex 2: Public Messaging (p. 41) for more information.

***Public Message #2**: An explosion has occurred at [Location]. Radioactive particles may be in the smoke and on the ground. Emergency personnel and law enforcement are on the scene responding to the incident and assisting those in need. Personnel are also working to promptly identify unaffected areas. If you are near [Location], immediately go inside the nearest structurally sound building, close the windows and doors, and stay inside until further instruction. If your HVAC system pulls air in from the outside, put it on recirculate mode or turn it off. If you cannot get inside a building, place a dry cloth or other facial covering (e.g., mask) over your nose and mouth and quickly move away from the area. Please stay clear of [Location].*

[9] 5 rem is the OSHA annual limit for all occupational exposures, including for radiation workers; however, under emergency conditions, dose received by emergency workers is not considered occupational dose.

Table 3 Radiation Hazard Zones

Radiation Hazard Zone Type[10]	Indicators	Response Restrictions[11]
N/A	▪ **Below** 10 mR/h (0.1 mGy/hr)	▪ None. Support all operations as needed while monitoring radiation levels.
Hot Zone (HZ)	▪ **Above** 10 mR/h (0.1 mGy/hr) and **Below** 10 R/h (0.1 Gy/hr)	▪ Support only emergency operations (lifesaving, firefighting, etc.). ▪ Minimize occupancy time in accordance with ALARA. ▪ If radiation detectors are available, monitor radiation levels and track exposure of all responders. If radiation detectors are limited or unavailable, track occupancy time and location. ▪ DRZ-levels of radiation exposure are not likely after an RDD – at least, not over a wide area. Instead, DRZ-levels of radiation may be encountered in the form of "hot spots:" small areas of >10 R/hr (0.1 Gy/hr) exposure, perhaps indicating the presence of highly contaminated ballistic debris or small chunks of radioactive material.
Dangerous Radiation Zone (DRZ)	▪ **Above** 10 R/h (0.1 Gy/hr)	

[10] *Nuclear Detonation Response Guidance: Planning for the First 72 Hours*, FEMA, 2023; National Council on Radiation Protection and Measurements (NCRP 2010).
[11] Adapted from ASTM Standard Practice E2601-23 *Standard Practice for Radiological and Nuclear Emergency Response*, 2023.

Tactic 7: Secure and Manage the Scene

Guidance: First responders establish initial public safety boundaries, such as the Hot Zone boundary. Law enforcement clears the scene of secondary devices, designates the area surrounding the Detonation Point a crime scene, and initiates coordination with the Federal Bureau of Investigation (FBI) and other investigative agencies. Tactic 7 activities happen concurrently with the lifesaving rescue operations described in Tactic 6 (p. 15).

- Establish a perimeter at ~800 ft (250 m) in all directions around the detonation point. This perimeter will serve as the initial Hot Zone to protect the public and responders who are not involved in lifesaving rescue operations from potential acute internal or external exposure and as an initial safety zone for potential secondary devices and other hazards. **Hot Zone entry should be limited to first responders conducting lifesaving rescue operations and other necessary work, as authorized by Incident Command**.
    - Once radiological measurements are available, the Hot Zone perimeter should be re-established for areas where radiation exposure rates exceed 10 mR/hr (0.1 mGy/hr) or contamination levels exceed 60,000 decays per minute (dpm)/cm^2 at ~0.5 inch (1.5 cm) above the ground for beta and gamma, or 6,000 dpm/cm^2 at ~0.25 inch (0.75 cm) above the ground with an alpha probe.
    - Note: establishing the Hot Zone boundary at an exposure rate of 2 mR/hr (0.02 mGy/ hr) is **not** appropriate for management of the scene (see Annex 8 (p. 87) for additional information).
- Until radiological measurements are available, enforce the initial Shelter-in-Place Zone at ~1600 ft (500 m) in all directions from the Detonation Point. First responders should continue to operate as needed in the Shelter-in-Place Zone, but all members of the public in this area should be instructed to remain indoors until notified of when and how to leave the area.
    - When the direction of the contamination spread is confirmed by radiological measurements, extend the Shelter-in-Place Zone to ~1.2 miles (2000 m) in the direction contamination is found (see Figure 4). The direction of the contamination spread will be determined by the results of measurements taken by Radiological Monitoring Teams 1 and 2 in Tactic 8.

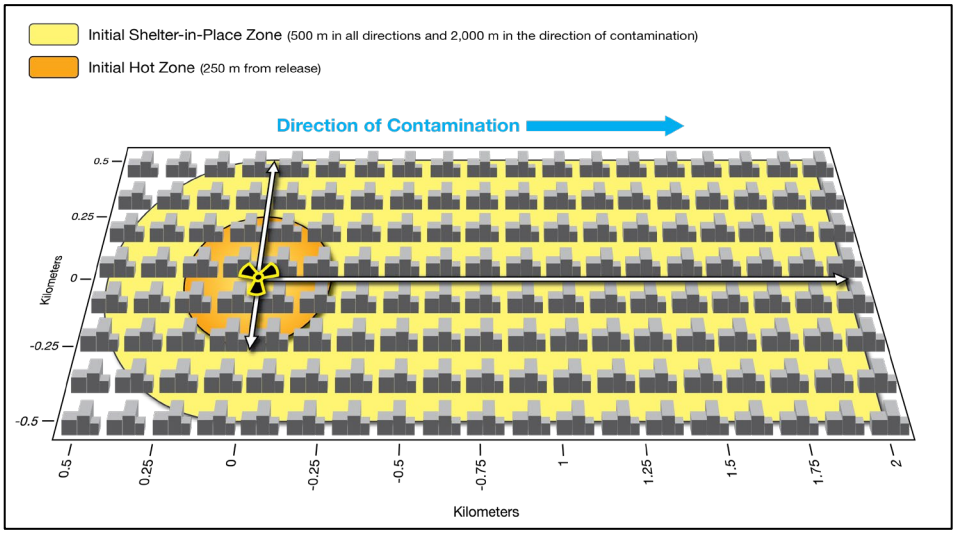


Figure 4 Initial Hot and Shelter-in-Place Zones, with Known Direction of Contamination

- The Detonation Point of approximately ~65 ft (20 m) in extent should be visually determined by the center of the soot spot left where the fireball interacted with the ground or other markings caused by the explosion. Unless there is an immediate lifesaving need, it is unnecessary for local first responders to enter the Detonation Point. Collecting radiological data in this area is not urgent, and local responders should not enter to take measurements.
- Key law enforcement activities to manage the scene include:
    - Designate the Crime Scene: Initially, law enforcement should declare the Detonation Site, which is the area immediately surrounding the Detonation Point, a crime scene. It should be cordoned off and left undisturbed. Specialists from the FBI will arrive on scene as quickly as possible to conduct an initial forensic assessment of the Detonation Site and elsewhere. Arrival time of law enforcement units and agencies will vary based on incident location and other incident-specific factors.
        - The size of the Crime Scene in the area around the Detonation Point will vary. Law enforcement may need to expand the size of the Crime Scene to encompass areas in which fragments from the explosion might be located. This may be at least 50% farther than the distance from the detonation point to the farthest piece of evidence found.
    - Take steps to prevent secondary attacks against first responders and/or the public, including characterizing and clearing packages, bags, and other containers or suspicious objects.
    - Because of the potential for secondary attacks and a need to preserve evidence, coordinate entry by first responders into the Crime Scene and limit work performed within to lifesaving and other critically important activities.
    - Enforce perimeter control: Manage crowd and traffic control and public safety operations to prevent persons and vehicles from entering potentially contaminated areas.
    - Make law enforcement-collected radiological data available to first responders and public health agencies: Withholding radiological data may obstruct health and safety decision makers from gaining situational awareness.
- First responder activities to support law enforcement:
    - Inside the Crime Scene, packages, bags, and other containers should be reported to Incident Command and should only be approached or investigated by a trained bomb technician.
    - Coordinate with law enforcement to clear the scene of hazards, including explosives, utilities, hazardous materials, and other structural concerns that are immediately dangerous to life and safety prior to operations that do not involve lifesaving.
    - Direct persons in the Crime Scene to safe exits from the impacted area and identify those who are injured and/or contaminated.
    - Until the Crime Scene has been processed and released, entry into the scene should take place only for lifesaving activities or other critically important actions with the concurrence of law enforcement.

- It will be critical for responders to take radiation measurements in the area directly outside the Detonation Point and out to ~800 ft (250 m) as described in Tactic 8: Measure and Map Radiation Levels – Detonation Site (p. 2322). These measurements will be necessary to determine the direction of contamination spread and to provide data for informing public health decisions.
- All personnel who enter the Crime Scene must be careful not to disturb or remove materials that might be evidence of the crime or that might compromise the integrity of the Crime Scene any more than required to accomplish their mission.

- Identify and preserve evidence to support the investigation: If the scene includes radioactive ballistic fragments, first responders should avoid moving or relocating any pieces, and instead mark and establish radiation hazard boundaries (e.g., Hot Spot, Hot Zone, Dangerous Radiation Zone) around this debris to ensure responders' health and safety.[12]
- Follow local protocols to communicate initial findings, measurements, and other situational information with the FBI and other investigative agencies as they arrive on scene to ensure a coordinated and jointly managed incident.

[12]With respect to characterization of the environment to support public and responder safety, radiation measurements or samples collected by local agencies in the immediate response are intended for public health decision-making and not investigative purposes. These measurements may later become evidence but are initially taken to inform immediate response operations.

Table 4 Summary of Areas and Zones Discussed in Tactic 7

Zone/Area	Radius	Description
Detonation Point	~65 ft (20 m)	(1) **Responders should not enter this area except to save lives**. (2) Radiological surveys should not be performed in this area. (3) The area ~65 ft (20 m) from the detonation point is part of a law enforcement-controlled Crime Scene.
Detonation Site	Varies	(1) The area 360 degrees immediately surrounding the detonation point that was affected by the blast. (2) **Responders should not enter this area except to save lives or to perform critical functions.** (3) All personnel entering this area must be careful not to disturb anything that may become evidence in the investigation.
Crime Scene	Varies	(1) Law enforcement designates and secures the Crime Scene, which should initially include the Detonation Point and Detonation Site. Law enforcement may expand the crime scene to cover an area 50% farther than the distance to the farthest piece of evidence found. (2) First responders conduct lifesaving rescue operations described in Tactic 6. (3) First responders may need to take measurements in this area to establish the direction of contamination spread (see Tactic 8, p. 22).
Dangerous Radiation Zone	Varies	(1) Radiation exposure rates are above 10 R/hr (0.1 Gy/hr). (2) **Enter only for lifesaving activities or to prevent a catastrophic situation** and with the informed consent of those entering the area.
Hot Zone	~800 ft (250 m)	(1) Initial Hot Zone set at ~800 ft (250 m) from the detonation point. Hot Zone boundary will be adjusted to 10 mR/hr (0.1 mGy/hr) (2) Hot Zone **entry should be limited to first responders conducting lifesaving rescue operations and other necessary work**, as authorized by Incident Command.
Shelter-in-Place Zone	Initially: ~600 ft (500 m) Tactic 8: ~1.2 miles (2000 m)	(1) Set at ~1600 ft (500 m) in all directions from the detonation point. When the direction of the contamination is confirmed by radiological measurements, extend the zone out to ~1.2 miles (2000 m) in the direction of the contamination to protect the public from low-level contamination and external radiation. (2) First responders operate as needed, but members of the public in this area should remain indoors until notified of when and how to leave.

MISSION: MEASURE AND MAP radiation levels at the Detonation Site, in the Near Field and in the direction of contamination spread to initially characterize and visualize the extent of the radiological contamination.

Tactic 8: Measure and Map Radiation Levels

Guidance: Incident command assembles three radiological monitoring teams, if resources permit, in two sequential phases, to conduct an initial characterization of radiological contamination, locate non-uniform high radiation areas, and provide radiological measurements for mapping. The EOC consolidates and maps field data to visualize the extent of contamination and to support decision-making on hazard boundaries and protective actions.

In the Field

All of the radiological measurements taken in the immediate response will be used to understand the extent of radiological contamination, including areas that are unaffected, to make health and safety decisions to protect responders and the public from high exposure levels, and to mitigate the spread of contamination. When taking radiological measurements, first responders should be alert for any possible hot spots or localized high radiation levels due to partially or non-dispersed radioactive sources or radioactive source fragments. Collecting radiological data is a secondary mission to lifesaving rescue operations and should not delay or interfere with the emergency response being conducted near the incident.

Incident Command collects radiological incident data by assigning Radiological Monitoring Teams to take radiological measurements in two sequential phases (illustrated in Figure 5 and outlined in priority order in Table 5) and as resources are available. All measurements taken by the Radiological Monitoring Teams should be recorded and communicated for data mapping or placed directly into the incident data map. An analyst, with expertise in interpreting radiological data for safety and protection, should review all the collected and mapped radiological data and provide recommendations to Incident Command for public health and safety decisions. See Annex 4: Data Assessment Decision Support Guide (p. 56) for additional information.

CBRNResponder Action: Record Radiological Measurements

Radiological Monitoring Teams should record all survey measurements in CBRNResponder as measurements are collected. It is important to record, at a minimum, the following information:

- Location of survey or observation
- Instrument type
- Units of measure

Table 5 Phases of Initial Radiological Contamination Surveys

Phase 1	Phase 2
• Detonation Site • Transect at ~0.5 mile (1 km) in the direction of contamination near the Detonation Point	• Nearfield • 10-Point Monitoring Plan (areas farther in the direction of contamination if contamination was detected at ~0.5 mile (1 km) Transect • Outlying Areas

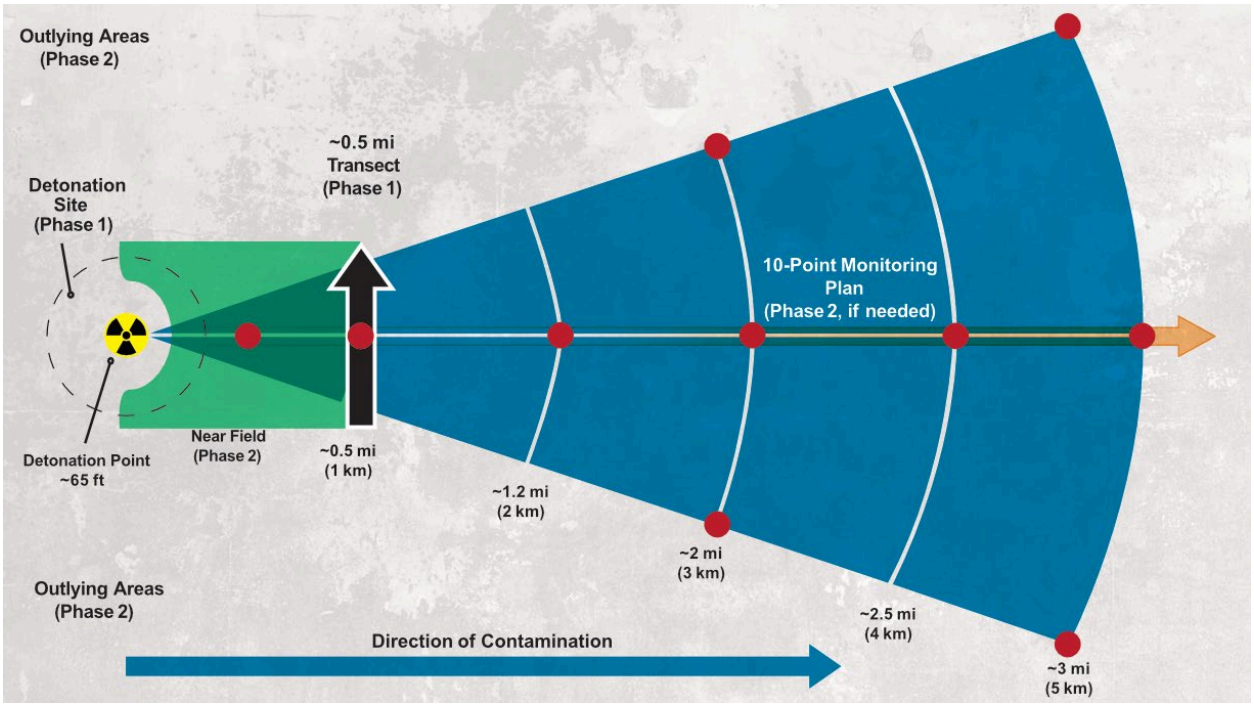


Figure 5 Initial Survey Areas with Phases

Phase 1: Detonation Site and Transect

Detonation Site

The objective of the first phase of radiological surveys is to understand if the wind spread the contamination in a specific direction. Because wind fields are complex in both open terrain and urban canyon settings, the observed wind direction should not be used as the only factor to determine the direction in which contamination has spread. The wind direction at the time of detonation may differ from the observed wind direction when responders arrive on scene, even if only a few minutes have passed. Similarly, if the weather data originates from fixed locations, such as a nearby airport, it may not correspond to the conditions before or after the time of detonation where it occurred; hence, it should not be used for decision-making. Radiation measurements are required to determine the direction of contamination. Because of this, this guidance uses the term

"direction of contamination" (sometimes also referred to as "downwind") to mean **the direction that wind carried contamination and not the observed wind direction.**

Incident Command assigns the first specialized hazardous materials team that arrives on scene as Radiological Monitoring Team 1. Team 1 is responsible for collecting radiological data to determine areas that may be Dangerous Radiation Zones at or above 10 R/hr (0.1 Gy/hr), estimate the general direction and magnitude of radiological contamination, and determine if alpha contamination is present at the incident scene. Because many alpha-emitting isotopes also emit gamma radiation, the detection of gamma radiation does not rule out the presence of alpha radiation. This is important since alpha-emitting isotopes may present an inhalation and ingestion hazard.

Table 6 outlines Radiological Monitoring Team 1's decision points and the possible outcomes from these measurements.

Table 6 Radiological Monitoring Team 1 Decision Points

Decision Point	Outcomes
Determine areas that are Dangerous Radiation Zones 10 R/hr (0.1 Gy/hr)	• If 10 R/hr (0.1 Gy/hr) is measured, stop, mark the point and move to a lower background area. Marking and moving away from Dangerous Radiation Zones will ensure responder safety and help to keep exposures ALARA.
Discern which direction from the Detonation Site has the highest radiological contamination, thus indicating the direction and extent of radiological contamination	• Determine the direction of contamination and location of the ~0.5 mi (1 km) Transect.
Determine if alpha contamination is present	• If no alpha contamination is found, cease this mode of monitoring. • If alpha contamination is found, begin to define the boundary of the Hot Zone based on a 6,000 dpm/cm^2 at ~0.25 inch above the ground with an alpha probe. Alpha probes should include predetermined conversion factors from counts per minute (cpm) to dpm/cm^2. • If beta contamination is found but no alpha contamination, continue to enforce the 10 mR/hr (0.1 mGy/hr) Hot Zone.

Steps for Radiological Monitoring Team 1

When performing radiation surveys, the Radiological Monitoring Teams should not enter the Detonation Point (the area within ~65 ft (20 m) around the point at which the detonation occurred) at any time. In addition, the Radiological Monitoring Team should minimize their time spent in the Crime Scene. When entering the Crime Scene is unavoidable, coordinate entry with law enforcement and take precautions to avoid potentially moving or removing evidence or otherwise disturbing the crime scene.

- Radiological Monitoring Team 1 takes a handful of measurements approaching the Detonation Point starting at ~330 ft (100 m) out until they reach the Detonation Point or until they reach an exposure rate of 10 R/hr (0.1 Gy/hr), whichever comes first.
- Radiological Monitoring Team 1 repeats the measurements from four or more different directions/approaches that span the 360 degrees around the Detonation Point (where possible based on site specific building and environmental considerations). In a dense urban environment only four directions of approach may be possible (for example, approaches from north, south, east, and west). All measurements are taken at ~ 3 ft (1 m) above the ground.
- If Radiological Monitoring Team 1 measures radiation at or above 10 R/hr (0.1 Gy/hr), they should stop, mark the point and move to a lower background area. Areas bounded by 10 R/hr (0.1 Gy/hr) will be designated the Dangerous Radiation Zones.
- Radiological Monitoring Team 1 continues measuring outwards from ~330 ft (100 m) in multiple directions if no clear direction of contamination is found.
- Radiological Monitoring Team 1 takes measurements using alpha and beta contamination probes at 0.25 inch above the ground to help characterize the radioactive material and determine what Hot Zone boundaries will need to be established past the initial boundary.

CBRNResponder Action: Classify Event as an RDD and Use Geo-shapes for Initial Protective Actions Boundaries

Once the direction of highest contamination is established, the event in CBRNResponder should be categorized as an RDD event and the wind direction should be added into CBRNResponder. Categorizing an event in CBRNResponder as an RDD will allow users to add geo-shapes onto the map of the initial Hot Zone and Shelter-in-Place Zone. This will allow the EOC to quickly visualize boundaries for protective action areas for public messaging and responder safety.

Transect at ~0.5 mile (1 km)

Once the direction of highest contamination is identified, Incident Command assigns the second specialized hazardous materials team that arrives on scene as Radiological Monitoring Team 2. This team is responsible for surveying the Transect at ~0.5 mile (1 km) in the direction of the highest contamination to determine if wind carried radioactive contamination. Table 7 outlines the decision points and possible outcomes from these measurements.

CBRNResponder Action: Adding the ~0.5 mile (1 km) Transect

If an event is categorized in CBRNResponder as an RDD and direction of contamination is known, a ~0.5 mile transect (1 km) will automatically highlight on the incident map. This allows responders to visually see the ~0.5 mile (1 km) transect and determine starting and end points that require radiological monitoring.

Table 7 Radiological Monitoring Team 2 Decision Points

Decision Points	Outcomes
Assess the extent and direction of contamination spread	• If radiation measurements at the ~0.5 mile (1 km) Transect are at background levels, it indicates that a significant amount of radioactive material was not carried by the wind or the identified direction of contamination is incorrect. • If radiation measurements at the ~0.5 mile (1 km) Transect are elevated, it indicates Phase 2 measurements further out are required to understand the extent of contamination spread.
Determine if alpha contamination is present	• If no alpha contamination is found, cease this mode of monitoring. • If alpha contamination is found, begin to define the boundary of the Hot Zone based on a 6,000 dpm/cm^2 at ~0.25 inch above the ground with an alpha probe. Alpha probes should include specific conversion factors from cpm to dpm/cm^2 to simplify analysis. • If beta contamination is found but no alpha contamination, continue to enforce the 10 mR/hr (0.1 mGy/hr) Hot Zone.

Steps for Radiological Monitoring Team 2:

- Radiological Monitoring Team 2 walks along the ~0.5 mile (1 km) Transect and takes measurements using low-range exposure rate meters at ~3 ft (1 m) above the ground in the center of intersections and the halfway point between intersections. If no intersections exist, Radiological Monitoring Team 2 should aim to take measurements approximately every ~150 ft (50 m), which should result in about 20 measurements (see Figure 6).
- Radiological Monitoring Team 2 also takes measurements with beta contamination probes at 0.5 inch above the ground and with alpha contamination probes at 0.25 inch above the ground.

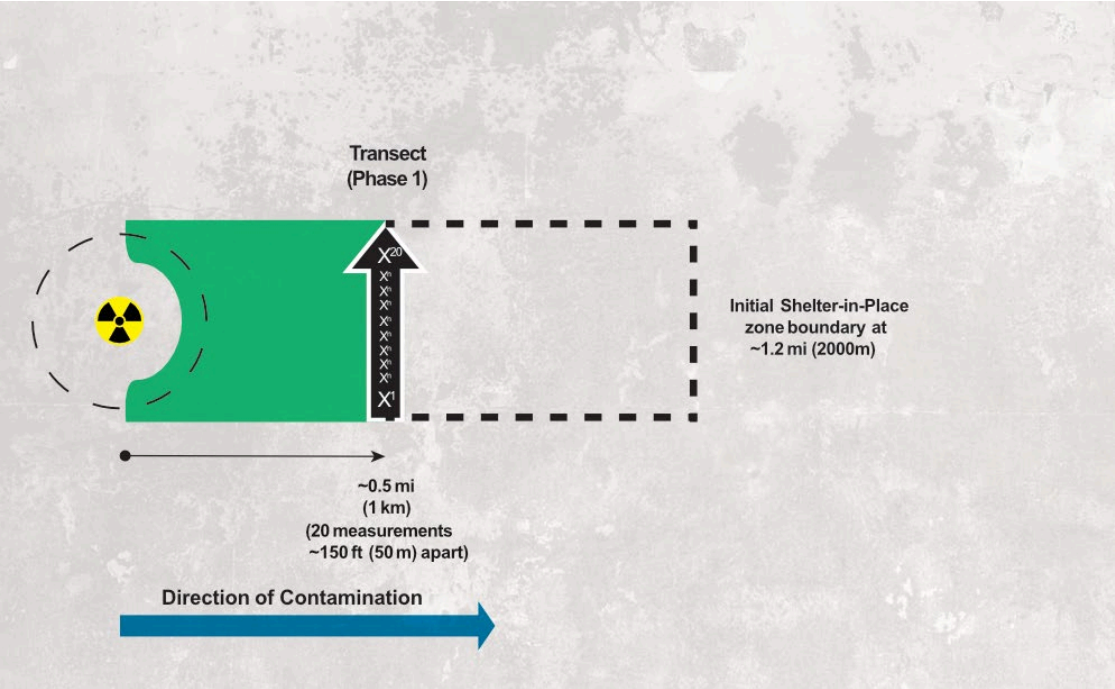


Figure 6 Transect at ~0.5 mile (1 km) Transect

Phase 2: Near Field, 10-Point Monitoring, and Outlying Areas

Near Field

The objective for measuring in the Near Field is to confirm the actual Hot Zone boundary and general location of deposition of radiological contamination. The area that is greater than 10 mR/h (0.1 mGy/hr) will likely be less than the ~800 ft (250 m) established as the initial Hot Zone, but it may be a complex and chaotic footprint due to urban wind fields and canyon effects. An RDD with low activity of radioactive material or a low fraction of dispersal may cause levels less than 10 mR/hr (0.1 mGy/hr) over a small area.

Steps for Radiological Monitoring Team 3:

- Radiological Monitoring Team 3 surveys the area between the detonation site and ~0.5 mile (1 km) Transect in the direction of contamination.
- Radiological Monitoring Team 3 collects measurements parallel to the direction of contamination (see Figure 7) to identify the edges of the plume where the exposure rate is greater than 10 mR/hr (0.1 mGy/hr) and to establish the general contour of the footprint.

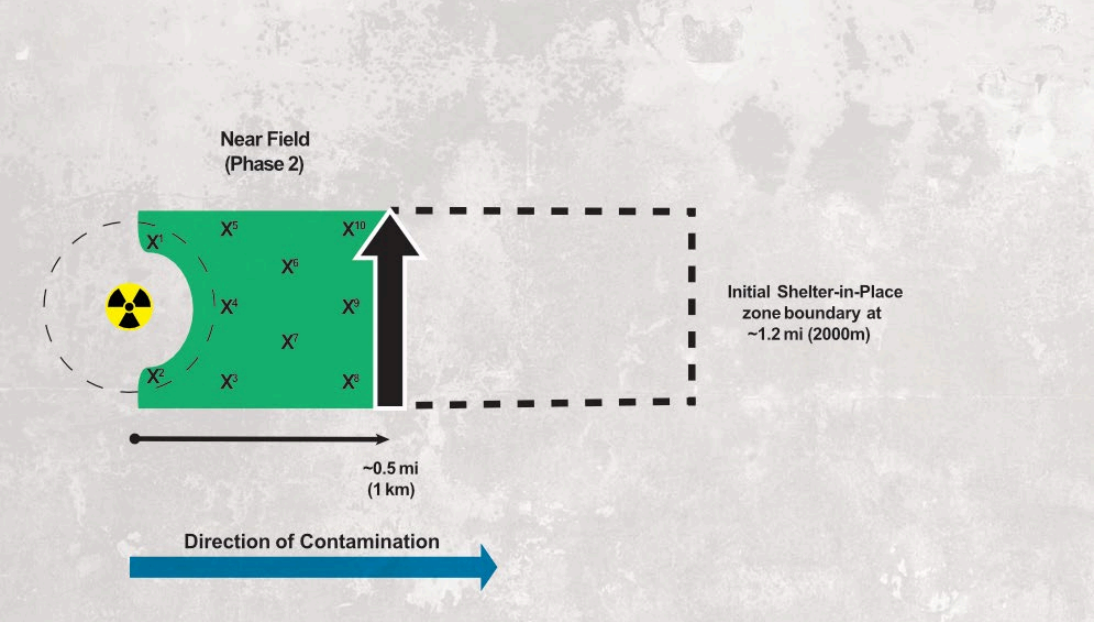


Figure 7 Near Field

10-Point Monitoring Plan

If radiological contamination is detected at the ~0.5 mile (1 km) Transect, first responders should initiate the 10-Point Monitoring Plan (see Figure 8) based on the direction of contamination as confirmed while collecting radiological measurements at the Transect. The Transect and Near Field surveys provide measurements for two of the 10 points, thus only eight additional points are needed.

CBRNResponder Action: Adding the 10-Point Monitoring Plan

A 10-Point Monitoring Plan layer can be added into CBRNResponder to allow first responders to visualize the suggested points for monitoring on a map. The 10-Point Monitoring Plan layer has a default 3-mile (5 km) size, which can be adjusted to fit the scale of the incident.

Data do not need to be obtained by sending out a radiological monitoring team. Contacting personnel who have radiation detectors at fixed locations, such as at firehouses, police precincts and hospitals, will facilitate rapid data collection. Request that measurements are taken outdoors at ~3 ft (1 m) above the ground. Measurements close to the recommended points on the grid are sufficient. If fixed collection points are not available or if additional teams exist, deploy first responders to collect measurements along the recommended grid (see Figure 8). Annex 6 (p. 69) is a protocol for conducting the 10-point monitoring plan.

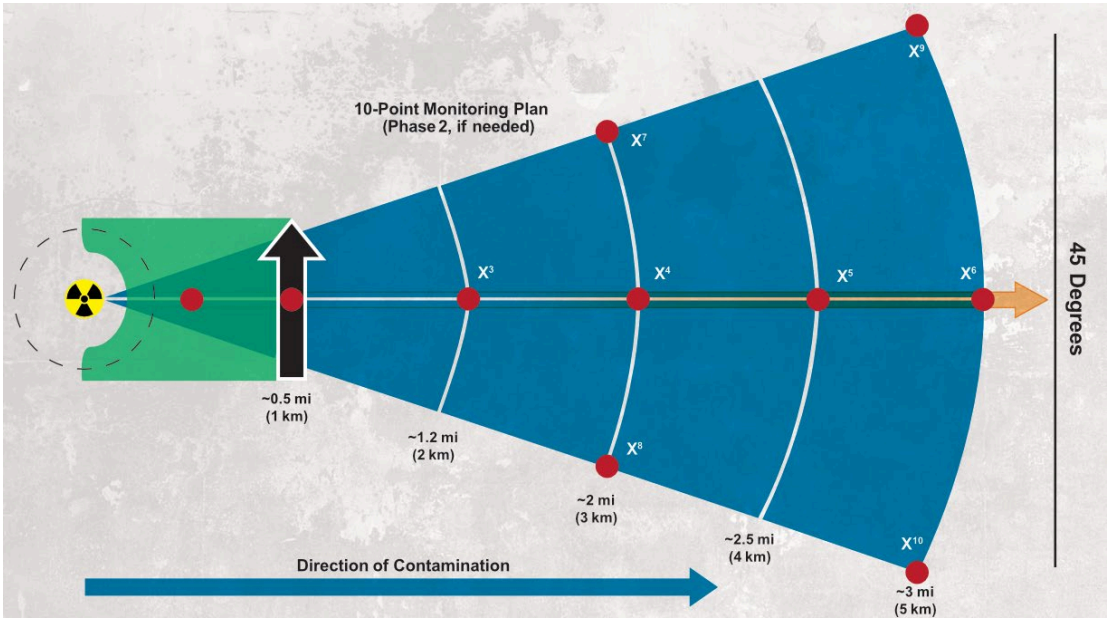


Figure 8 10-Point Monitoring Plan

Outlying Areas

The objective of measuring the outlying areas, which are the areas outside of the detonation site, nearfield, and 10-point monitoring area, is to confirm that radiation is **not** present in these areas. These outlying measurements of background radiation (no contamination) will be important to map and critical when communicating hazard areas to the public.

Fixed Location Monitoring Steps:

- Incident Command assigns a team of two people to coordinate the collection of radiation measurements from fixed locations throughout the jurisdiction and neighboring areas. Data do not need to be obtained by sending out a radiological monitoring team. Instead, first responders can contact personnel at locations such as firehouses, police stations, universities, hospitals, and other local, state and federal partner agencies, with available radiation detection equipment and request that measurements be taken outdoors at ~3 ft (1 m) above the ground (see 30Figure 9). Data collected from fixed locations should include the radiation measurement and the instrument that was used, the exact location, and the individual responsible for taking the measurement, in case additional information is required.
- If no fixed locations exist that have radiation detection equipment, a team of two first responders (and more teams if resources permit) can drive around the jurisdiction and surrounding areas to confirm background radiation measurements.

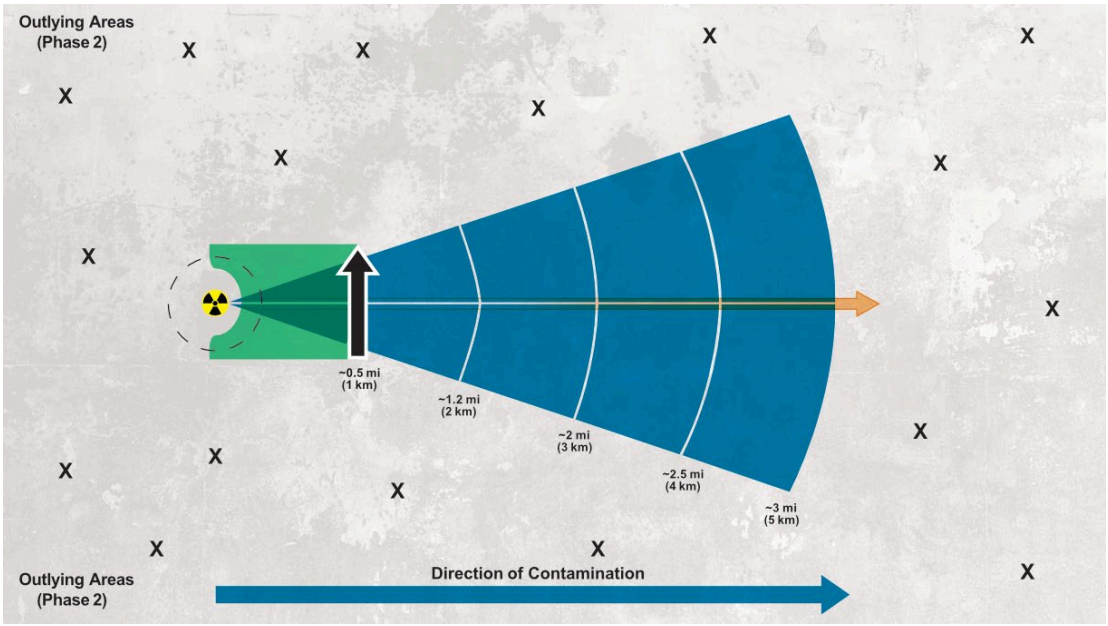


Figure 9 Outlying Areas

Table 8 outlines, in phase order, the survey areas, objectives, equipment needs and personnel requirements to complete Tactic 8. For all activities, responders should have the capacity to upload data into the incident data map in real time (i.e., by smartphone, computer, or radio/phone call to EOC). If exposure rate meters are not readily available, responders may use suitable preventive radiological and nuclear detection (PRND) equipment to complete the necessary measuring and mapping of radiological data.[13]

Table 8 Summary Requirements to Implement Tactic 8

Phase	Survey Area (see Figure 5)	Objectives	Equipment Needs[14]	Minimum Personnel Requirements
Phase 1	**Detonation Site** Includes the area 360 degrees immediately surrounding the detonation point (Does not include the detonation point)	Identify discernable direction from detonation point with highest radiological contamination to determine the direction and extent of radiological contamination Assess the pattern of contamination in the immediate area around the Detonation Point Identify points of highest contamination and determine if a Dangerous Radiation Zone exists (>10 R/hr or >0.1 Gy/hr) Determine if surface contamination is due to alpha or beta radiation	• Exposure rate meters ○ High range (R/hr) ○ Low range (microR/hr) • Meter with alpha and beta contamination probes	Two first responders with highest level of proficiency in the operation of radiation detection equipment
	~0.5 mile (1 km) Transect Includes the area at ~0.5 mile (1 km) in the direction of contamination	Determine if the RDD dispersed at a distance Determine if surface contamination is due to alpha or beta radiation	• Low-range exposure rate meters (microR/hr) • Meter with alpha and beta contamination probes	Two first responders with highest level of proficiency in the operation of radiation detection equipment

[13] DHS S&T published the "Using Preventative Radiological Nuclear Detection Equipment for Consequence Management Missions" job aids, which includes a guide to help first responders understand the capabilities of their equipment. It is available at: www.dhs.gov/publication/st-frg-using-preventative-radiological-nuclear-detection-equipment-consequence

[14] **High Range Instrument**: Capable of measuring multiple R/hr levels, ion chamber or high range Geiger-Müeller (GM) instrument.
Low Range Instrument: Capable of measuring background levels and to a few mR/hr.
Beta Contamination Probe: Thin window GM detector or thin window plastic scintillator detector.
Alpha Contamination Probe: Zinc sulfide detector or combination zinc sulfide/plastic scintillator alpha/beta detector.

Table 8: Summary Requirements to Implement Tactic 8 (continued)

Phase	Survey Area (see Figure 5)	Objectives	Equipment Needs	Minimum Personnel Requirements
Phase 2	**Near Field** Includes the area between the Detonation Point and the ~0.5 mile (1 km) Transect	Define the Hot Zone boundary of 10 mR/hr (0.1 mGy/hr) or 60,000 dpm/cm² at ~0.5 inch (1.5 cm) above the ground for beta and gamma (if no alpha contamination is present) and the deposition of the plume	• Low-range exposure rate meters (micro-R/hr) • Meter with alpha and beta contamination probes	Two first responders proficient in operating low-range exposure rate meters
	10-Point Monitoring Plan Includes the area from ~0.5 to 3 miles (1 to 5 km) outwards in the direction of contamination	If measurements at the Transect indicated the presence of contamination, assess the extent and magnitude of contamination spread	• Low-range exposure rate meters (micro-R/hr) • Meter with alpha and beta contamination probes	Either a team working from a command center and collecting radiological measurements from fixed locations (e.g., police stations and fire houses) OR two first responders with proficiency in using radiation detection equipment
	Outlying Areas Includes any location outside the areas listed above	Document unaffected areas to assure public	• Communications equipment (radios, cell phones, etc.) • Low-range exposure rate meters (microR/hr)	Either a team working from a command center and collecting radiological measurements from fixed locations (e.g., police stations and fire houses) OR two first responders with proficiency in using radiation detection equipment

Jurisdictions that lack an inventory of radiation detection instruments sufficient to outfit and deploy three radiation monitoring teams can still accomplish the goals of this tactic, although it will take more time to make the measurements. One instrument that detects gamma radiation is sufficient to discern the relative extent of contamination or lack thereof, which will allow for decision makers to determine where populations should continue to shelter-in-place. Additionally, it is estimated that one team can walk and complete the Transect measurements in less than an hour so Incident Command can decide if Phase 2 is necessary.

It is important to promptly rule out alpha contamination since alpha emitting isotopes may present an inhalation hazard to first responders and the public. If alpha contamination is present, but there are not enough alpha survey probes available for all responders assigned to conduct the 10-point monitoring survey, it is likely that responders can still conduct a successful survey with gamma-detecting equipment because many alpha emitters (e.g., Am-241, Ra-226) also emit gamma radiation. Additionally, gamma measurements of alpha emitting radionuclides taken early in the response can be retroactively adjusted by technical experts to estimate alpha radioactivity levels. Also, later into the response, a greater number of specialized instrumentation may become available to support additional surveys for alpha contamination directly.

In the EOC

Mapping

- Emergency management and other agencies in the EOC will aggregate data collected from all radiological monitoring teams into an incident data map and create a single integrated visualization of the extent of contamination.
- Updated contamination maps should be shared with all agencies operating on the scene, and additional assets arriving in the field and in the EOC.
- An analyst, with expertise in interpreting radiological data for safety and protection, should review all radiological data and provide recommendations to Incident Command and the EOC to support their making public health and safety decisions. The CMHT can be accessed remotely at all times to support analysis of radiological data. See Annex 4: Data Assessment Decision Support Guide (p. 56) for additional information.
- **Modeling of ground deposition (colloquially referred to as "plume modeling") should not replace taking field measurements.** Modeling is most informative to decision makers when the models can incorporate and be confirmed by field measurements.
    - IMAAC can provide models of dispersion in urban environments and will incorporate the field measurements to adjust estimates of where contamination may have settled.

CBRNResponder Action: Evaluating, Validating and Analyzing Data

As radiological monitoring teams at the Detonation Site, in the Near Field, and further out collect radiological data and upload it into CBRNResponder, analysts should evaluate data in CBRNResponder and validate its appropriateness. Analysts may request additional data points in areas where discrepancies exist or where patterns emerge. For example, once analysts have enough validated data, they should analyze the data in CBRNResponder and make recommendations for responder health and safety, public evacuations, and additional protective actions.

MISSION: EVACUATE AND MONITOR populations from impacted areas and begin to identify locations to open community reception centers for screening and population

Tactic 9: Commence Evacuations

Guidance: First responders establish evacuation routes based on radiological measurements taken in the field to avoid evacuating populations through heavily contaminated areas. Since people should be sheltering in place, evacuations during the immediate response should prioritize populations who do not have access to adequate shelter or are in danger due to non-radiological hazards. Phased evacuations of affected areas may take time to plan and conduct safely and might not begin for 24 hours or more. Emergency management organizes a press conference with updates on the response, evacuation and self-decontamination instructions (Public Message #3, p. 35).

- Direct evacuees who have sheltered-in-place in the Hot Zone to a limited number of exit points ensuring that they do not travel through heavily contaminated areas or close to other hazards at the scene.
    - Evacuation might be required due to elevated radiation levels, contamination, infrastructure impacts (e.g., loss of electrical power, loss of water) or a combination of these.
    - Some people who are sheltering in place may not need to evacuate. Advising them to continue sheltering will reduce evacuation-related risks.
- Expect mass spontaneous self-evacuations from all over the jurisdiction regardless of whether populations are in the impacted areas or not.
- Initiate planning for phased evacuations, which might not begin for 24 hours or more. Initiation includes beginning to identify possible evacuation routes by locating areas that have little or no contamination.
- If contamination is measured beyond the ~0.5 mile (1 km) Transect (see Tactic 8), expect the size of the evacuation area to continue to be refined after ground deposition is further mapped (as a result of responders completing the 10-Point Monitoring Plan).
- Be prepared for the possibility that the area requiring evacuation may expand in accordance with the protective action guidance for relocation when a larger set of high-fidelity field measurements are taken in the 24–48 hour timeframe. Phased evacuations may be necessary.
- Emergency management organizes a press conference with the mayor, police chief, fire chief and/or public health official with radiation safety expertise to update the public on the response, evacuation, self-decontamination instructions, and other protective actions.
    - Information from the press conference should be pushed through all available communication methods. See Annex 2: Public Messaging (p. 41) for more information on press conference content.

Public Message #3: Press Conference

An explosion that released radioactive particles has occurred at [Location]. There will be a press conference at [time] carried on all local networks and streamed at [URL]. Emergency personnel are on scene providing care to those in need and assessing the extent of the incident. If you have been asked to move inside the nearest structurally sound building, stay inside the building with the windows and doors closed until instructed by officials that it is safe to evacuate, which may occur in 24-48 hours. If your HVAC system pulls air in from the outside, put it on recirculate mode or turn it off. If you are outside of the area, please stay clear to allow emergency personnel to work.

Radioactive particles settle like dust on outside surfaces, including your clothes, exposed body parts and other objects. If you are concerned about contamination because you were outside at the [Location] at the time of the explosion, take the following steps to reduce your radiation exposure:

- *Remove your outer layer of clothing. This can remove up to 90% of radioactive material (this percentage is an estimate and may vary depending on amount of skin covered by clothing, for example, long pants versus shorts).*
- *Place the clothing you were wearing in a plastic bag or other container and place the container away from people and pets. Do not throw the bag or container into regular garbage collection bins to prevent potential spread of contamination.*
- *Take a warm shower with plenty of soap. Do not scratch your skin.*
- *Wash your hair with shampoo or soap and water.*
- *If you cannot shower, use a wipe or clean wet cloth to wipe skin that was not covered by clothing, such as your hands and face.*
- *Gently blow your nose and wipe your eyes and ears with a clean wet cloth.*
- *Put on clean clothing. If you do not have clean clothes, shake or brush off your outer layer of clothing and redress. Be careful to not breathe in the particles.*

Tactic 10: Monitor and Decontaminate

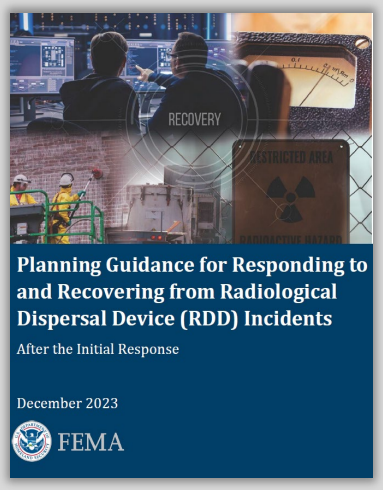
Guidance: First responders perform quick screening and dry decontamination of individuals at designated exits from the Hot Zone to the extent practical and without unduly slowing down self-evacuation. Because people are expected to self-evacuate the affected area and to self-decontaminate when they reach their destination, priority should be given to life saving and stabilizing the scene. Community Reception Centers (CRCs) are unlikely to be established in the first 12–24 hours following an RDD. Emergency management should choose from a list of pre-identified CRC locations or begin to identify possible locations to open CRCs. Once CRC locations are determined, mobilizing equipment, supplies, and personnel to these locations should begin.

- **Anyone needing medical treatment (due to trauma or other injuries) should be sent directly to hospitals or alternate healthcare facilities**.
- At Hot Zone exit points:
    - Perform quick screening and dry decontamination of people who were in the Hot Zone, as is practical and without slowing down the evacuation.
    - At a minimum, advise evacuees to remove external clothing, if feasible, and to use wet wipes to clean exposed skin. A damp towelette is considered dry decontamination.
    - Self-decontamination information is available at: www.cdc.gov/radiation-emergencies/prevention/self-decontaminate.html
    - Initiate procedures to control the spread of contamination.
    - Separate out people who may need further radiological evaluation due to potential for internal contamination by looking for those who have external contamination on their head, hair, and clothing on the upper body.
        - People that do not exhibit significant external upper body contamination, especially around the nose and mouth, are unlikely to have received a significant internal dose that would require further evaluation.
    - Direct evacuees who require further radiological evaluation to CRCs once they open.
- Though disaster assistance centers and shelters are not ideal places to provide screening or treatment, they should be considered as interim screening centers if there are no adequate sites for CRCs or if people arrive at shelters without prior screening at a CRC.
    - Information on setting up CRCs is available at: www.cdc.gov/radiation-emergencies/media/pdfs/2024/04/population-monitoring-guide.pdf
    - Information on operating a public shelter in a radiation emergency is available at: www.cdc.gov/radiation-emergencies/media/pdfs/2024/04/operating-public-shelters.pdf
- Additional information on the medical evaluation and treatment support from the DOE's Radiation Emergency Assistance Center/Training Site (REAC/TS) can be found at: http://orise.orau.gov/reacts
- Additional information and resources for emergency medical services personnel and emergency department staff can be found on the Radiation Emergency Medical Management (REMM) website at: https://remm.hhs.gov
- Begin to identify locations for setting up CRCs for screening and decontamination in areas far from the Hot Zone in low background locations (preferably at levels less than twice background or at most approximately 50 μR/hr (~0.5 μGy/hr)).

  - A CRC plan should include pre-selected locations suitable for establishing CRCs if needed.
  - If no specific CRC plan has been developed, consider leveraging plans developed by local or state health departments for points of dispensing (PODs) or sheltering.
  - Information on transforming POD plans into CRC plans is available at www.cdc.gov/radiation-emergencies/media/pdfs/2024/04/POD_to_CRC_Planning_Tool-508.pdf
- Do not decontaminate motor vehicles at this time in the response due to the extensive time and effort required to survey and decontaminate vehicles.
- Do not waste effort trying to contain contaminated wash water at this time in the response. However, be sure to notify wastewater treatment plants.[15]

Planning for Extended Response and Long-Term Recovery

This "Radiological Dispersal Device (RDD) Immediate Response Guidance" describes the missions and tactics first responders should execute during the first minutes and hours after an RDD detonation. This document should be the starting point for jurisdictions that want to develop an RDD response capability.



However, the emergency does not end after the immediate response. **A separate guidance is available that describes how to plan for the days, weeks, months, and years that follow.** The "Planning Guidance for Responding to and Recovering from Radiological Dispersal Device (RDD) Incidents: After the Initial Response" picks up where the Immediate Response Guidance leaves off and provides planners with a framework that covers response and long-term recovery.

The Planning Guidance for Responding to and Recovering From RDD Incidents is available here: www.fema.gov/sites/default/files/documents/fema_rd-planning-guidance-for-responding-to-and-recovering-from-radiological-dispersal-device-rdd-incidents.pdf

[15] According to the US EPA PAG Manual (2017), "In early phase scenarios where it might not be practical or would interfere with other lifesaving and public health protection priorities, do not waste effort trying to contain contaminated wash water but be sure to notify sewage treatment plants."

ANNEXES

Annex 1: Glossary of Terms

~0.5 mile (1 km) Transect	An initial survey at approximately ~0.5 mile (1 km) from the point of release that is orthogonal to the direction of contamination. It is used to establish an indication of the extent of contamination and to gather information on the location of the point of highest concentration to locate the actual plume centerline.
10-Point Monitoring Plan	An early and coherent set of field measurements that guides first responders to prioritize subsequent monitoring of affected areas and provide the data that are needed to refine dispersion modeling of the footprint of contamination and convert the measurements into dose projections for early protective action decision making.
Airborne Radioactivity	Radioactive material dispersed in the air in the form of dusts, fumes, vapors or gases.
ALARA	"As Low As Reasonably Achievable" (ALARA) is a radiation safety concept for minimizing dose.
Background	Naturally occurring radiation level that varies with geography and altitude.
Community Reception Centers (CRCs)	A physical space that provides contamination screening and decontamination services to people displaced by a large-scale radiation incident. CRCs are established to assess people for exposure, contamination and the need for decontamination, and to register people for monitoring, radiological assessment, or medical management if necessary.
Dangerous Radiation Zone	For radiological safety, the Dangerous Radiation Zone is defined by the National Council of Radiation Protection and Measurements (NCRP) as an area where radiation levels exceed 10 R/hr (0.1 Gy/hr).
Detonation Point	The point at which the detonation occurred and surrounding areas to a distance of about ~ 65 feet (20 m). Access to the Detonation Point is controlled by law enforcement and investigatory personnel. Emergency response personnel should not enter the Detonation Point **except to save lives.**
Detonation Site	The area 360 degrees immediately surrounding the Detonation Point that was affected by the blast. Responders should not enter this area **except to save lives or to perform other critical functions.** All personnel entering this area must be careful not to disturb anything that might become evidence in the investigation.
Dose	The amount of energy deposited in an absorber by ionizing radiation, measured in rad (r, US) or Gray (Gy, international).
Dose Equivalent	The biological damage caused by ionizing radiation that accounts for the amount of energy deposited in tissue as well as the relative biological effectiveness of the type of radiation to which the person was exposed, measured in rem (US) or Sievert (Sv, international).

Exposure	The amount of ionization produced in air resulting from x-ray or gamma-ray radiation, measured in Roentgen (R, US and international).
External Radiation	A source located on or outside the body that emits radiation that penetrates the epidermis and irradiates organs and tissues.
Groundshine	External radiation exposure caused by deposition of radioactive particles deposited on the ground after passage of the aerosol plume.
Hot Spot	A region in a radiation/contamination area where the level of radiation/contamination is significantly greater than in neighboring regions in the area.
Hot Zone	For radiological safety, the Hot Zone is defined by the National Council of Radiation Protection and Measurements (NCRP) as an area where radiation levels exceed 10 mR/hr (0.1 mGy/hr) or 60,000 dpm/cm^2 beta and gamma at ~0.5 inch (1.5 cm) and 6,000 dpm/cm^2 at 0.25 (~0.75 cm) inch with an alpha probe. Alpha probes should include predetermined conversion factors from cpm to dpm/cm^2.
Personal Protective Equipment (PPE)	Equipment worn to minimize exposure to serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical or other workplace hazards. PPE may include items such as gloves, safety goggles and shoes, earplugs or muffs, hard hats, respirators, coveralls, vests or full body suits.
Plume	The column or cloud of smoke emanating from a continuously emitting chimney or smokestack.
Radiological Dispersal Device (RDD)	The combination of radioactive material and the means (whether active or passive) to disperse the material with malicious intent; however, fission reactions do not occur in the RDD or its dispersed material.
Secondary Device	An additional device placed to target first responders, other individuals, or infrastructure before, during or after a response.
Shelter in place	The use of a structure and its indoor atmosphere to temporarily separate individuals from a hazard or threat.
Shelter-in-Place Zone	The extent of an area defined by Incident Command or public health official to protect the public from an environmental radiation hazard.

Annex 2: Public Messaging Guidance

Keeping the public informed as early as possible during the early phase of an RDD response is critical to the success and effectiveness of the response and recovery. The public must understand what protective actions they can take to ensure their safety and that of their loved ones. Consistent, clear, and timely messages are important throughout the response. Every effort should be made to continue to provide updated messages to the public as the response progresses.

This annex provides suggested public messages that jurisdictions can issue to the public based on the operations and activities being conducted in the field. Although no timeline for message release is included in this annex, first response agencies should aim to have the first public safety message out as soon as an explosion with smoke and debris is confirmed, ideally within 10 minutes. The remaining messages should be issued progressively as the response moves from lifesaving rescue operations to incident stabilization. A table at the end of this annex provides more public messages that can be issued, if needed, at the discretion of Incident Command and/or Public Information Officer(s) at the Joint Information Center.

A public information officer (PIO) working in the Emergency Operations Center (EOC) or the Joint Information Center (JIC), if established, is responsible for releasing these messages in coordination with activities occurring in the field. Messages should be distributed over multiple channels, including Emergency Alert System (EAS) and the Wireless Emergency Alerts (WEA) to increase the number of people who receive them. Pre-written messages should be translated and available in multiple languages.

Public Message #1: Response Units Arrive on Scene to Assess the Hazard

Why this message: Members of the public in the general area around the Detonation Site may have both seen and felt the explosion. The public will begin to see a large presence of emergency response personnel and equipment arriving on scene and may learn about an explosion having occurred. It is reassuring for them to hear that emergency personnel are on scene and determining the cause of the explosion as quickly as they can. Regardless of the cause, a shelter in place message is also appropriate to protect the public from smoke inhalation and falling debris after any explosion. If radiation is found on the scene, the public will have already been notified to move inside the nearest structurally sound building. Emergency personnel need the unaffected public to avoid the impacted area so they can focus their attention on mitigating the hazard, conducting lifesaving rescue operations, and protecting property and infrastructure.

Public Emergency Notification: Response Units Arrive on Scene to Assess Hazard
WEA (90-character): *Explosion at XX St & XAve in X. Go inside a building ASAP & stay inside. – [Agency]*
WEA (360-character): *Explosion at XX St & XAve in X. Move inside the nearest structurally sound building ASAP & stay inside until further notice. Close your doors and windows and, if possible, set your air conditioning or heating to recirculate the air in your home/building. - [Agency]*
Public Message #1: *An explosion has occurred at [Location]. Emergency personnel are on scene. If you are near [Location], immediately move inside the nearest structurally sound building, close the windows and doors, and stay inside until further instruction. If your HVAC system pulls air in from the outside, put it on recirculate mode or turn it off. If you cannot get inside a building, place a dry cloth or other facial covering (e.g., mask) over your nose and mouth and quickly move away from the area. Please stay clear of [Location].*

Public Message #1a: Radiation is Confirmed on Scene of Explosion

Why this message: At this point in the response, on-scene emergency personnel have confirmed the presence of radiation and have notified their Command and other appropriate personnel. The public should be directed to move inside the nearest structurally sound building. If they cannot do so, placing a dry cloth or other facial covering such as a mask over their nose and mouth as they evacuate the area will offer some protection. Notifying the public to evacuate away from the impacted area will allow emergency personnel on the scene to execute response operations.

Public Emergency Notification: Radiation Confirmed at Scene of Explosion
WEA (90-character): *Explosion at XX St & XAve in X. Go inside a building ASAP & stay inside. – [Agency]*
WEA (360-character): *Explosion at XX St & XAve in X. Radioactive particles may be in the smoke and on the ground. Move inside the nearest structurally sound building ASAP & stay inside until further notice. Close your doors and windows and, if possible, set your air conditioning or heating to recirculate the air in your home/building. – [Agency]*
Public Message #1a*: An explosion has occurred at [Location]. Radioactive particles may be in the smoke and on the ground. If you are near [Location] immediately move inside the nearest structurally sound building and stay inside until further instruction. If your HVAC system pulls air in from the outside, put it on recirculate mode or turn it off. If you cannot get inside a building, place a dry cloth or other facial covering (e.g., mask) over your nose and mouth and quickly move away from the area. Please stay clear of [Location].*

Public Message #2: Lifesaving Rescue Operations and Incident Characterization are Being Conducted

Why this message: This message gives the public additional information about what is happening at the scene, while also reinforcing the shelter in place protective action.

Immediate Response Actions at the Scene
WEA (90-character): *Radiation emergency at XX St & X Ave in X. Go inside a building [ASAP] & stay inside. – [Agency]*
WEA (360-character): *Explosion at XX St & X Ave in X. Radioactive particles may be in the smoke and on the ground. Emergency personnel are at the scene. If you are nearby, move inside the nearest building and stay inside until further instruction. Stay clear of this area to allow emergency personnel to do their work. – [Agency]*
Public Message #2*: An explosion has occurred at [Location]. Radioactive particles may be in the smoke and on the ground. Emergency personnel and law enforcement are on the scene responding to the incident and assisting those in need. Personnel are also working to promptly identify unaffected areas. If you are near [Location], immediately go inside the nearest structurally sound building, close the windows and doors, and stay inside until further instruction. If your HVAC system pulls air in from the outside, put it on recirculate mode or turn it off. If you cannot get inside a building, place a dry cloth or other facial covering (e.g., mask) over your nose and mouth and quickly move away from the area. Please stay clear of [Location].*

Public Message #3: Scene is Secured and Radiological Measurement and Mapping is Being Conducted

Why this message: Emergency management organizes the first press conference of the response with the mayor, police chief, fire chief and/or public health official with radiation safety expertise to update the public on the response, evacuation, self-decontamination instructions and other protective actions.

Press Conference and Update
WEA (90-character): *Important safety information: There will be a press conference at time and date. – [Agency]*
WEA (360-character): *Important safety information: Emergency personnel are on-scene responding to the explosion. If you have been asked to seek shelter, remain there with doors and windows closed until instructed that it is safe to evacuate. There will be a press conference at time carried on all local networks and streamed at [URL]. – [Agency]*
Public Message #3*: An explosion that released radioactive particles has occurred at [Location]. There will be a press conference at time carried on all local networks and streamed at [URL]* *Emergency personnel are on scene providing care to those in need and assessing the extent of the incident. If you have been asked to move inside the nearest structurally sound building, stay inside the building with the windows and doors closed until instructed by officials that it is safe to evacuate, which may occur in 24-48 hours. If your HVAC system*

pulls air in from the outside, put it on recirculate mode or turn it off. If you are outside of the area, please stay clear to allow emergency personnel to work.

Radioactive particles settle like dust on outside surfaces, including your clothes, exposed body parts and other objects. If you are concerned about contamination because you were outside at the [Location] at the time of the explosion, take the following steps to reduce your radiation exposure:

- *Remove your outer layer of clothing. This can remove up to 90% of radioactive material (this percentage is an estimate and may vary depending on amount of skin covered by clothing, for example, long pants versus shorts).*
- *Place the clothing you were wearing in a plastic bag or other container and place the container away from people and pets. Do not throw the bag or container into regular garbage collection bins to prevent potential spread of contamination.*
- *Take a warm shower with plenty of soap. Do not scratch your skin.*
- *Wash your hair with shampoo or soap and water.*
- *If you cannot shower, use a wipe or clean wet cloth to wipe skin that was not covered by clothing, such as your hands and face.*
- *Gently blow your nose and wipe your eyes and ears with a clean wet cloth.*
- *Put on clean clothing. If you do not have clean clothes, shake or brush off your outer layer of clothing and redress. Be careful to not breathe in the particles.*

Sample Full Press Conference Remarks

Note: This is a sample of remarks that could be given during a press conference. It makes assumptions about the response. Every community is different, and the status of infrastructure, hospitals, schools, and other facilities will vary depending on the jurisdiction. This sample is a starting point and should be amended as needed.

I am providing information on the explosion that occurred at [Location] at [Time]. This is preliminary information as we begin to conduct a full investigation into what happened. We will provide updates as additional information becomes available.

An explosion that released radioactive particles occurred at [Location] at [Time]. We recommend everyone in the [Shelter in Place] boundaries go inside a structurally sound building and close the windows and doors. If your HVAC system pulls air in from the outside, put it on recirculate mode or turn it off. Remain sheltered until instructed by emergency personnel to leave, which may occur in 24-48 hours. We will continue to provide updates as they are available.

If you were outdoors in the affected [area] at the time of the explosion and believe you may have been exposed to radioactive particles, take the following steps to reduce your radiation exposure. Radioactive particles settle like dust on your clothes, exposed body parts, and other exposed objects:

- First, remove your outer layer of clothing. Removing this layer can remove up to 90% of radioactive material that has settled on your body. This percentage is an estimate and may vary depending on the amount of skin covered by clothing, for example, if you are wearing long pants versus shorts.

- Place the clothing you were wearing in a plastic bag or other container and place the container away from people and pets. Do not throw the bag or container into regular garbage collection bins to prevent potential spread of contamination.
- Next, take a warm shower with plenty of soap. Do not scratch your skin.
- If you are unable to shower, use a wipe or clean wet cloth to wipe skin that was not covered by clothing, such as your hands and your face.
- Gently blow your nose and wipe your eyes and ears with a clean wet cloth.
- Put on clean clothing. Clothing that is stored in a closet or a closed drawer is clean. If you do not have clean clothes, shake brush or wipe off your clothing as best as you can away from other people or pets. Cover your nose and mouth with a cloth or mask if you can, so you don't swallow any hazardous particles you shake loose.
- Food in sealed containers and any unspoiled food in your refrigerator or freezer is safe to eat. Wash your hands with soap and water before handling food and use a damp towel or cloth to clean all cans, bottles, packaged foods, counters, plates, pots, and utensils before using them.

Lifesaving rescue operations are ongoing in the impacted area. Emergency response personnel are on scene responding to the incident and assisting those in need. They are transporting anyone injured or exposed to large amounts of radiation to nearby hospitals. Hospitals in the area have surged their capacity and are accepting individuals who are injured or may have been exposed to harmful levels of radiation. Please do not go to the hospital if you are not injured or do not need urgent medical care.

The [Law Enforcement Agency] has secured the scene and is treating the impacted area as a crime scene. Law enforcement agencies from the state and the federal government are on scene working with investigators.

At this time, we [Do/Do Not] have estimates on a total number of people who are injured. If you would like to report someone who may be missing, please contact [Number/Email] and provide detailed information on the person you believe is unaccounted for.

Do not go to the affected area to try to find or rescue a loved one. It might place you and your loved ones in greater danger and hinder response operations. We have asked everyone who was inside the area at the time of the explosion to move inside the nearest structurally sound building until emergency personnel deem it is safe for them to leave. There are a number of [schools, daycare centers, health care facilities, and nursing homes, etc.], within the damaged area that are sheltering in place. Please know that your loved ones are being cared for by the [school staff, teachers, etc.] professionals on site.

An update on other city services:

- The following train lines and bus lines have been impacted by this incident: [Train/Bus Lines]. Check [Transit Authority] website for additional information and service changes.
- You can use city tap water for showers and for washing hands.
- City drinking water [is being/was] sampled to ensure its safety. Results [will be shared when available/were shared]. Water [is/is not] safe to drink.
- City, state and federal offices outside of the impacted area are [Open/Closed].

We will continue to update you as the response continues.

Additional WEA and Public Messages

Incident Command and/or PIO(s) at the JIC might wish to release additional messages such as one or more of those below.

Message: Evacuation Assistance

Why this message: Populations that are sheltered in place should be informed that they should only follow evacuation instructions when they are provided by emergency response personnel.

Evacuation Assistance
WEA (90-character): *Do not evacuate until informed by emergency personnel that it is safe. – [Agency]*
WEA (90 character alternate): *For information on where and when it is safe to evacuate, go to [URL]*
WEA (360 character): *Evacuation: Emergency personnel have identified safe evacuation routes. Only evacuate when you are told it is safe to do so. Follow the instructions given by emergency personnel. Wear a mask or a dry cloth over your nose and mouth. For more information on where and when to evacuate, go to [URL]*
Public Message: *An explosion that released radioactive particles has occurred at [Location]. Emergency personnel have identified areas where it is safe to evacuate. Evacuate only when you are directed to do so by emergency personnel and evacuate to only the areas specified by emergency personnel.*

Message: Learning More About this Emergency

Why this message: People directly impacted by the incident, their family and friends, and those in surrounding areas will want to know where they can find the most up to date and accurate information. This message provides the public with information about where to seek credible and timely updates.

Learning More About this Emergency
WEA (90-character): *From: [Agency]. For more information, [visit [URL], streaming at [URL] or broadcast on [network].]*
WEA (360-character): *For accurate and authoritative information, visit [URL], streaming at [URL] or broadcast on [network]. While our response to this incident might change as events unfold, our goal to keep you safe remains constant. – [Agency]*
Public Message*: In addition to these public messages, you can find additional authoritative information about this incident and measures you can take to keep yourself and your loved ones safe in several places:* • *Online at [URLs]* • *By watching press conferences on [broadcast and cable channels]* • *Streaming video via [streaming channels]* *Please be aware that our understanding of this incident and our response are changing as events unfold. What will not change is our determination to do our utmost to keep you safe.*

Message: Looking for Loved Ones

Why this message: During an emergency, it is understandable that loved ones will want to reunite and make sure their family and friends are safe. People going to the affected area, however, will not only put more people at risk, but may also interfere with response and rescue efforts. This message instructs people to try to contact their loved ones via alternative methods (e.g., call, text) and if necessary, how to provide information to help emergency personnel locate them.

Looking for Loved Ones
WEA (90-character): *Do not go to the scene. This will interfere with rescue efforts and place you at risk. – [Agency]*
WEA (360-character): *Do not go to the scene to try to find your loved ones. This will interfere with rescue efforts and place you at greater risk. Try to contact your loved ones via text and, if you have information about where they might have been, call [XX], email [XX] or post on [XX]. – [Agency]*
Public Message*: Do not go to the scene of the explosion to try to find your loved ones. Doing so will interfere with emergency response efforts, making it more difficult for emergency personnel and their equipment to reach the scene and to take injured persons to the hospital. Going to the area would also put you at unnecessary risk. We know that you are worried about your loved ones and want to find them to make sure they are safe; the best way to accomplish this is to let emergency personnel do their jobs. Please try to text your loved one and, if you make contact, share information from this and other public messages that might help to keep them safe.* *If you have information that might help emergency personnel locate your loved one (for example, perhaps they regularly go to a certain place outside for lunch), you can call [phone number] or [email address, post to website, etc.]. The information will be passed on to personnel at the scene. At the present time, do not go to the area near the explosion.*

Message: Helping Others Shelter

Why this message: People that are sheltering in place may be hesitant to let others into their shelter due to fears about contamination and exposure to radiation. People needing a safe place to shelter should not be denied shelter and the public should be informed that letting people into their shelter can save lives. Those entering the location can easily self-decontaminate by removing shoes and outer clothing and/or brushing or wiping off fallout particles as they enter.

Helping Others Shelter
WEA (90-character): *If sheltering, consider sharing your space with others who do not have a safe space. – [Agency]*
WEA (360-character): *If you are in a safe public location (such as an office building, grocery store, or public building), consider sharing with others who do not have a safe place to shelter from the radiation outside. – [Agency]*
Public Message*: If you are sheltering with others in a safe and sturdy building (such as an office building, grocery store, or public building), consider sharing this shelter with others who do not have a safe place to protect them from radiation exposure. Letting people into your building can save lives. You can let people into your shelter without additional risk of radiation contamination by asking your visitor to self-decontaminate (brush/wipe off radioactive materials and remove outer layers if possible). See How to Decontaminate.*

Message: Food, Water and Medicine Safety

Why this message: The public will want to know if their food, water, and medications are safe to consume, especially if they are being asked to shelter in place for an extended period. Use this message to provide information about where the public can seek additional information.

Food, Water, and Medicine Safety
WEA (90-character): *From: [Agency], for information on food, water, and medicine safety, see [URL]*
WEA (360-character): *From: [Agency] Food, beverages, and medicines are safe if they were in sealed containers or in the refrigerator. Fruits and vegetables that were on a table should be washed before eating or cooking. The water supply is being sampled to ensure its safety and results will be shared when the analysis is complete. For more information, see [URL]*
Public Message*: If you are located in [location impacted by contamination] or if you are concerned about the safety of your food:* • *Wash your hands with soap and water before handling food. This will help remove any radioactive material that might be on your hands, limiting its spread to your food.* • *Use a damp towel or cloth to clean all cans, bottles, packaged foods, counters, plates, pots, and utensils before using them.* • *Seal these towels or cleaning cloths in a plastic bag and place them away from people and animals.* • *To keep radioactive material from falling on areas that you already cleaned, remember to work from the higher areas to the lower levels.* • *Food, beverages, and medicine in sealed containers or in covered cups (such as travel mugs) and any unspoiled food in your refrigerator or freezer is safe to eat.* *[Officials] are currently testing the tap water to confirm that it is safe to drink. You can safely drink water, juices, or other drinks in sealed containers or in your refrigerator or freezer. Tap or well water can be used for cleaning yourself and your food. The risk from having radioactive particles on your body or consuming radioactive particles on your food*

is significantly reduced by washing, even if the water itself is contaminated. Boiling tap water does not get rid of radioactive particles. *For more information, go to [URL]*

Message: Disposing of Potentially Contaminated Clothes and Cleaning Wipes

Why this message: As people are performing self-decontamination, questions will arise about how to handle their contaminated clothing and wipes. This message provides instructions for bagging and sealing items that may be contaminated.

Disposing of Potentially Contaminated Clothes and Cleaning Wipes
WEA (90-character): *Place contaminated clothing and cleaning wipes in a bag or container, and seal with tape.*
WEA (360-character): *Place contaminated clothing and cleaning wipes in a secure bag or container, and seal with tape. Do not press on the bag to expel the air inside as this can spread contamination. Place the bag or container away from people and pets and wait for disposal instructions. – [Agency]*
Public Message*: If you were exposed to smoke or dust from the explosion your clothing, as well as any moist towelettes, washcloths, and other materials you used to decontaminate yourself, may be contaminated. To dispose of these:* • *Gently place them in a plastic bag, bin, or other container that can be closed and sealed.* • *Seal the container.* • *For plastic bags, twist the top of the bag several times, fold the twisted part, and tape securely with strong tape.* • *DO NOT squeeze the bag to expel extra air as this can spread contamination.* • *For wastebaskets, boxes, etc. close the container and tape around any seams or gaps.* • *Place the container in a secure place away from people and pets.* • *DO NOT dispose of these bags or other containers in regular garbage collection bins.*

Message: Population Contamination Screening

Why this message: This message provides information about the location(s) of community receptions centers (CRCs). A radiological incident will create a lot of panic and anxiety, and it is expected for people to be concerned about exposure to radiation. It is especially important, however, to deter people from seeking screening services or exposure assessments from a hospital. Hospitals will likely be inundated and will need to focus their resources on treating patients requiring medical attention, as opposed to healthy people who are just concerned about exposure.

Population Contamination Screening
WEA (90-character): *Important information for people who were near the explosion: [URL]*
WEA (360-character): *If you were near the explosion and were exposed to smoke, you can be screened for contamination at the Community Reception Center (CRC) located near XX St. and XX Ave in XX. Additional centers will be opening over the next day. DO NOT go to a hospital unless you are ill or injured. A list of all CRC locations and their hours of operation is posted online at URL.*
Public Message*: A radiological explosion has occurred at [Location]. If you were in this area during the time of the explosion and believe you may have been exposed to hazardous materials, you can visit a community reception center where you can be screened for radiation exposure and receive needed services.* • *Community reception centers are at the following locations: [Locations]. These locations are open from [Hours] and are staffed by trained specialists from the fire department and the health department.* • *Please only visit a community reception center if you were in the [Location] at the time of the explosion and believe you were exposed to smoke from the blast.* • *If you were more than 2 miles (3 kilometers) away from [Location] at the time of the explosion, you do not need to be screened at this time. Screening is being prioritized for those who were nearest to the area at the time of the event.* • *DO NOT go to a hospital if you are only concerned about radiation exposure and are not ill or injured.*

Message: Self-decontamination

Why this message: This message provides information about how to self-decontaminate by removing the outer layer of clothing, using wipes, or showering if possible. Studies have demonstrated that up to 90% of contamination can be removed with self-decontamination methods and can quickly minimize one's exposure.

Self-decontamination
WEA (90-character): *Decontaminate yourself by removing outer clothing, showering, or wiping yourself with moist towelettes.*
WEA (90-character alternate): *For information on how to reduce exposure to radiation, visit: [URL]*
WEA (360-character): *If you were outdoors [near/in X] after the explosion and believe you were exposed to radioactive particles: decontaminate by removing outer clothing, showering, and washing your hair, or wiping yourself with moist towelettes. This can remove up to 90% of any radioactive material. Follow the instructions [at URL / given during the recent press conference].*
Public Message*: A radiological explosion has occurred at [Location]. If you were in this area at the time of the explosion you might have become contaminated. To decontaminate yourself, take the following steps:* • *Remove your outer layer of clothing. This can remove up to 90% of radioactive material (this percentage is an estimate and may vary depending on amount of skin covered by clothing, for example, long pants versus shorts).*

- *Seal the clothing you were wearing in a plastic bag or other container, seal with tape, and place the container away from people and pets. For plastic bags, twist the top of the bag several times, fold the twisted part, and tape securely with strong tape. Do not throw the bag or container into regular garbage collection bins to prevent potential spread of contamination.*
- *Do not scratch your skin.*
- *Take a warm shower with plenty of soap. Wash your hair with shampoo or soap and water.*
- *If you cannot shower, use a wipe or clean wet cloth to wipe skin that was not covered by clothing, such as your hands and face.*
- *Gently blow your nose and wipe your eyes and ears with a clean wet cloth.*
- *Put on clean clothing. If you do not have clean clothes, shake or brush off your outer layer of clothing and redress. Be careful to not breathe in the dust-like particles.*

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Department of Homeland Security. 2013. Communicating During and After a Nuclear Power Plant Incident. www.fema.gov/sites/default/files/documents/fema_nuclear-power-plant-incident_communicating-during-after_june-2013.pdf

Annex 3: Personal Protective Equipment Recommendations

This annex provides recommendations for emergency personnel on the appropriate personal protective equipment (PPE) needed when responding to a radiological dispersal device (RDD) detonation. Note that these PPE recommendations do not address protection against non-radioactive airborne contaminants or other hazards on scene. Until all hazards on scene are identified, responders should wear PPE that is protective for all potential hazards at the site of an explosion. Radiation (including from inhaled radioactivity) is only one of the possible hazards that responders might encounter at the scene of a radiological emergency.

Radiation Exposure After an RDD Detonation

Emergency personnel responding to the detonation of an RDD may encounter two types of radiation exposure: internal exposure from inhaled airborne radioactivity and external radiation exposure from radioactive material deposited on the ground. The direct radiation from contamination on the ground is called "groundshine," which is a concern for emergency personnel. If the RDD produced a large aerosol fraction and high airborne concentrations in the undiluted plume of aerosol, the most significant hazard within the first 15 minutes of the response, however, will be from airborne radioactivity. Factors, such as when emergency personnel arrive on scene and the location in which they are operating, should guide the appropriate PPE to be used when conducting lifesaving rescue operations.

In general, emergency personnel should always work to keep their exposure As Low As Reasonably Achievable (ALARA) to mitigate the hazards associated with radiation. Wearing appropriate PPE that includes respiratory protection, maximizing distance from and minimizing time within Dangerous Radiation and Hot Zones, and using appropriate shielding will reduce the primary sources of radiation exposure.

Airborne Radioactivity (internal exposure by inhalation)
Airborne radioactivity concentrations that could lead to a high acute dose if inhaled are possible following dispersal from an RDD that produced a large aerosol fraction of the radioactive material. Based on experimentation, it is possible the initial airborne concentrations in the undiluted plume could be dangerous without respiratory protection. However, the plume of high concentration airborne particles is expected to pass and fall below acute levels in approximately 10–15 minutes. Subsequently, responders who arrive on scene 10–15 minutes after detonation are unlikely to encounter dangerously high airborne concentrations that could result in an acute internal dose. Emergency personnel who first encounter the plume at 10-15 minutes are likely to be exposed to diluted concentrations. Once the plume passes, the remaining levels of airborne radioactivity along with any additional contribution from resuspension will have relatively low concentrations.

Whole Body Radiation Exposure (external exposure from groundshine)
Although not as significant as inhalation exposure, groundshine due to removable contamination or fragments deposited on the ground is also a concern for emergency personnel. Radiation levels in the vicinity of the detonation may be high, but not so high that responders cannot enter the Detonation Site before radiation instruments and personal dosimeters are available on the scene. Even if a large amount of radioactivity was contained in the device and was poorly dispersed, responders will be moving in, out, and

around the scene and are not likely to exceed occupational levels of dose, 5 rem,[16] before instrumentation can be employed to identify hot spots or a localized Dangerous Radiation Zone, > 10 R/hr (0.1 Gy/hr). Even in an extreme case, it would be highly unlikely for a responder to receive a dose higher than the Environmental Protection Agency's guidance for life-saving operations, 25 rem, before radiation instrumentation is available. Any type of dose rate instrument that is not off scale (i.e., when the levels of radiation exceed the instrument's maximum measurement capability) is sufficient to define stay times and control integrated exposure for individuals or groups working in close proximity.

Recommended PPE

The following recommendations for PPE are aimed specifically at protecting emergency personnel from inhalation of airborne radioactivity and external radioactive contamination. The recommendations do not address protection against other airborne nonradioactive contamination hazards caused by the incident (e.g., smoke from a fire). Other hazards at the scene may dictate the need for additional equipment.

Respiratory Protection: Responders on Scene in First Approximately 0–5 Minutes

The smoke plume after an explosion is a visual reference for where there may be high airborne concentrations near the Detonation Point. The presence of high aerosol concentrations that cannot be determined immediately following dispersal, combined with the complex wind field in an urban canyon environment and the inability to predict the plume progression with precision on a distance scale of less than 0.5 mile (1 km), necessitates respiratory protection. The most protective type of respirator available should be donned immediately for first responders already in close proximity of the incident within approximately the first 0 – 5 minutes after the detonation. If no respirator is available, improvised respiratory protection such as a face covering made of dry cloth or handkerchief placed over the nose and mouth, or a surgical mask should be used to escape from the area and take shelter indoors. Sheltering will avoid inhalation of a high concentration of airborne radioactivity.

Note**: In some cases, wet/damp face coverings could actually enhance the amount of inhaled particles**. For example, cesium chloride is water-soluble, so a wet cloth could concentrate the radioactivity, as well as cause labored breathing. Leakage around the edges of the wet/damp cloth may also cause inhalation of particles.

Respiratory Protection: Responders on Scene in First Approximately 15 Minutes

Using a positive-pressure self-contained breathing apparatus (SCBA) to the extent practical is recommended for only the first 0–15 minutes after the detonation. SCBA protects responders from inhaling airborne radioactivity, while assuring an optimal immediate response to the incident.

If it is not possible to wear an SCBA while driving a vehicle, drivers should wear a full-face air-purifying respirator with a P-100 filter or a HEPA filter instead. To further minimize a

[16] Under emergency conditions, dose received by emergency workers is not considered occupational dose. The mention of 5 rem is only for reference to characterize the risk.

driver's exposure to airborne particulates inside the cab, the windows of the vehicle should be closed the entire time and the ventilation system set to recirculation.

Any responders who may have been exposed to the smoke plume without SCBA should be monitored with a GM or scintillation detector for upper body contamination, especially around the nose and mouth. If contamination is found, they should be referred for medical evaluation.

Respiratory Protection: Responders on Scene After Approximately 15 Minutes

Following the passage of the plume, the remaining levels of airborne radioactivity after the first 15 minutes, along with any additional contribution from resuspension, will be relatively low. An air-purifying respirator (APR) is sufficient respiratory protection for responders. Supplied-air respirators are excessive for this level of airborne radiation hazard. A half-face or full-face APR or an N95 respirator are recommended. Many responders typically use a full-face APR that affords more protection.

Cessation of Respiratory Protection

Responders should continue to use an APR until the analysis of air sampling demonstrates that airborne concentrations from resuspension are below the level set by local health authorities. The presence of other non-radiological respiratory hazards (e.g., asbestos, silica, particulate matter) should be taken into consideration when deciding if respiratory protection is required.

Removable Contamination: All Times

First responders wearing duty uniforms of long sleeves and long pants will have little exposed skin. Responders in bunker gear that covers their entire bodies will prevent most or all skin contamination. In addition to a regular duty uniform, responders should wear goggles and gloves to protect from external contamination and follow standard decontamination procedures upon exiting the Hot Zone. Level A suits are not needed as protective clothing to mitigate skin contamination.

Emergency personnel should use personal radiation detectors (PRDs) or other detection instruments to help minimize external exposures, enable them to locate low background areas for staging operations, control the time they spend in areas with higher levels of radiation, and increase their distance from known hot spots in the area(s) where they are operating.

Table 9 Minimum Recommended PPE for Responders during Immediate RDD Response

Equipment	Hazard	Protection	Timeframe in the Response
Positive-pressure SCBA	Airborne Radioactivity	Protects responders from inhalation of airborne particles	For the first 15 minutes of the response
Half-face respirator and goggles or full-face APR with P100 or HEPA filter	Airborne Radioactivity	Protects responders from inhalation of airborne particles	In the first 15 minutes, if wearing SCBA is not possible (such as when driving)
Half-face APR with P100 or HEPA filter	Low-level Airborne Radioactivity	Protects responders from inhalation of airborne particles	After the first 15 minutes
Goggles	Removable Contamination	Protects responders from eye contamination	Throughout response
Gloves	Removable Contamination	Protects responders from skin contamination	Throughout response
Regular duty uniform	Removable Contamination	Protects responders from skin contamination	Throughout response

References

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Musolino SV, Harper FT. Emergency response guidance for the first 48 hours after the outdoor detonation of an explosive radiological dispersal device. Health Phys. 2006 Apr; 90(4):377–385. DOI: 10.1097/01.HP.0000196111.16261. Erratum in: Health Phys. 2007 Jul;93(1):87. Erratum in: Health Phys. 2013 Aug;105(2):215. PMID: 16538143

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Musolino, SV, Harper, FT, Buddemeier, B, Brown, M, Schlueck, R. Updated Emergency Response Guidance For The First 48 Hours After The Outdoor Detonation Of An Explosive Radiological Dispersal Device, Health Physics,105:65–73, 2013.

Annex 4: Data Assessment Decision-Support Guide

During the immediate response to a radiological dispersal device (RDD) detonation, key decisions will need to be made to protect the health and safety of both first responders and the public. First responders may not have time to rigorously assess data since decisions may need to be made quickly to protect the public, responders, and the environment, and to maintain doses As Low As Reasonably Achievable (ALARA). Flawed data will exist and the data analyst (also referred to as a "data assessor") role may not be easily filled by the first teams on-site.

Once a data analyst becomes available during the early phase, it is still unlikely that they will have the time and resources to completely reconcile suspicious data. However, a data analyst might be able to take some initial steps to quickly identify data that is incomplete or likely invalid and prevent that data from being used by first responders and emergency response leadership to make decisions. To do this, data analysts should develop a validation and verification (V&V) process that can be scaled up as the response progresses.

At the most basic level, when using CBRNResponder for data collection V&V can start by automatically applying flags to measurements. For data quality assessment (DQA) guidance, information on data verification and validation procedures, and how to utilize CBRNResponder flags for data V&V see Radiological Data Assessment Guidance for Emergency Response.[17]

Decision-making should be driven by analysis of data collected by responders in the field, so, it is critical to identify which local agency possesses enough radiological health and safety expertise to analyze the collected data and support decisions based on incident specifics. Data assessment for some decisions will be made at the scene by the hazmat unit and/or a health and safety officer; data analysis for other decisions will be made by radiation safety professionals, including (potentially) a Radiological Operations Support Specialist (ROSS).

The following flowchart (Figure 10) is intended to graphically show how radiological information that is collected while carrying out Tactics 1, 2, 7, and 8 can be used by the data analyst to help inform some of the decisions that must be made during the first few hours in the response. This is followed by Table 10which describes the data assessment process in greater detail.

[17] See references listed under "Data Assessment" in Annex 9

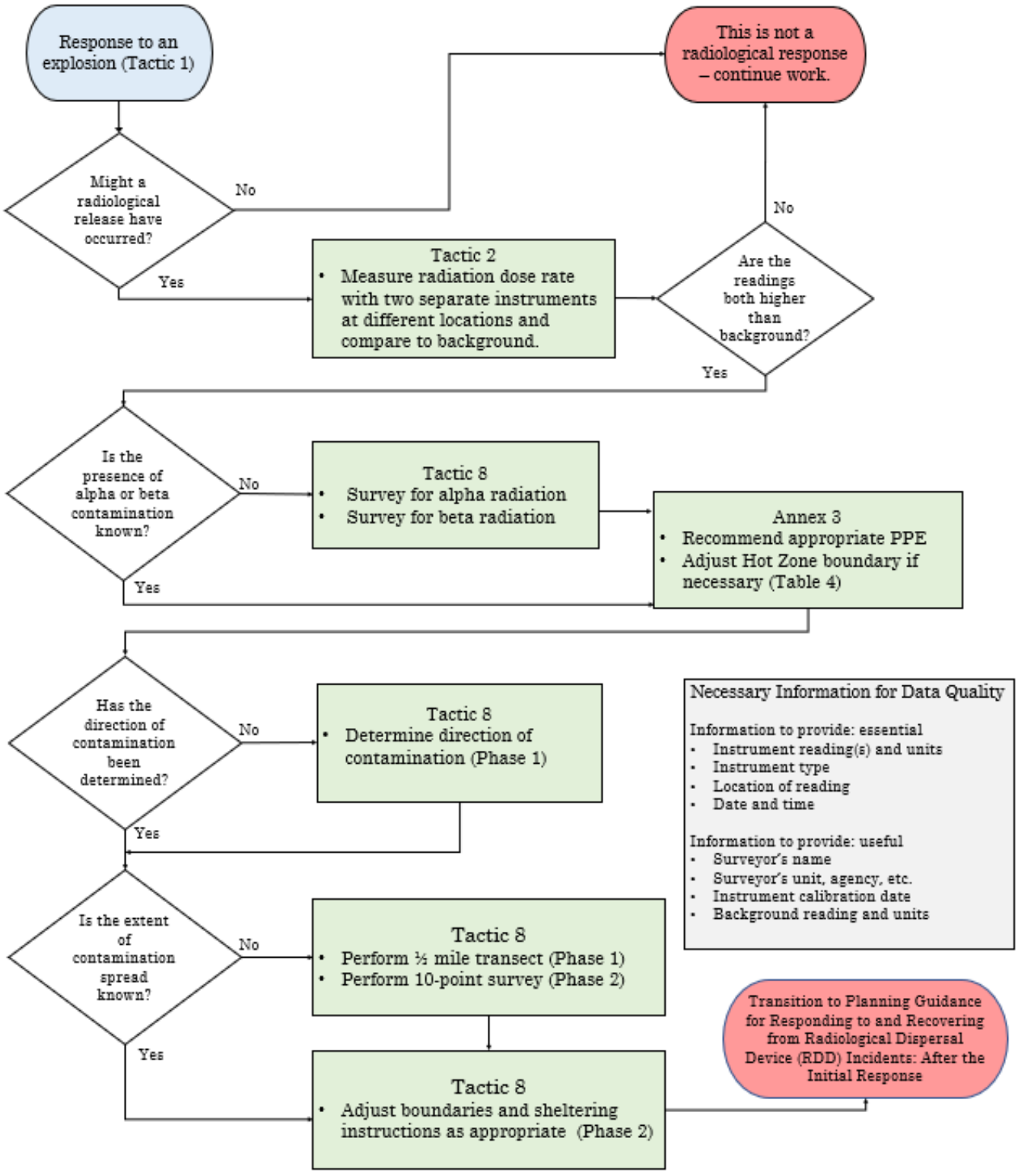


Figure 10 Data Assessment and Evaluation Flowchart

Table 10 Data Assessment and Evaluation

What are we trying to learn?	How do we find out?	Who assesses information collected?	Why do we want or need this information?
Did a radiological release occur? **Tactic 1, p. 8**	Make radiation measurements at the scene of the explosion. Take measurements with two different instruments at two locations and compare the readings. If both readings are higher than background, then assume there is a radiological release.	Trained personnel in the hazmat unit on the scene	*Having this information will support:* • Declaring a radiological incident. • Requesting help from outside agencies. • Activating the jurisdiction's RDD response plan. • Issuing Public Messaging #1/1a/2 with default shelter in place boundaries of ~1600 ft (500 m) in all directions.
Is there alpha contamination present? **Tactic 7, p. 18**	Make alpha contamination measurements at the scene.	Radiation Control Agency, hazmat unit, ROSS	*Knowing whether there is alpha contamination will help to support:* • Adjusting PPE requirements and Hot Zone boundaries if necessary. • If **no alpha** is found, Radiological Monitoring Teams 1 and 2 can discontinue alpha monitoring and focus on obtaining gamma exposure rate measurements. **If alpha is found**, first responders can begin to define the boundary of the Hot Zone based on 6,000 dpm/cm² at 0.25 inch (~0.75 cm) above the ground with an alpha probe; this Hot Zone boundary will likely be at a lower exposure rate than 10 mR/hr (0.1 mGy/hr) or 60,000 dpm/cm² at 0.5 inch (1.5 cm) beta and gamma criteria.
What direction did the radiological contamination go? **Tactic 8, p. 22**	From multiple approaches, Radiological Monitoring Team 1 moves from ~330 ft (100 m) out from the detonation point to ~65 ft (20 m) out from the detonation point and stops if they reach a Dangerous Radiation Zone of 10 R/hr (0.1 Gy/hr).	Hazmat unit (Radiological Monitoring Team 1)	*Knowing the direction of contamination helps indicate:* • The direction and magnitude of radiological contamination. • Where to conduct the ~0.5 mile (1 km) Transect measurement. • The potential magnitude of radiological contamination. • Expanding shelter-in-place boundaries to ~1.2 miles (2 km) in the direction of contamination.

What are we trying to learn?	How do we find out?	Who assesses information collected?	Why do we want or need this information?
What is the extent of contamination spread? **Tactic 8, p. 22**	Radiological Monitoring Team 2 takes radiological measurements along the 0.5 mile (1 km) Transect and finds radiation at background levels.	Radiation Control Department/ROSS	*This will support determinations that:* • There is no contamination present at or beyond 0.5 mile (1 km) Transect. • Response and recovery efforts should be focused close to the Detonation Site.
	Radiological Monitoring Team 2 takes radiological measurements along the ~0.5 mile (1 km) Transect and finds radiation at background levels. AND Radiological Monitoring Team 1 takes radiological measurements at ~330 ft (100 m) in the direction opposite the direction of contamination from Detonation Site and finds radiation at background levels.	Radiation Control Department/ROSS	*These measurements will support decisions to:* • Release populations that are sheltering in place in areas that are found not to be contaminated. • Focus response and recovery efforts close to the Detonation Site.
How do we confirm the initial assessment of the direction of contamination? **Tactic 8, p. 22**	Radiological Monitoring Team 2 takes radiological measurements along the ~0.5 mile (1 km) Transect and confirms that surface contamination exists.	Radiation Control Department/ROSS	*Elevated measurements can be used to determine that:* • There is contamination ~0.5 mile (1 km) from the Detonation Point – and possibly further away. • Indicates that radiological material was dispersed by the wind. • The highest point of the surface contamination on the ~0.5 mile (1 km) Transect will indicate direction of contamination.

Annex 5: CBRNResponder Integration

CBRNResponder is the national standard and whole community solution for the management of radiological data during an emergency. The CBRNResponder Network is the product of collaboration among the Federal Emergency Management Agency (FEMA), Department of Energy (DOE) / National Nuclear Security Administration (NNSA), NA-84 and the Office of Radiological Security (ORS), the Environmental Protection Agency (EPA), the Defense Threat Reduction Agency (DTRA), and the Department of Homeland Security's Science and Technology Directorate (DHS S&T). CBRNResponder is provided free to all federal, state, local, tribal and territorial organizations, allowing users to uniformly establish a flexible, efficient and networked approach to the management of radiological data.

CBRNResponder can be accessed on smartphones/tablets via the CBRNResponder iOS, Android, Windows applications and via the Web (www.CBRNResponder.net), allowing it to be seamlessly and rapidly deployed at all levels of government during a response to a radiological or nuclear emergency. For more information, contact CBRNResponder at support@CBRNResponder.net.

Using CBRNResponder during the immediate response to a radiological dispersal device (RDD) detonation response will allow first responder agencies to manage and map radiological data collected in the field. This will provide response organizations with a common operating picture of the radiological environment. Integrated throughout this Immediate Response Guidance are tips and action items for first responder agencies to take to effectively use CBRNResponder during the response. In this annex, additional information is included on how to use CBRNResponder to achieve some of the objectives outlined throughout the Tactics.

This annex assumes that first responder agencies in the field have CBRNResponder accounts at the time of the incident and data analysts in the Emergency Operations Center (EOC) are also equipped with CBRNResponder accounts for analysis and decision-making. It also assumes that first responders in the field have telemetry devices, including smart phones, laptops, tablets, etc., with which to enter and share radiological data. A version of this Annex containing the most current screenshots of the system will be maintained in the CBRNResponder document library, accessible via www.CBRNResponder.net. Additional instructional materials are available at youtu.be/c1OIwiQlX7Q.

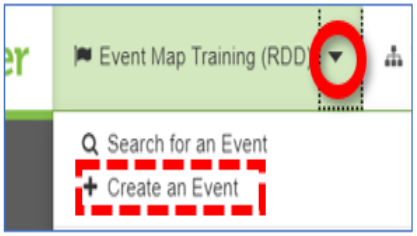
For Tactic 3: Give Report from the Scene

CBRNResponder Action: Create an Event

After an initial report from the scene that the explosion involves radiation, the Incident Command Post or EOC creates an event in CBRNResponder and includes the following points:

- Location of detonation
- Two initial radiation readings and locations of measurements

1. Log in to www.cbrnresponder.net
2. Select "create" from the green Events tile OR "Create an Event" from the event menu drop-down:



3. Complete the required fields marked with an asterisk
4. Click "Save Changes"

At this point, your event has been created and your organization's responders (and any partner organizations' responders) can begin collecting data for the event

For Tactic 5: Notify Partners and Request Assistance

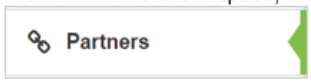
CBRNResponder Action: Share Event with Partners

Share the event in CBRNResponder with agencies who are responding in the field and those who may support the incident through modeling and other analysis so that all agencies supporting the response have a single common operating picture. This will also allow agencies to aggregate and consolidate data from all organizations collecting radiological data in the field.

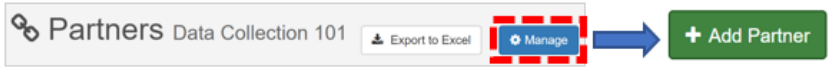
It is recommended that agencies pre-establish CBRNResponder partnerships to better facilitate this process during an actual incident. For information on establishing standing partnerships, view the CBRNResponder Job Aid, located in the Resource Library under the User Manuals and Job Aids folder on the CBRNResponder website (www.CBRNResponder.net).

Pre-established partners will have access to the event and all of its data once it is created. Follow the below instructions to add additional event-specific partners:

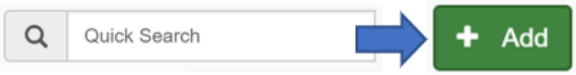
1. From within the event-space, click the "Partners" tab:



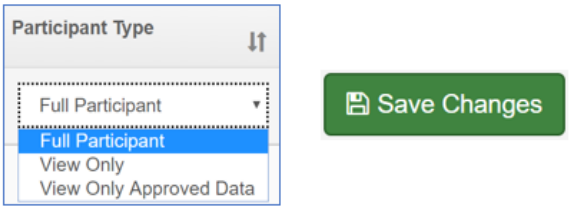
2. Select "Manage" from the Partners page and then "Add Partner":



3. Use the Quick Search field to search for the organization(s) you would like to share data with, then click "Add" next to the organization's name:



4. Click "Continue" and then choose the Participant Type: Full Participant, View Only, or View Only Approved Data. Then, select "Save Changes" at the top:



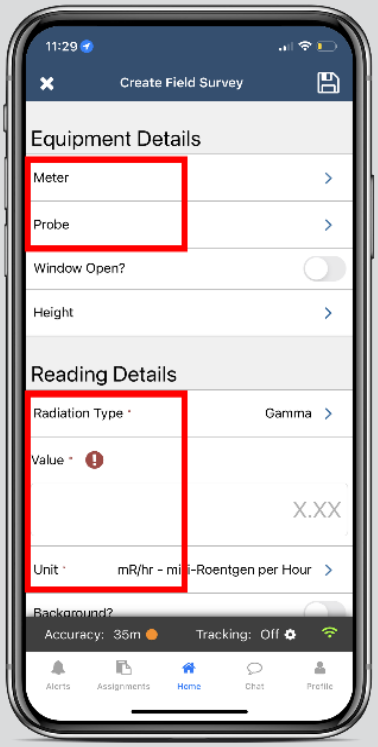
For Tactic 8: Measure and Map Radiation Levels

CBRNResponder Action: Record Radiological Measurements

Radiological survey teams should record all survey measurements in CBRNResponder as they are collected. It is important to record the following information into CBRNResponder, at a minimum:

- Location of survey or observation (this can be done using a smartphone's GPS location, selecting a point on a map, or entering the location manually by address or latitude and longitude)
- Instrument type
- Unit of measurement
- Other required fields marked by a red asterisk

The RadResponder mobile application is now the CBRNResponder mobile application. Ensure you have the CBRNResponder application downloaded as the individual RadResponder mobile application is no longer supported. For one-page job aids on collecting data via the mobile application, visit the Resource Library on the CBRNResponder website: www.CBRNResponder.net.



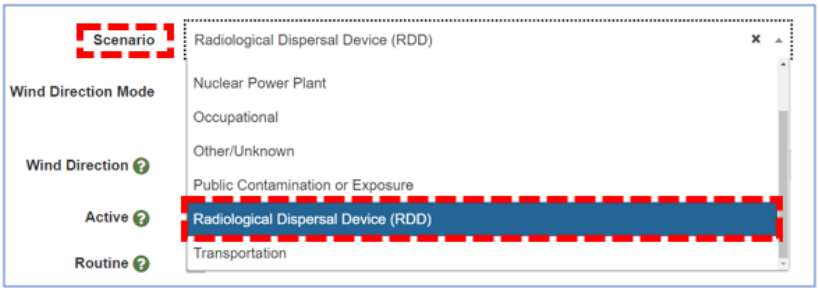
Tactic 8 continued

CBRNResponder Action: Classify Event as an RDD and Use Geo-shapes for Initial Protective Action Boundaries

All events in CBRNResponder have the option to display the 10-Point Monitoring Plan and Transect once the direction of contamination is determined. However, classifying an event in CBRNResponder as a RDD scenario will allow users to add geo-shapes onto the map of the initial Hot Zone and initial Shelter-in-Place Zone. This will allow the EOC to quickly visualize boundaries for protective action areas for public messaging and responder safety.

1. From the Event Details tab, click "Edit" to classify the event as a RDD scenario:

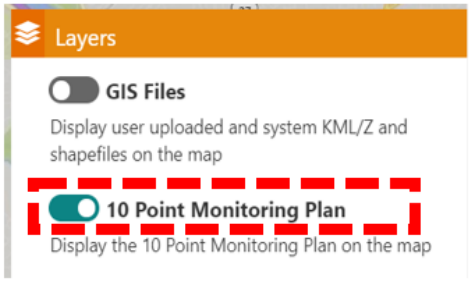
2. Select the "Radiological Dispersal Device (RDD)" Scenario:



3. Choose the Wind Direction Mode and enter the Wind Direction. You can hover over the question mark for an explanation of how Wind Direction is reported in RadResponder:

4. Click "Save Changes"
5. Select "Map" from the left side menu:

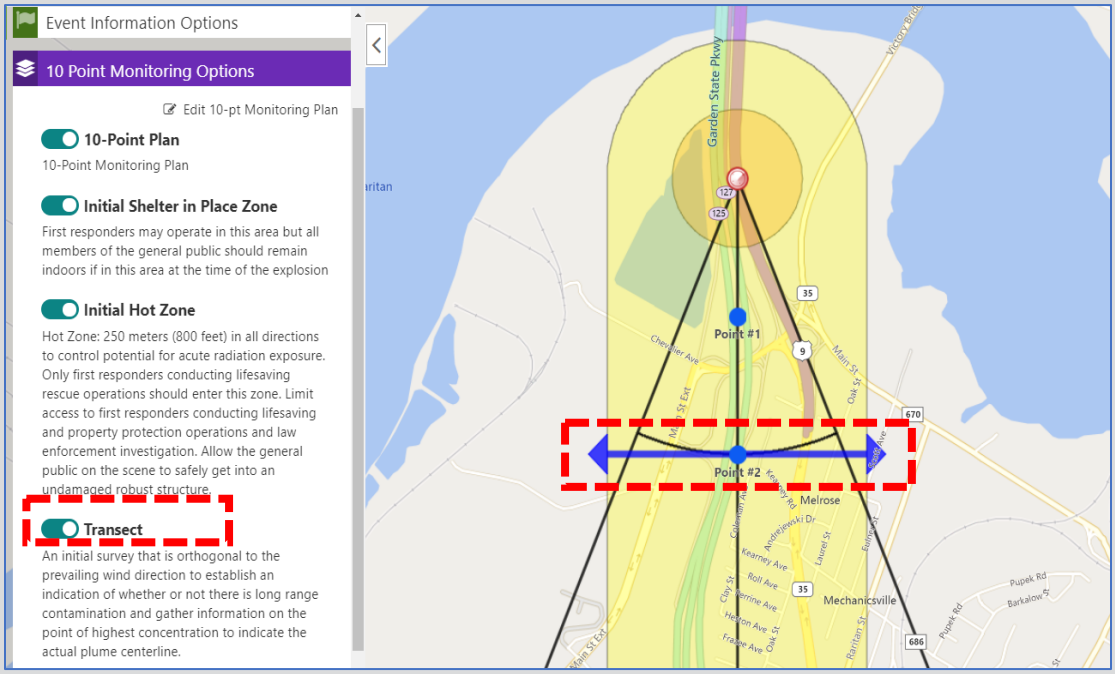
6. In the "Layers" menu, toggle on the "10 Point Monitoring Plan" layer to display the geo-shapes:



Tactic 8 continued

CBRNResponder Action: Adding the ~0.5 mile (1 km) Transect

If the direction of contamination is known and the event is identified as an RDD, a ~0.5 mile (1 km) Transect will display on top of the initial Shelter-in-Place Zone. This allows responders to visually see the Transect and determine starting and end points that require radiological monitoring.

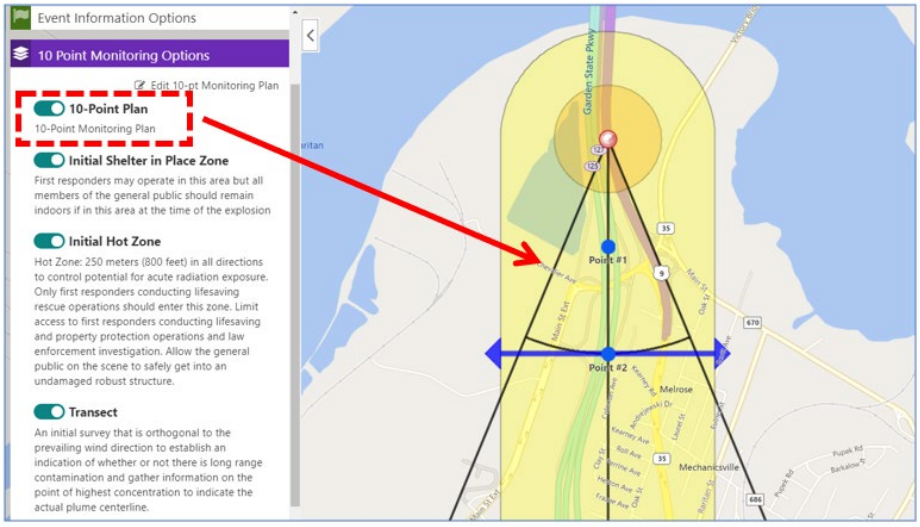


Tactic 8 continued

CBRNResponder Action: Adding the 10-Point Monitoring Plan

All events in CBRNResponder can display the 10-Point Monitoring Plan. This plan allows first responders to visualize the suggested points for monitoring on a map.

1. On the Event Map select the "10 Point Monitoring Options" menu:
2. Toggle on the "10-Point Plan":



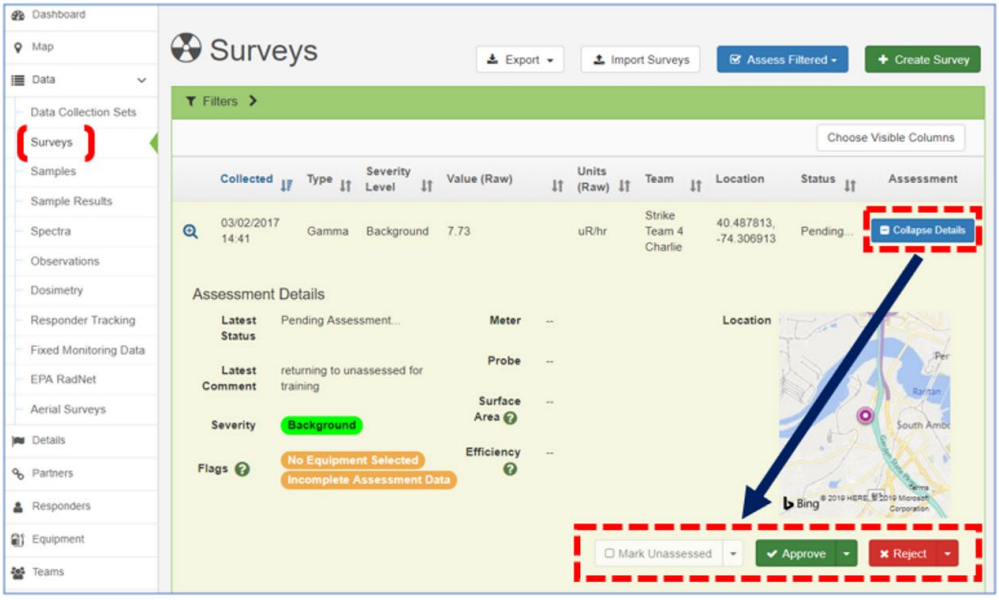
Tactic 8 continued

CBRNResponder Action: Evaluating, Validating, and Analyzing Data

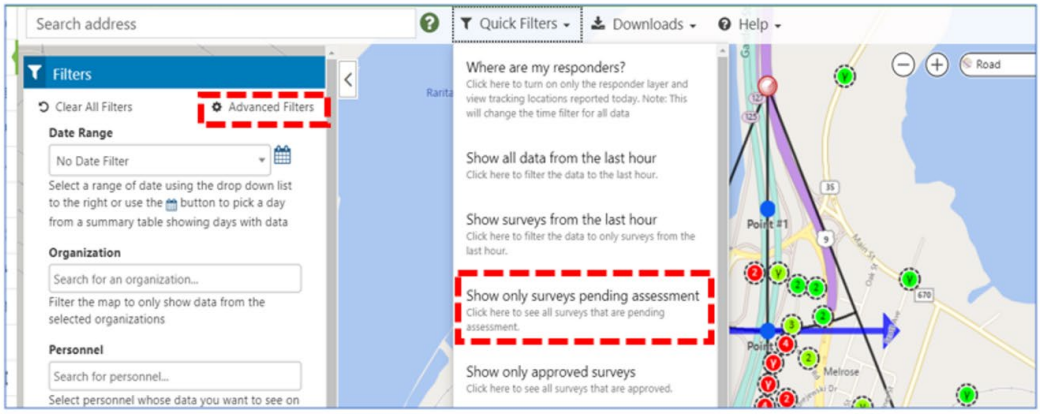
As radiological survey teams at the Detonation Site, in the Near Field, and in the direction of contamination collect radiological data and upload it into CBRNResponder, data assessors and analysts in the Incident Command Post and EOC should evaluate data in CBRNResponder and validate its appropriateness. Analysts may request additional data points in areas where discrepancies exist or where patterns are emerging, for example. Once analysts have enough validated data, they should assess the data in CBRNResponder and make additional recommendations for responder health and safety, evacuations, and protective actions. The DOE's Consequence Management Home Team is available remotely to support analysis of radiological data.

Assess (approve or reject) data from the data tables or via the event map

Data Tables:



Event Map: Data assessors may use the Advanced Filters or Quick Filters to filter to only data that has been approved, rejected, or is pending review:



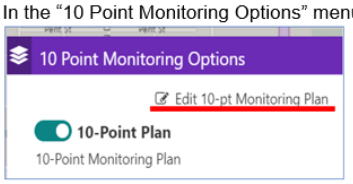
Tactic 8 continued

Optional CBRNResponder Action:

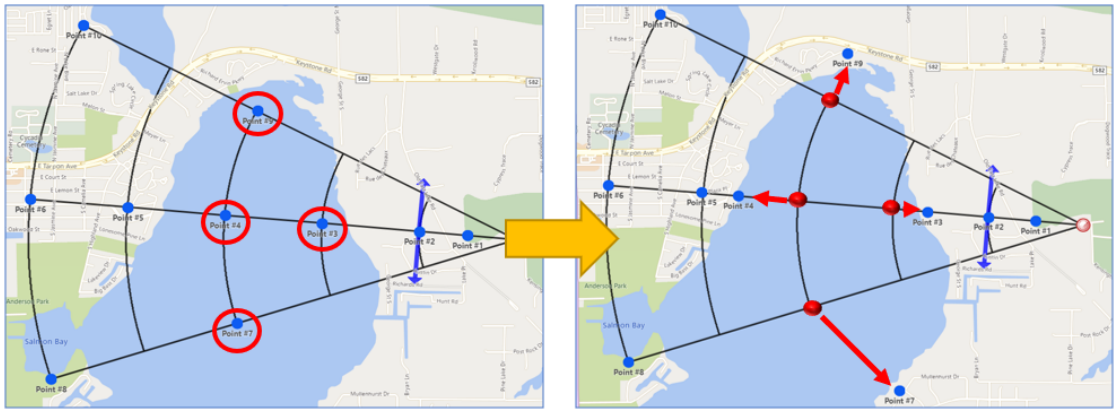
Editing the Individual 10 Points on the 10-Point Monitoring Plan

The 10-Point Monitoring Plan is meant to serve as initial guidance for where to collect and record radiological measurements. For individual points that fall in inaccessible areas such as in a body of water or an intersection, users can move the points to a more accessible location for data collection.

1. In the "10 Point Monitoring Options" menu, click "Edit 10-pt Monitoring Plan":



2. From within the edit page, click and drag the points to their desired location:



3. Once the points have been moved to their desired location, click the save icon at the bottom of the "10 Point Monitoring Options" menu:

Annex 6: Protocol for Conducting 10-Point Monitoring Plan

Objective

The protocol for the 10-Point Monitoring Plan during the early phase is intended to standardize a method for rapidly obtaining initial radiological information after dispersion of radioactive material. A standardized protocol facilitates two principal endpoints when a large aerosol fraction is released by a source and results in material carried by the wind and deposited onto the ground far from the point of release:

- The 10-Point Monitoring Plan provides an early and coherent set of field measurements to help local first responders prioritize subsequent monitoring of affected areas.
- The 10-Point Monitoring Plan provides data that are needed to refine dispersion modeling of deposition and dose projections for early protective action decisions.

Protocol

The initial 10 monitoring points and locations are not in any order of priority and should be collected in an efficient manner as conditions and resources permit (see Figure 11):

- Point 1 is ~1600 ft (500 m) from the point of release.
- Points 2, 3, 4, 5 and 6 are spaced ~0.5 mile (1 km) apart on the assumed centerline of the plume based on the prevailing wind direction.
- Points 7, 8, 9 and 10 are located at ~2 miles (3 km) and ~3 miles (5 km) at ± 22.5 degrees azimuth on either side of the centerline.

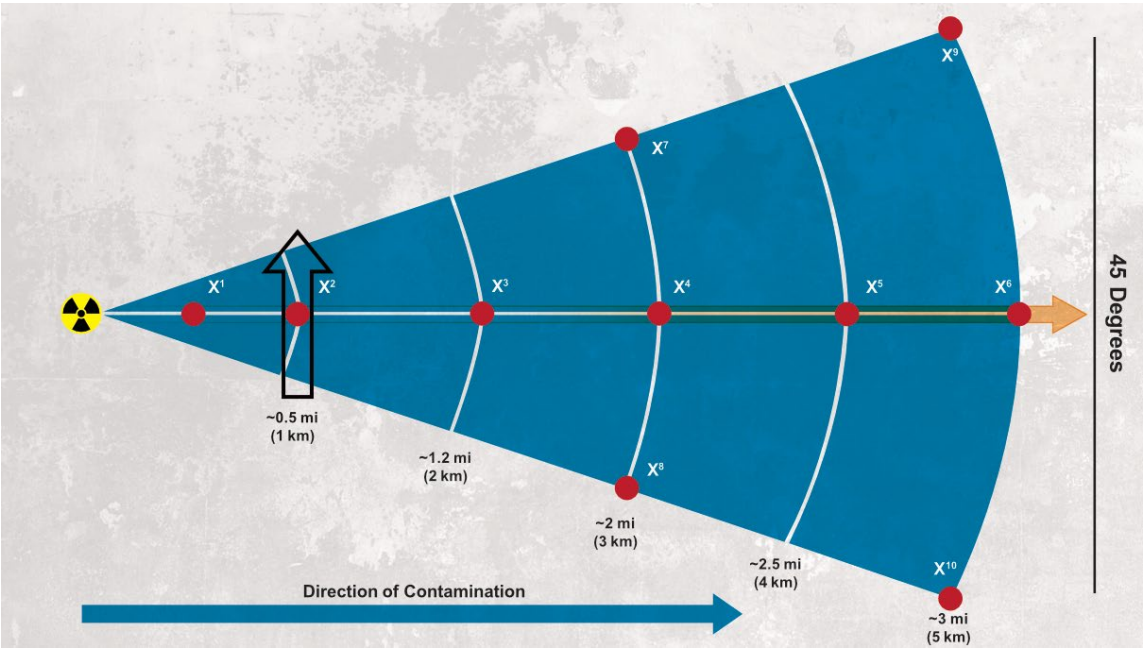


Figure 11 10-Point Monitoring Plan

A grid of monitoring points can be generated using CBRNResponder, which will provide specific locations for each of the 10 points; however, the measurements do not need to be taken at these precise coordinates. The data quality of a measurement taken at a fixed location (such as a fire station two blocks away from the provided coordinate or an accessible point when the provided coordinate is on private property) is of equal quality as taking a measurement on the exact coordinate on the 10-Point Monitoring Plan grid. **The precise reporting of the actual latitude and longitude of the coordinate where the measurement was taken is the vital parameter to log into CBRNResponder.**

These radiological measurements can be collected by a Radiological Monitoring Team or by collecting measurements from fixed locations (such as fire and police stations equipped with radiological detection equipment). Personnel at fixed locations can be requested to take a measurement outside of their building and report the data manually to a command center or through an application, such as CBRNResponder (See Annex 5 for more information on CBRNResponder integration). The measurements should be collected at ground level only and not on the tops of buildings in urban areas. This is important because current National Atmospheric Release Advisory Center (NARAC) operational models (provided to FSLTT agencies through IMAAC) that will incorporate these measurements do not resolve to individual buildings.

When performing these surveys, surface measurements at ~0.25 inch (0.75 cm) with alpha and beta probes should be taken regardless of the knowledge of the radioactive material that was released, unless specifically directed not to make alpha and beta probe measurements.

Centerline Confirmation

Before the 10-Point Monitoring Plan is commenced, gather data on the actual centerline and associated azimuth of the plume, since conducting the 10-Point Monitoring Plan based on an *assumed* prevailing wind direction could result in an unproductive, time consuming, and null survey. Because wind fields are complex in both open terrain and urban canyon settings, the observed wind direction should not be used to determine the direction in which contamination has spread. Instead, a survey team should initially conduct a Transect at approximately ~0.5 mile (1 km) to establish an indication that there is long range contamination and gather information on the point of highest concentration. These data will help visualize the actual plume centerline relative to local micrometeorology, which may be different from meteorology at the location remote from the point of release. The 10-Point Monitoring Plan should be informed by these data and be mounted as a second priority to measurements at the ~0.5 mile (1 km) Transect and the Detonation Site.

Alternatively, if resources permit, two radiological monitoring teams can be formed – one can commence the ~0.5 mile (1 km) Transect and the other begin the 10-Point Monitoring Plan but be prepared to adjust to a revised azimuth based on the Transect. Subsequently, the Transect team can transfer over to help complete the 10-Point Monitoring Plan if contamination is observed at the Transect. If additional radiological monitoring teams exist, a Transect at ~2 miles (3 km) should be considered to gather more information about the plume centerline location. **Record the make/model of instruments and probes and probe efficiencies (if known).**

Potential Outcomes from Survey

There are several potential outcomes from the initial 10-point monitoring survey:

- No contamination was found:
  - Were there only local ballistic fragments around the point of release?
  - Is it possible the material lifted very high, drifted a long distance and was not deposited on the ground within the first ~3 miles (5 km)?
  - Was the assumed direction of contamination inaccurate?
- Contamination was found more toward one side of the assumed centerline:
  - If this is the case, the grid of coordinates should be rotated 45 degrees toward the higher levels of contamination and all of the points (except those initially taken) should be monitored. This should result in seven additional data points and should give sufficient data for refining the plume (see Figure 12).

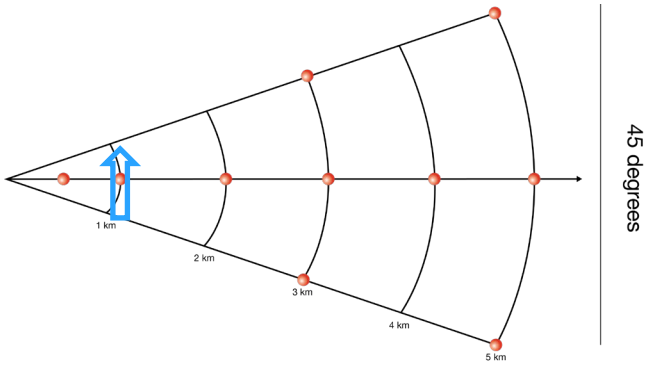


Figure 12 Transect of the Assumed Centerline of the Plume

- Higher contamination levels were found at points more distant than close:
  - Expand the distances used in the template from ~2.5 to ~3.5 miles (4 to 5.5 km) and augment the monitoring by adding four additional points, one on the centerline at ~3.5 miles (5.5 km) and three at about 4–4.5 miles (~6.5 to 7 km) at 22.5, 0, and -22.5 degrees azimuth.

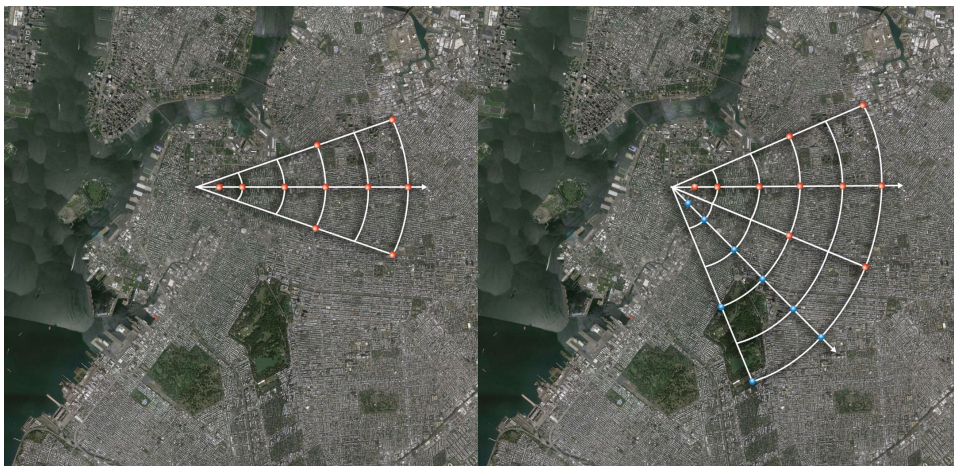


Figure 13 Adjustment to the Results of the First Set of 10 Measurements

Considerations

- During the 10-Point Monitoring Plan, no other sampling activities should be conducted, such as air or soil/vegetation sampling, on-site measurement, etc. These other activities are time consuming and will delay completion of the survey. It is most likely that external exposure rates will dominate the protective action recommendations, and inhalation from resuspension will be a second order pathway. The 10-Point Monitoring Plan should be the highest priority with respect to available personnel and equipment, and other environment measurements should be separately organized.
- Not all first responders will be fully equipped to meet the data quality objectives and may only be equipped to collect external exposure rates. If this is the case, a mixed set of measurements is sufficient where some, but not all, of the 10 points are measured without the surface contamination probes. Based on the measurements taken without the full range of instrumentation, an analyst will make a determination on what constitutes a representative data set with mixed data quality.

Summary of Data Objectives

Upon completion of the 10-Point Monitoring Plan, the following data needs are met:

- Exposure rate (open window) at ~3 ft (1 m) above the ground.
- Alpha contamination at ~0.25 inch (0.75 cm) above the ground (not required for points beyond the ~0.5 mile (1 km) Transect).
- Beta contamination at ~0.5 inch (1.5 cm) above the ground (not required for points beyond the ~0.5 mile ~0.5 mile (1 km) Transect).

Annex 7: Radiological Dispersal Device (RDD) Response Planning Worksheets

This annex uses questions to guide jurisdictions through the planning process for the immediate response to an RDD detonation. Additionally, it may serve as a framework for jurisdictions to plan for facilitated discussions and tabletop exercises. A timeframe for each tactic is included; jurisdictions should replace the "n" with a time that is realistic for the resources, assets and capabilities of the jurisdiction, recognizing that the tactics are non-linear and may be executed concurrently. The questions may prompt jurisdictions to identify roles and responsibilities, help determine existing or new resources needed for this type of response and identify gaps in their radiological preparedness efforts to improve response and recovery operations.

The guiding questions for each Tactic are arranged below so that each Tactic's questions can be printed out on a single sheet of paper.

Tactic 1: Initiate Response & On Scene Recognition

(Timeline: Explosion + "n" minutes)

1) What agencies respond to the report of an explosion? What are the first agencies on scene? _____

2) For the agencies arriving on scene first, what are the first operational assignments of responders? _____

3) When do you expect this activity to occur/when in the response timeline will this occur? _____

4) Are the first assets on scene equipped (personnel or vehicles) with radiological detection equipment? YES or NO

YES

a) What type of instrument(s) are responding agencies equipped with?

_____

b) What is the protocol for using this equipment at the scene of explosion?

_____

c) When is radiation detection equipment turned on by responding agencies?

_____

d) Are there protocols for ensuring equipment responds properly to background radiation and to a source of known strength?

_____

NO

a) What agency would the first responders on scene call to take a radiological reading? _____

b) What is the protocol for requesting this team to the scene of an explosion?

_____

c) How soon can an agency with radiological detection equipment arrive on scene? _____

d) What type of radiological detection equipment would the requested agency arrive with? _____

Tactic 2: Confirm the Presence of Radiation

(Timeline: Explosion + n minutes)

Assumption: Agency/initial response units are on scene with radiological detection equipment.

1) When a responder receives a radiological alarm at the scene of the explosion, who do they report it to? _____
2) Once a radiological alarm is reported, does a specific agency confirm that there has been a release or do agencies work together to take readings to confirm the release?

   _____
3) Where, in relation to the explosion, will the first radiological confirmation reading be taken? _____
4) Is there a jurisdictional- or agency-determined threshold for a radiation measurement above background that would trigger the agency to determine the incident involved radiological material? _____
5) How would this agency confirm that the radiological measurement taken was indeed from an RDD and not from another source (such as a malfunctioning piece of equipment or a medical patient)? _____
6) Would the first agency to take a radiological measurement request a second radiological reading from another agency or another unit within their agency?

   _____
7) Would the first agency ask that this measurement be taken with a different type of radiological detection equipment? _____
8) Where would a second confirmation reading be taken, in relation to the first reading and the explosion itself? _____
9) If different agencies or personnel gather readings at the same time, who coordinates or leads the collection of all readings? _____
10) When do you expect this activity to occur/when in the response timeline will this occur? _____

Tactic 3: Report from the Scene

(Timeline: Explosion + n minutes)

Assumption: The presence of radiation is confirmed by at least two readings in the field.

1) Now that there are two readings with elevated radiation levels, what do the initial responding units on scene do?
    a) Who do they notify? _____
    b) How do they make this notification? _____
    c) Is there a radio call/code that they will use? _____
    d) Do responders from different agencies use the same radio frequency and same radio call/code? _____
    e) Who notifies emergency management (or the agency that is responsible for public messaging)? _____
    f) How are the measurements documented? _____
2) What agency can officially activate this RDD plan/protocol? Are they on-scene or do they need to be notified? _____
3) What additional units/agencies have arrived on scene? _____
    _____
4) Were the arriving units/agencies and those still en route notified that radiation was present on scene? If yes, how were they notified? _____
    _____
5) Will any on-scene agencies be collecting the following data? YES or NO
    If yes, how will they be collecting it, what units of measurement will be used, and who will they give it to?
    a) Radiation readings with specific locations _____
    b) Extent of damage to surrounding buildings, including broken windows
    _____
    c) Fires and other hazards resulting from the explosion
    _____
6) What agency and from where (in the field vs the EOC) is an initial incident data map created to support the collection, mapping and sharing of radiological data?

a) What software (CBRNResponder, GIS, etc.) will they use to create the initial incident data map? _____

b) Who within the jurisdiction can validate the accuracy of the radiological data? _____

c) Who are the "analysts" reviewing this data to make recommendations and decisions in the field and at the EOC? _____

d) Which agencies and partners is the data being shared with?

_____

7) When do you expect this activity to occur/when in the response timeline will this occur? _____

Tactic 4: Issue Protective Action to the Public

(Timeline: Explosion + n minutes)

Assumption: RDD Response Plan/Protocol has been activated. Agencies arriving on scene know that radiation is present at the scene.

1) How is Public Message #1/1a released?
    a) What agency/agencies will release Message #1/1a? _____
    b) In what form will they issue this message? _____
    c) At what time in the response can you anticipate disseminating this message to the public? _____
    d) Can anything be done in advance to reduce your time estimate for when this message can be released to the public? _____
    e) What information do you require to disseminate this message?

    _____
    f) Who provides this essential information? _____
    g) When do you expect this activity to occur/when in the response timeline will this occur? _____

Tactic 5: Notify Partners and Request Assistance

(Timeline: Explosion + n minutes)

Assumption: Local agencies that do not have enough technical or operational capabilities to fully assess and manage the mid-to-long term environmental impacts of an RDD should immediately request state and federal assets. Some support assets will respond on their own authority. Some assets can support immediately because they do not require deploying to the scene.

1) What capabilities (or state or federal teams) would your jurisdiction request immediately? _____
2) What agency would make the official request for assistance and to whom would they make it? _____
3) In addition to teams and equipment to support the radiological assessment of the response, what else would your jurisdiction request to support response operations?

   _____

   a) Would they make this request immediately or wait until the response has progressed further? _____
4) Agencies will likely have a liaison that will report to the EOC; where will state/federal field assets report to? _____
5) What agency is responsible for writing pre-scripted requests for state and federal RDD support assets? _____
6) What, if any, pre-scripted mission assignments with the state do you have?

   _____
7) When do you expect this activity to occur/when in the response timeline will this occur? _____

Tactic 6: Initiate Lifesaving Rescue Operations

(Timeline: Explosion + n minutes)

Assumptions: Responders are on the scene of the explosion and initiate lifesaving rescue operations.

1) What, if any, existing protocols will first responders follow on scene of a hazmat incident? _____

2) Who will direct first responders that it is acceptable to initiate lifesaving rescue operations in the Hot Zone even with the presence of radiation? _____

_____

3) Will this be a uniform direction/order for law enforcement, fire and emergency medical services (EMS), or will initial actions on scene be determined by each specific agency? _____

4) What personal protective equipment (PPE) will first responders be wearing?
    a) Is this the same across law enforcement, fire and EMS?

    _____

5) What, if any, protocols are responders following for dosimetry? _____

_____

6) Where will fire, law enforcement, EMS and other agencies on scene stage their equipment/trucks? _____

7) How is Public Message #2 released?
    a) What agency/agencies will release Message #2? _____
    b) In what form will they issue this message? _____
    c) At what time in the response can you anticipate disseminating this message to the public? _____
    d) Can anything be done in advance to reduce your time estimate for when this message can be released to the public? _____
    e) What information do you require to disseminate this message?

    _____

    f) Who provides this essential information? _____

8) When do you expect this activity to occur/when in the response timeline will this occur? _____

Tactic 7: Secure and Manage the Scene

(Timeline: Explosion + n minutes)

Assumptions: Responders are conducting lifesaving rescue operations. An initial Hot Zone and Shelter-in-Place Zone are defined. Law enforcement is on the scene and is establishing the crime scene, blocking intersections, directing traffic and providing crowd control. First responders are also securing other necessary critical infrastructure and key resources.

1) What agency has primary responsibility for perimeter security? _____

_____

2) What agency has primary responsibility for crime scene management?

_____

3) What agency will determine the enforced boundaries using practical/natural perimeters, such as streets, rivers, etc., of the Hot Zone and Shelter-in-Place Zone?

_____

4) Approximately how many personnel would be required to complete full perimeter security? _____

5) Aside from street closures, what other steps would law enforcement take to secure the scene?_____

6) What other infrastructure within the Hot Zone and Shelter-in-Place Zone would law enforcement aim to secure? _____

7) Will any of the first responders securing the perimeter be equipped with radiation detection instruments? _____

8) What, if any, protocols are responders following for dosimetry? _____

_____

9) What additional agencies (local, state, federal) will be involved in crime scene management operations? _____

10) What type of evidence will be collected initially? _____

_____

11) For responders conducting crime scene management in the Hot Zone, what type of PPE will be required? _____

_____

12) Are any procedures in place for handling potentially contaminated evidence?

_____

13) How will on-scene agencies ensure that lifesaving rescue operations can continue during this mission? _____

14) When do you expect this activity to occur/when in the response timeline will this occur? _____

Tactic 8: Measure and Map Radiation Levels

(Timeline: Explosion + n minutes)

Assumptions: Initial Hot Zone and Shelter-in-Place Zone are set, and the public is sheltering in place. Responders are on the scene conducting lifesaving rescue operations. Additional responders are on the scene with radiation detection equipment and will begin taking measurements. Readings taken by individual responders and from fixed locations are being consolidated and mapped to understand the extent of the contamination, begin evacuations and keep the public informed.

1) What additional agencies have arrived on scene? _____

   _____

2) What, if any, agency/agencies have the equipment/training to conduct radiological surveys? _____

3) What type of equipment, if any, do they have to conduct this type of survey?

   _____

4) How many radiological monitoring teams can the agencies pull together?

   _____

5) How many responders are on each Radiological Monitoring Team?

   _____

6) How will responders record measurements? _____

   _____

7) How will responders share measurements with the command element and the EOC?

   _____

8) Does the jurisdiction have a priority order for where measurements are taken?

   _____

9) How will the measurements taken in the field be integrated into the jurisdiction's incident data map? _____

   a. What agency is responsible for ensuring the incident data map is updated?

      _____

   b. If fixed sites (like fire houses or police stations) will be used to take measurements, how will those measurements be reported to the command element and the EOC? _____

c. Can the agency collecting radiological readings from the field add to the incident data map and/or collect data from multiple agencies or are they able to collect data from only their own responders?

_____

d. What is the realistic timeframe for producing an updated incident data map with field data? _____

10) With what other agencies will the agency consolidating and mapping the data distribute the mapping products to when complete? _____

_____

11) When do you expect this activity to occur/when in the response timeline will this occur? _____

Tactic 9: Commence Evacuations

(Timeline: Explosion + n minutes)

Assumptions: Responders have collected radiological data from the field and the data has been consolidated and mapped, offering a visual of the extent of contamination to the jurisdiction.

1) What agency(s) are responsible for defining evacuation routes from the Hot Zone and the Shelter-in-Place Zone to outside areas? _____

   _____

2) How will agencies determine and enforce the limited number of exit points?

   _____

3) What agencies will be on the scene to assist with population monitoring?

   _____

4) Will agencies try to decontaminate people as they leave the Hot Zone?

   _____

5) How will agencies notify those populations that can be evacuated? _____

   _____

6) What protocols are in place to support mass self-evacuations? _____

   _____

7) What additional resources will be needed to support evacuations from the Hot Zone and Shelter-in-Place Zone? _____

8) What agency will arrange the press conference for release of Public Message #3?
   a) What agency/agencies will participate? _____
   b) In what form will they issue this message? _____
   c) At what time in the response do you anticipate disseminating this message to the public? _____
   d) Can anything be done in advance to reduce your time estimate for when this message can be released to the public? _____
   e) What information do you require to disseminate this message?

      _____
   f) Who provides this essential information? _____

9) When do you expect this activity to occur/when in the response timeline will this occur? _____

Tactic 10: Monitor and Decontaminate

(Timeline: Explosion + n minutes)

Assumptions: Responders on the scene know the extent of the contamination and the public has started to evacuate out of the Hot Zone. Unaffected areas in the Shelter-in-Place Zone are also evacuating. Some evacuating populations will require decontamination; many more populations will believe *they require decontamination but likely will not.*

1) Does the jurisdiction have a Community Reception Center (CRC) plan or any plan/protocol (for example, one that includes staffing, contamination monitoring equipment and other resources) for population monitoring and decontamination?

   _____

2) What agencies have a role in picking a location for a CRC and setting it up?

   _____

3) What is the realistic timeline for establishing the initial CRC? _____

   _____

4) What other population monitoring activities does the jurisdiction plan to conduct?

   _____

5) What agencies will monitor exit points from the Hot Zone to determine if any evacuating persons require medical treatment (based on visual contamination on head and upper body)? _____

   a) Will agencies decontaminate people leaving the Hot Zone? YES or NO

6) What agencies will transport evacuating persons that require medical care to hospitals? _____

7) How will evacuating populations be notified of CRC locations? _____

   _____

8) When do you expect this activity to occur/when in the response timeline will this occur? _____

Annex 8: Frequently Asked Questions

Much of the information in this document is likely to be new to readers, including many who have received some training but lack extensive experience working with or around radiation and radioactivity. Some questions arose repeatedly during the process of writing and reviewing this document; those that were asked most frequently are addressed in this section.

1. Why is conducting isotope identification not an immediate priority?

This guidance does not prioritize conducting isotope identification for a couple of reasons. First, the type of radioactive material that is present will have little to no impact on the initial lifesaving response to an explosion, such as search and rescue, triage and treatment, and fire suppression. Similarly, knowing the radioisotope will have minimal impact on how the Missions and Tactics described in this guidance are executed during the first minutes and hours after a detonation.

The second reason is more technical: the radioisotope identifiers (RIIDs) and other spectrometers most commonly possessed by first responders use a sodium iodide-based detector. In radiation fields on the order of 1 mR/hr (0.01 mGy/hr) and higher, the high count rate may cause the identification algorithm used by the equipment to produce erroneous results. This issue – and the time taken to get the measurement – could then result in unnecessary confusion and delay to the response.

What is important, however, is that responders rapidly identify and confirm the presence of radiation, which will enable them to initiate the Tactics described in this guidance and acknowledge the complications that radiation will pose to their emergency response. After confirming the presence of radiation, it will also be important for responders to determine if alpha radiation is present. While identifying the radioisotope would identify if it emits alpha radiation, it is easier, quicker, and more reliable to survey for alpha radiation directly. See Question #5 for information on surveying for alpha radiation.

2. When initial units arrive at the Detonation Site, should the current wind direction guide the response?

The wind direction, noted by first responders when they arrive on scene or estimated through other means such as a National Weather Service weather station, is not a reliable method to assess direction of contamination spread. Relying on this data to estimate plume movement could be misleading for reasons that include:

- The wind direction at the time of detonation may differ from the observed wind direction when responders arrive on the scene;
- Other sources of meteorology data may come from weather stations far away from the incident;
- And complex urban wind fields affect dispersion patterns.

For these reasons, Tactic 8: Measure and Map Radiation Levels is specifically designed to determine the direction of contamination using field measurements rather than assumptions about the wind direction.

It is also important to note that establishing the Incident Command Post in an upwind direction is still a valid standard practice, though it is different from and independent of the guidance to use field measurements to determine the direction and locations of contamination.

3. Why does the recommendation for PPE change after the first 15 minutes of a response?

Because the initial plume will pass beyond the Hot Zone in 10–15 minutes, most first responders will not be exposed to high airborne concentrations of particulates; they will arrive after it has passed, or they will first encounter the plume at a great enough distance at which radioactivity concentrations have become diluted. Therefore, the remaining levels of airborne radioactivity (along with any additional contribution from resuspension) will be relatively low and a half-face respirator and goggles or full-face respirator are sufficient.

4. Can the **Emergency Response Guidebook** (ERG) be used in lieu of this Immediate Response Guidance?

The ERG was developed by the Department of Transportation to help with response to transportation emergencies involving hazardous materials. By definition, an RDD is a weapon of mass destruction.[18] The ERG, however, does not take the dispersal mechanisms of an act of terrorism into account. In addition, because the ERG is aimed primarily at response to transportation accidents, it assumes that information will be available that will help to assess the radiological materials present. For example, the hazard placarding and UN Number on the shipment reflects both the quantity of the radioactive material in the shipment and the robustness of the packaging of the radioactive material. Both these parameters will be unknown at the scene of an RDD detonation.

Even in a transportation accident with any form of hazardous material, the ERG is merely a starting point for Incident Command. In many cases it alone is not sufficient and would prompt the use of other reference material and guidance to manage the scene, protection of personnel, and protective actions for the public. In a similar manner, once you confirm radiation is present on the scene of an explosion, assume it's an RDD and activate your RDD plan.

5. Why is it important to make surface measurements for alpha radiation?

With the exception of uranium, isotopes such as Americium-241 (Am-241) and all isotopes of plutonium are primarily toxic when inhaled due to the alpha radiation they emit. Some of these alpha-emitting radionuclides (e.g., Am-241) will have an associated gamma signature, but it will grossly underestimate the hazard of airborne radioactivity from resuspension of contamination on the ground. Thus, if protective actions are based on the external gamma exposure rates, they likely will not be representative of the actual hazard boundaries and exposure pathways. Conversely if beta and alpha surface measurements are promptly performed and the presence of alpha radiation is ruled out, the hazard assessment based on exposure rates at ~3 feet (1 m) above the ground will be the correct approach.

[18] According to the Department of Homeland Security (www.dhs.gov/topics/weapons-mass-destruction), "A weapon of mass destruction is a nuclear, radiological, chemical, biological, or other device that is intended to harm a large number of people."

6. Why define the Hot Zone at 10 mR/hr (0.1 mGy/hr) and not 2 mR/hr (0.02 mGy/hr)?

Although an exposure rate of 2 mR/hr (0.02 mGy/hr) is often used as a de facto boundary or decision point, it is an exposure rate that has a negligible impact on responder health and safety in the context of consequence management. It stems from a Nuclear Regulatory Commission value to be used by radioactive materials licensees, for allowable radiation exposure in public areas during routine operations. It is not intended to apply during emergency operations or to first responders.

For life safety and property protection, applying an exposure rate decision point of 2 mR/hr (0.02 mGy/hr) to first responders is overly conservative and may delay performing search and rescue, providing first aid to injured victims, transporting victims to the hospital, and may lead to an avoidable loss of life.

The zoned approach (e.g., Hot Zone, Dangerous Radiation Zone) presented in this guidance is based on the NCRP definitions for the Hot and Dangerous Radiation Zones, which are intended as boundaries to help facilitate the management of responder dose. Personnel crossing the boundary into the Hot Zone should only do so if they have appropriate PPE, appropriate radiation instrumentation, and radiation safety training; or if there is an immediate need to save a life.

The area outside the Hot Zone will contain non-radiological risks associated with ongoing response activities, security considerations, and so forth. For reasons of general safety, the Incident Commander might choose to exclude members of the public from areas in which radiation exposure rates exceed 2 mR/hr (0.02 mGy/hr).

Thus, while members of the public might be excluded from areas in which exposure rates exceed 2 mR/hr (0.02 mGy/hr) unless they are already in a safe location (e.g., sheltering inside their homes), this is an area in which first responders can work freely, without the need for radiological precautions except those to reduce skin contamination and other appropriate PPE.

In areas at exposure rates higher than 10 mR/hr (0.1 mGy/ hr) – which should be marked by the Hot Zone boundary – first responders are required to have proper PPE, appropriate radiation instruments, and appropriate training in order to enter and work.

7. What makes a good RDD response checklist and what resources are available?

Responding to an RDD detonation is complex and there are many aspects with which first responders are likely to be unfamiliar. A checklist may help to ensure that actions are taken in a certain sequence and that important points are not forgotten or skipped.

Effective checklists are typically concise, easy to use, focus on critical steps, and contain between five to nine items. Since each agency or jurisdiction may have their own checklist and SOP format, this guidance does not provide a comprehensive checklist. Rather, the key components of a useful checklist are provided below. Consider developing a brief checklist for each expected action, such as:

- Initial response and assessment (e.g., identify hazards, life safety)

- Establishing incident command (e.g., command post, structure, staging areas)
- Responder health and safety (e.g., PPE, ALARA, dosimetry)
- Radiological assessment (e.g., contamination, isotope identification)
- Boundaries and zones (e.g., perimeters, decontamination area)

Resources

ASTM E2601 includes example checklists in Appendix X5, as well as example SOPs in Appendix X8.

Gawande, Atul. *The Checklist Manifesto*. Picador Books, 2011.

Annex 9: Key References

This Immediate Response Guidance is focused on the early phase response by local first responders and is based on research and experiments published in the following references:

Harper, FT, Musolino, SV, and Wente, WB. Realistic radiological dispersal device hazard boundaries and ramifications for early consequence management decisions, Health Phys. 93:1–16, 2007

Musolino, SV, Harper, FT. Emergency response guidance for the first 48 hours after the outdoor detonation of an explosive radiological dispersal device, Health Phys. 90:377–385, 2006

Musolino, SV, Harper, FT, Buddemeier, B, Brown, M, Schlueck, R. Updated Emergency Response Guidance For The First 48 Hours After The Outdoor Detonation Of An Explosive Radiological Dispersal Device, Health Phys. 105:65–73, 2013

Additional resources are available to support planning for the response and recovery from an RDD. The references provided below are a sample of some of the resources that are available for planners. Some of the resources referenced here require subscription or fees for full access.

General References

American College of Radiology. 2006. *Disaster Preparedness for Radiology Professionals: Response to Radiological Terrorism v 3.0*.

American National Standards Institute (ANSI). 2000. *Radiation Safety Training for Workers*.

ASTM International. 2023. *Standard Practice for Radiological and Nuclear Emergency Response*.

Federal Emergency Management Agency, Office of Response and Recovery, Planning and Exercise Division, National Planning Branch. 2023. *Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plan*. www.fema.gov/sites/default/files/documents/fema_incident-annex_nuclear-radiological.pdf

Federal Emergency Management Agency. 2019. *National Response Framework: Fourth Edition*. www.fema.gov/sites/default/files/2020-04/NRF_FINALApproved_2011028.pdf.

Federal Emergency Management Agency. Guidance on shelter in place, https://www.fema.gov/sites/default/files/documents/fema_shelter-in-place_guidance-nuclear.pdf.

International Atomic Energy Agency. 2006. *Manual for First Responders to a Radiological Emergency*. www-pub.iaea.org/MTCD/publications/PDF/epr_Firstresponder_web.pdf.

Janssen, LL, Nelson, TJ, Cuta, KT. Workplace Protection Factors for an N95 Filtering Facepiece Respirator, Journal of Occupational and Environmental Hygiene, 4:698–707, 2007.

National Council on Radiation Protection and Measurements (NCRP). 2005. *Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism*. Commentary No.19.

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National Council on Radiation Protection and Measurements (NCRP). 2010. *Responding to Radiological and Nuclear Terrorism: A Guide for Decision Makers*. Report No. 165.

National Council on Radiation Protection and Measurements (NCRP). 2017. *Guidance for Emergency Response Dosimetry*. Report No. 179.

National Council on Radiation Protection and Measurements (NCRP). 2019. Implementation Guidance for Emergency Response Dosimetry. Commentary No. 28.

National Council on Radiation Protection and Measurements (NCRP). 2022. *Instrument Response Verification and Calibration for Use in Radiation Emergencies*. Statement No. 14.

US Department of Energy. 2009. *Preliminary Report on Operational Guidelines Developed for Use in Emergency Preparedness and Response to a Radiological Dispersal Device Incident*. DOE/HS-0001 ANL/EVS/09-1 Interim Final.

US Department of Homeland Security. 2024. *Nuclear Detonation Preparedness: Communicating in the Immediate Aftermath*. https://www.fema.gov/sites/default/files/documents/fema_nuclear-detonation-preparedness_communicating-in-the-immediate-aftermath_v3_2024.pdf.

US Department of Justice. 2000. *A Guide for Explosion and Bombing Scene Investigation*. http://www.ojp.usdoj.gov/nij/pubs-sum/181869.htm

US Environmental Protection Agency. PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents. Washington, DC: U.S. EPA; EPA-400-R-17-001; 2017.

US Department of Transportation, Pipeline and Hazardous Materials Safety Administration. 2024. *Emergency Response Guidebook*. https://www.phmsa.dot.gov/training/hazmat/erg/emergency-response-guidebook-erg.

Contamination Control

New York City Department of Health and Mental Hygiene. 2014. *Field Guide for Health and Safety Officers: Radiological Incidents*. Page 35 and 36. https://remm.hhs.gov/fieldguide.htm.

US Department of Defense. Office of the Assistant Secretary of Defense for Nuclear, Chemical, Biological, Defense Programs/Nuclear Matters. *DoD – 3150.M Nuclear Weapon Accident Response Procedures (NARP) Internet Supplement, Functional Areas: Chapter 12 Contamination Control.* https://www.acq.osd.mil/ncbdp/narp/docs/pdf_Functional_Areas/Contamination%20Control_Rev1_bm122211.pdf.

US Department of Homeland Security. 2023. *Optimizing Radioactive Contamination Screening at Community Reception Centers*. https://www.dhs.gov/science-and-technology/publication/optimizing-radioactive-contamination-screening.

Hospitals and Patient Decontamination

Centers for Disease Control and Prevention, Emergency Preparedness and Response. *Radiological and Nuclear Terrorism: Medical Response to Mass Casualties.* https://www.orau.gov/hsc/RadMassCasualties/.

Centers for Disease Control and Prevention. *Radiological Emergencies: Emergency Management Pocket Guide For Clinicians*. https://www.cdc.gov/radiation-emergencies/media/pdfs/clinicianpocketguide.pdf.

Centers for Disease Control and Prevention. *Radiological Terrorism: Just in Time Training for Hospital Clinicians*. 2013. https://archive.org/details/gov.hhs.cdc.radiological

Radiation Emergency Assistance Center/Training Site. Hospital Medical Management. https://orise.orau.gov/reacts/resources/guide/hospital-medical-management.html.

Radiation Emergency Medical Management. *Procedures for Radiation Decontamination*. 2023. https://remm.hhs.gov/ext_contamination.htm.

U.S. Department of Energy Office of Environmental Management. *Pre-hospital Practices [for] Handling a Radiologically Contaminated Patient*. 2014. https://www.youtube.com/watch?v=QgVy3t-rl3w.

Data Analysis

Pacific Northwest National Laboratory. *Radiological Data Assessment Guidance for Emergency Response*. December 2022. https://www.cbrnresponder.net/#resources/documents/36.

Pacific Northwest National Laboratory. *Recommendations for Radiological Data Assessment Implementation*. 2022. https://www.osti.gov/biblio/1871837.

Public Health and Emergency Medical Services

Gusev IA, Guskova AK, and Metter FA (eds). 2001. *Medical Management of Radiation Accidents, 2nd ed*. CRC Press.

Karam PA. *Radiological Incidents and Emergencies* (ch. 34). 2018. In Veenema TG (ed). *Disaster Nursing and Emergency Preparedness: For Chemical, Biological, and Radiological Terrorism and other Hazards 4th ed.* Springer.

Ricks RC, Berger ME, and O'Hara FM (eds). 2002. *The Medical Basis for Radiation-Accident Preparedness: The Clinical Care of Victims*. Parthenon Publishing.

US Department of Energy, Oak Ridge Institute for Science and Education. 2017. *Radiation Emergency Assistance Center/Training Site – Medical Aspects of a Radiation Incident, 4th Edition*. https://orise.orau.gov/reacts/resources/documents/medical-aspects-of-radiation-incidents.pdf

US Department of Health and Human Services. Centers for Disease Control and Prevention. 2014. *Population Monitoring in Radiological Emergencies: A Guide for State and Local Public Health Planners.* https://www.cdc.gov/radiation-emergencies/media/pdfs/2024/04/population-monitoring-guide.pdf

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US Department of Homeland Security. 2016. *IND Quick Reference Guide for Planners, Safety Officers, and Supervisors for Protecting Responders.* https://www.dhs.gov/sites/default/files/publications/Quick%20Reference%20Guide%20Final.pdf

US Department of Homeland Security. 2019. *Planning Considerations: Evacuation and Shelter-in-Place: Guidance for State, Local, Tribal, and Territorial Partners.* https://www.fema.gov/sites/default/files/2020-07/planning-considerations-evacuation-and-shelter-in-place.pdf

US Department of Homeland Security. Shelter-in-Place Pictogram Guidance, p.6. https://www.fema.gov/sites/default/files/documents/fema_shelter-in-place_guidance.pdf

Radiation Safety and Radiological Response Training

Training development: resources planners can use to develop training.

- ANSI Standard N42.37, *American National Standard for Training Requirements for Homeland Security Purposes Using Radiation Detection Instrumentation for Interdiction and Prevention* (2006) https://ieeexplore.ieee.org/document/7819435
- ANSI Standard N13.36, *Ionizing Radiation Safety Training for Workers*
- Fire Brigades, Training and education. 29 CFR 1910.156 (c) https://www.ecfr.gov/current/title-29/part-1910/section-1910.156#p-1910.156(c)
- Hazardous Materials Technician 29 CFR 1910.120(q)(6)(iii) https://www.ecfr.gov/current/title-29/part-1910/section-1910.120#p-1910.120(q)(6)(iii)
- Hazardous Materials Specialist; (29 CFR 1910.120(q)(6)(iv)) https://www.ecfr.gov/current/title-29/part-1910/section-1910.120#p-1910.120(q)(6)(iv)

Training delivery: organizations that deliver trainings to first responders.

- Radiation Emergency Assistance Center/Training Site https://orise.orau.gov/reacts/index.html
- Federal Emergency Management Agency https://training.fema.gov/
- Center for Domestic Preparedness (CDP), Federal Emergency Management Agency https://cdp.dhs.gov
- Counterterrorism Operational Support, Center for Radiological Nuclear Training https://www.ctosnnsa.org, including:
  - AWR-140-W, Introduction to Radiological/Nuclear WMD Operations
  - AWR-400-W. Radiological Dispersal Device (RDD) Response Guidance: Planning for the First 100 Minutes
  - MGT-469 Radiological Dispersal Device (RDD) Response Guidance Train the Planner
  - PER-300-W, Primary Screener/Personal Radiation Detector (PRD) Refresher
  - PER-307-W, Introduction to Nuclear Detonation Effects and Response Strategies
  - PER-354, Response to Radiological/Nuclear Weapons of Mass Destruction (WMD) Incidents

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