Radiological Dispersal Device (RDD) Response Guidance

Planning for the First 100 Minutes

November 2017

Homeland Security
Science and Technology

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National Urban Security Technology Laboratory

Radiological Dispersal Device (RDD) Response Guidance: Planning for the First 100 Minutes

November 2017

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Publication Notice

Why Guidance for the First 100 Minutes?

This document uses a notional 100 minute timeframe to provide technical recommendations on field operations, public messaging, and response coordination. We chose 100 minutes as the guidance framework knowing that it was optimistic, but hoping that it would set a high bar for local responders and planners. Use the 100 minute timeframe presented here as a starting point, and adjust the timeframe as needed during your planning discussions. Here are two critical assumptions made by placing this guidance on a timeline:

- In the first hours of a radiological dispersal device (RDD) detonation response, it is unlikely that federal and state support is on scene. This means that local jurisdictions and agencies must rely on their own assets, technical equipment, and training.
- 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 achieved and *when* it must be completed to have the desired impact. A complete local RDD response protocol will include an achievable, detailed timeline of how Tactics and coordination are executed.

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 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. Additionally, regional representatives from federal agencies, many of which were involved in the development of this guidance, are available to assist in the development of local RDD response plans. Below are recommended points of contact:
- Federal Bureau of Investigation (FBI) Field Office - Weapons of Mass Destruction (WMD) Coordinator
- Federal Emergency Management Agency (FEMA) – Regional Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Coordinator
- Department of Energy National Nuclear Security Administration (DOE/NNSA) – Radiological Assistance Program (RAP) Regional Coordinator
- Environmental Protection Agency (EPA) – Regional On-Scene Coordinator (OSC)

Contact Information

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INTRODUCTION

This Science-based Response Planning Guidance for the First 100 Minutes of the Response to a Radiological Dispersal Device Detonation (Planning Guidance) delineates Missions and Tactics that should be executed by first responders and local response agencies in the first 100 minutes of a response to an outdoor explosive radiological dispersal device[1] (RDD) detonation, based on realistic estimates of the possible consequences. It includes recommendations for equipment requirements, including personal protective equipment (PPE), and public messaging.

The first 100 minutes 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. These activities must take place within the first few minutes of responders arriving on scene and the effectiveness and coordination of these early actions will define how well or how poorly the response will go in the emergency phase and beyond, as other state and federal assets and specialized teams arrive on scene to support the response. This document provides actionable guidance, sample text for an RDD response protocol, and annexed tools that can be used for local planning of an effective response to an RDD to protect first responders and the general public, and establish interagency coordination and integration of state and federal assets. The information presented here is based on research and extensive experiments conducted by the Department of Energy (DOE) National Laboratories.

The Tactics described in this document are presented using a response timeline. This timeline requires that local jurisdictions execute several Tactics within a very short timeframe. As stated above, this timeline may not be realistic for all jurisdictions and will be dependent on staffing, equipment, and location-specific policies and protocols. Local jurisdictions that opt to use this planning guidance should modify the timeline to fit their personnel, equipment and other resources to meet the health and safety requirements of their jurisdiction. In the event of a secondary radiological device beyond the planning distances described in this document, the Tactics described in this guidance can be replicated and independently carried out around the second site.

Structure of the Planning Guidance

The Planning Guidance is organized into "Missions" (strategic, big picture, overall response concepts) and "Tactics" (on the ground, operational response actions) to make it accessible and applicable to response planners, emergency managers and first responders. There are five time-phased Missions (see Figure 1) – *Recognize, Inform, Initiate, Measure and Map,* and *Evacuate and Monitor*. There are ten Tactics grouped under the Missions (see Figure 2) to give more focus to individual operational areas. For each Tactic, guidance is provided for activities in the field and/or in a command center or an Emergency Operations Center (EOC) (see Table 1). The Tactics are numbered, but not implied to be sequential. Missions and Tactics overlap on the response timeline. Within each Tactic, the Planning Guidance identifies the objective and then provides several recommendations for execution. The Planning Guidance also includes references to RadResponder, which is a software platform developed by the Federal Emergency Management Agency (FEMA), the Department of Energy National Nuclear Security Administration (DOE/NNSA), and the Environmental

[1] RDD definition: The combination of radioactive material and the means (whether active or passive) to disperse the material with malicious intent; fission reactions do not occur in the RDD or its dispersed material.

Protection Agency (EPA). RadResponder can be used to collect and map radiological data. This functionality can help the responders execute specific Tactics. These actions are included in gray pull out boxes throughout the document entitled "RadResponder Action" and are detailed further in Annex 5. Overall, the annexes provided at the end of the document can be used to further explore and incorporate the recommended information in this Planning Guidance.

This is a flexible guidance document, and it is intended that individual jurisdictions will use it in different ways based on their preferred approach to RDD response planning (specific agency roles, staffing, equipment, technical capability, etc.). This is your tool: cut and paste the guidance text into your local RDD response protocol, change text that does not work for your jurisdiction, and leverage the information included here in interagency RDD response preparedness discussions.

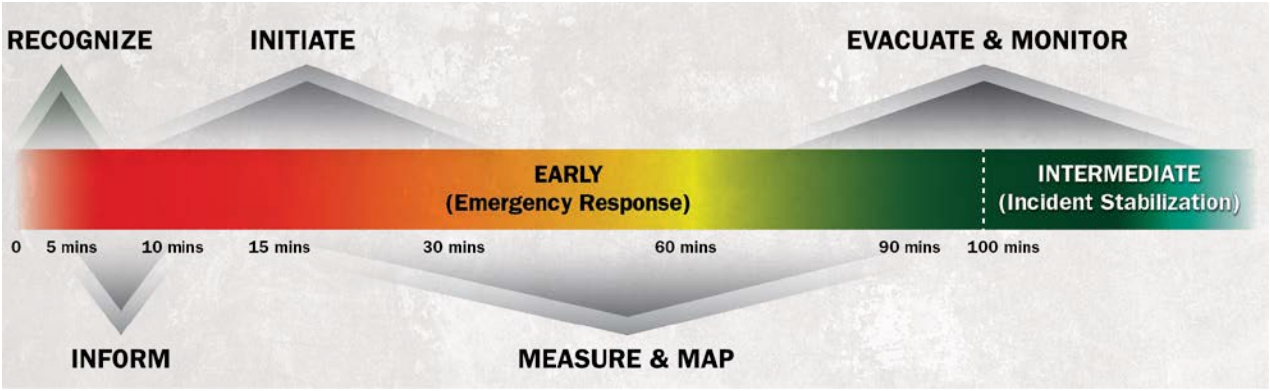


Figure 1: Time-Phased Response Missions

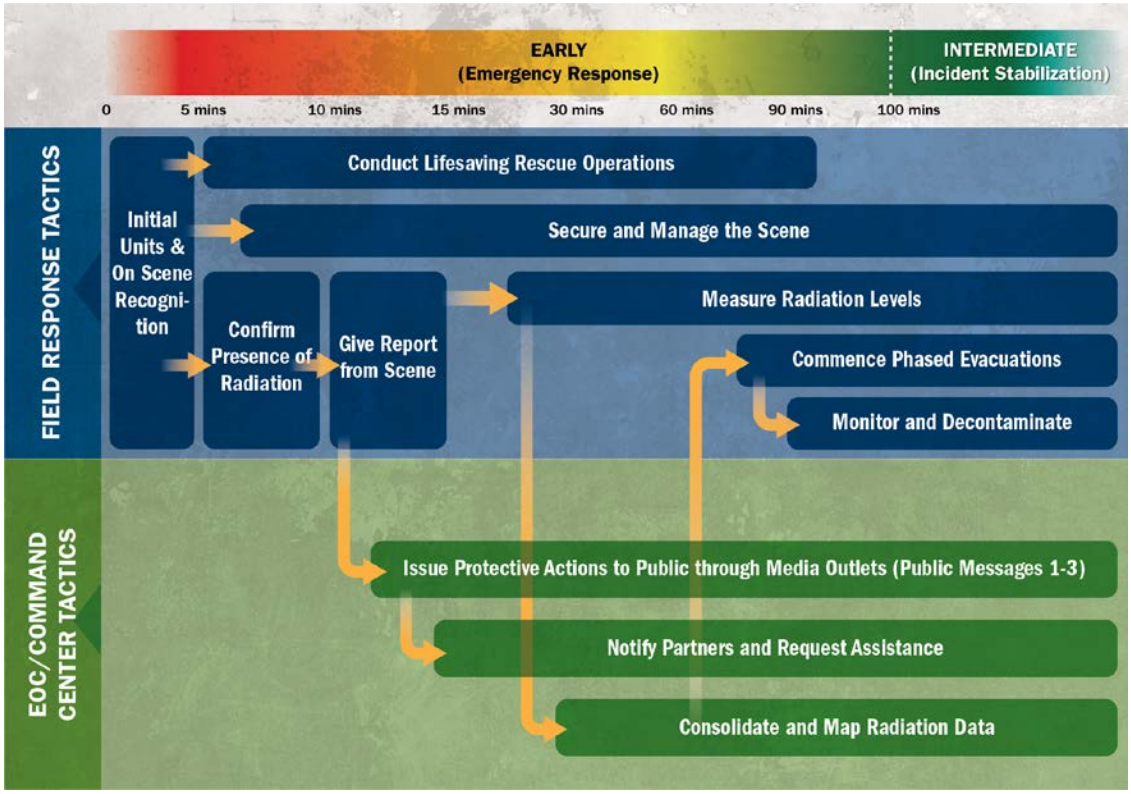


Figure 2: Time-Phased Tactics

Table 1: Summary of Missions and Tactics

MISSION	TACTIC	ACTIVITIES	
		FIELD RESPONSE	EOC/ COMMAND CENTER
RECOGNIZE that radiation is present at scene of explosion. (0-5 minutes)	**1. Initial Response & On-scene Recognition**	First responders are equipped with radiation detection equipment that is in continuous use when responding to an explosion.	
	2. Confirm the Presence of Radiation	After an initial indication that radiation is present, first responders take at least two readings, in at least two locations, with at least two separate radiation detection instruments to confirm that elevated radiation levels above background are present at the explosion scene.	
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. Give Report from the Scene**	The Incident Commander or designated official on scene notifies command center(s), including the EOC (if already activated), that the explosion was from an RDD and also informs emergency personnel arriving on scene that radiation is present.	
	4. Issue Protective Actions to the Public		Emergency management issues pre-approved public messaging with immediate shelter-in-place instructions.
	5. Notify Partners and Request Assistance		Emergency management notifies local, state and 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**	First responders initiate lifesaving rescue operations, including search and rescue, fire suppression, and medical triage and treatment. These operations are **not** delayed because of the presence of radiation.	Emergency management issues Public Message #2.
	7. Secure and Manage the Scene	Law enforcement clears the scene of all hazards, including secondary devices, then establishes initial public safety boundaries around the scene, designates the area immediately surrounding the detonation point (~20 m (~65 ft) in extent) a crime scene, and initiates initial coordination with the FBI and other investigative agencies. These activities happen concurrently with the lifesaving rescue operations described in Tactic 6.	
MEASURE & MAP radiation levels at the detonation site, in the near field, and downwind to initially characterize and visualize the extent of the radiological contamination. (15-90 minutes)	**8. Measure and Map Radiation Levels**	The Incident Commander assembles three strike teams, in two sequential phases, to conduct an initial characterization of radiological contamination, locate non-uniform high radiation areas, and provide survey data for mapping.	The EOC consolidates and maps field data that visualizes the extent of contamination to support analyst decision making on hazard boundaries and refining protective actions based on actual radiological measurements.

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 Phased Evacuations**	First responders establish evacuation routes based on radiological measurements taken in the field that avoid evacuating populations through heavily contaminated areas.	Emergency management organizes a press conference with updates on the response, evacuation and self-decontamination instructions (Public Message #3).
	10. Monitor and Decontaminate	First responders perform quick screening and decontamination of individuals at exits from the Hot Zone, to the extent practical, without unduly slowing down the evacuation.	Emergency management begins to identify possible locations to open CRCs.

RDD Response Protocol Trigger: An explosion is reported in your jurisdiction.

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

Tactic 1: Initial 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 locations, with at least two separate radiation detection instruments (can be the same model/type) to confirm that elevated radiation levels above background are present at the explosion scene.

- 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 protocol. Following the "two readings – two locations – two separate instruments" rule can help mitigate the misidentification of an RDD detonation.
- The two measurements should be taken at different locations a minimum of approximately 15 meters (m) – approximately 50 feet (ft) – apart from each other at a height of 1 m (~3 ft) above the ground. No specific points are required when selecting the two locations for measurements as long as the two measurements are neither side-by-side nor are they too far apart.
- Each of the two measured exposure rates or count rates should be greater than approximately three to five times the natural background to signify the presence of elevated radioactivity levels.
- The two separate pieces of radiation detection equipment 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 when confirming readings.
- It is critical that local agencies document and understand normal background radiation levels in their jurisdiction, and how the background reads on the specific instruments and equipment used by their responders. Because the response criteria for identifying contaminated areas might rely heavily on knowledge of area-specific background radiation, it is recommended that any training and routine operational use of detection instrumentation facilitate an increased knowledge and mapping effort of normal radiation background and any areas with natural variations.

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: Give Report from the Scene

Guidance: The Incident Commander or designated official on scene notifies command center(s), including the EOC (if already activated), that the explosion was from an RDD and also 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 (see Annex 8: Initial RDD Report Form):
  - Location of detonation;
  - At least two initial radiation readings and measurement locations, taken in Tactic 2 including, if possible, typical background readings for the area;
  - Direction that smoke from the explosion traveled (if observed at the time of detonation);
  - Extent of damage; and
  - Fires or other hazards on scene resulting from the explosion.
- Emergency personnel arriving on scene should follow recommendations for PPE outlined in Tactic 6 and Annex 3 before initiating any operations.
- Responding EMS and receiving hospitals are notified to prepare for receipt and treatment of 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. 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 as protective action zones are established and additional radiological measurement data are collected and posted. One tool that can be used to complete this mapping is FEMA's RadResponder. Tips for using RadResponder are highlighted throughout this Planning Guidance in gray pull-out boxes. More detailed information can be found in Annex 5: RadResponder Integration.

RadResponder Action: Create an Event

After an initial report from the scene that the explosion involves radiation, the ICP or EOC creates an event in RadResponder 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 shelter-in-place recommendation, will minimize the 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.
- 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 area for public radiation safety should be 500 m (~1600 ft) in all directions (see Figure 3).
- Use all media available, including reverse notification systems, to disseminate the message as quickly as possible without waiting to schedule a press conference.
- 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 500 m (~1600 ft) radius shelter-in-place boundary to move inside a structurally sound building as quickly as possible and to stay inside.
- See Annex 2: Public Messaging for more information on Public Message #1 and #1a.

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 you cannot get inside a building, place a dry cloth 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 you cannot get inside a building, place a dry cloth over your nose and mouth and quickly move away from the area. Please stay clear of [Location.]

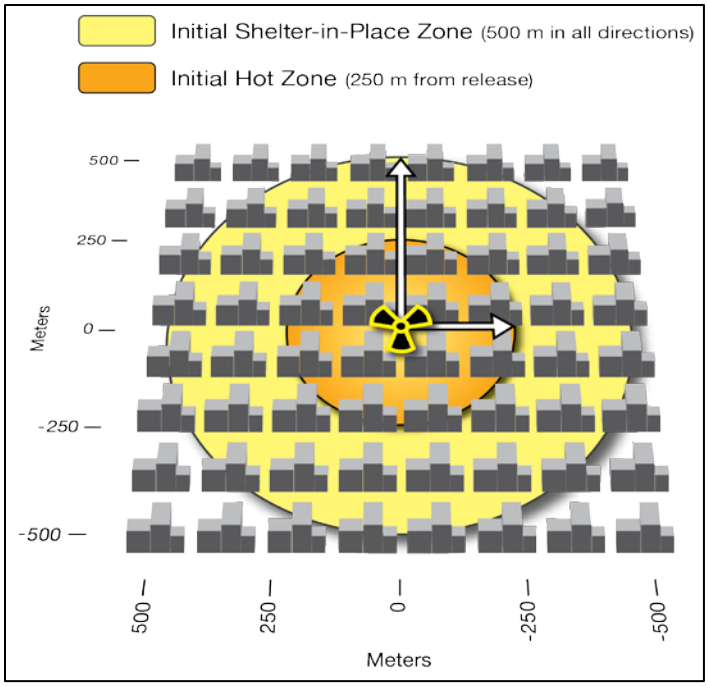


Figure 3: Initial Hot and Shelter-in-Place Zones, with Unknown Direction of Contamination

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 has detonated in their jurisdiction.
- Emergency management may leverage pre-scripted mission requests for pre-identified gaps in local response operations to facilitate the arrival of resources.
- See Table 2 below for radiological support teams/assets that may be requested. Making contact with these specialized state and federal teams during planning will help facilitate their integration into your RDD response protocol. During an emergency all support requests should be routed through official channels, typically from local to state to FEMA Region.

Table 2: Assets/Team and Capabilities to Request

	Assets/Team		Capability to Request
County/State	Local/county/state hazardous materials teams		Incident characterization and assessment
	State radiation control officials/radiation specialists		
	National Guard Civil Support Team (CST)		
	National Guard Homeland Response Force (HRF)		Command and control for incoming National Guard assets with capabilities in assessment, search and extraction, decontamination, emergency medical, security and logistics support
Federal	DOE/NNSA	Aerial Measuring System (AMS)	Incident characterization, environmental and public health assessments, patient (medical) management, and documentation
		Consequence Management Home Team (CMHT)	
		Federal Radiological Monitoring and Assessment Center (FRMAC)	
		National Atmospheric Release Advisory Center (NARAC)	
		Radiation Emergency Assistance Center/Training Site (REAC/TS)	
		Radiological Assistance Program (RAP)	
	Interagency Modeling Atmospheric and Assessment Center (IMAAC)		Interagency coordination element responsible for production, coordination, and dissemination of federal atmospheric dispersion modeling and hazard predictions
	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)	Coordinated advice and recommendations on environmental, food, health, and animal health matters

- The majority of state and federal assets will not be on the scene during the first 100 minutes, but delaying the request for assistance will slow their arrival. Federal assets and teams that do not require physically being on scene will begin supporting state and locals immediately (for example, the CMHT and NARAC will immediately begin assisting). Some assets may deploy on their own authority without an official request.
- If possible, the incident data map should be shared electronically with local, state and federal agencies that may support the incident so that all agencies supporting the response have the same common operating picture of the incident.

RadResponder 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 RadResponder partnerships to better facilitate this process during an actual incident.

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 are **not** delayed because of the presence of radiation. Emergency management issues Public Message #2.

- Search and rescue, fire suppression, medical triage and treatment, and other lifesaving rescue operations must take priority over conducting radiological measurements or decontamination.
- First responders should wear appropriate PPE to reduce intake of airborne radioactivity and mitigate skin and eye contamination. See Annex 3: PPE Recommendations for more information.
- Until all hazards on scene are identified, responders should wear PPE that is protective for all potential hazards at the site of a terrorist explosion. In addition to radiation, there are other hazards that could result from a terrorist device and there will likely be dangers from the explosion itself.
- Radiation monitoring, 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).
    - If occupancy times are minimized until additional radiation instruments are brought to the scene, the risk of acute radiation exposure can be mitigated. For example, the existence of a Dangerous Radiation Zone greater than 10 roentgens (R) / hour (hr) (0.1 gray (Gy) / hr) is unlikely, but possible, over a wide area. But even at that exposure rate, first responders can work for up to 30 minutes and keep their doses below 5 rem (50 mGy). Even in an extreme case, it would be unlikely that a responder would receive a dose higher than the EPA Protective Action Guidance for lifesaving rescue operations of 25 rem (250 mGy) during the emergency phase.
    - Radiation monitoring should commence as soon as possible.

PPE Recommendations

Note: Recommendations 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:

- If on or near the scene at the time of detonation without respiratory protection, use improvised protection such as 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-Containing Breathing Apparatus (SCBA). If it is not practical to wear positive-pressured SCBA (such as when driving), wear full-face air purifying respirator with P-100 or High-Efficiency Particulate Air (HEPA) filter.
- If arriving on scene after 15 minutes, wear a half- or full-face 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, protective eyewear and gloves to minimize exposure to skin and eyes. Level A Hazardous Material suits are unnecessary for protection from radioactive contamination.

In general, first responders should take appropriate planning measures for keeping exposures As Low As Reasonably Achievable (ALARA).

- 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 will be from resuspension of contamination and dust from the ground.
- First responders should be alert for any possible localized high radiation levels due to partially or non-dispersed radioactive sources.
- One potential unique exposure risk is that a large 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) who are treating the person.
- 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 and potential ongoing exposure to contamination.
- Emergency management issues Public Message #2 that includes information about the radiological hazard and reiterates the shelter-in-place message. See Annex 2: Public Messaging for more information on Public Message #2.

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

An explosion has occurred at [Location] that released radioactive particles. Emergency personnel are on scene and firefighting, assisting those in need with medical care and evacuation assistance, and providing law enforcement. Personnel are also working to promptly identify unaffected areas. If you are inside a building in this [Location], stay where you are until further instructions are provided by authorities. If you are away from the impacted area, please stay clear to allow emergency personnel to do their work.

Tactic 7: Secure and Manage the Scene

Guidance: Law enforcement clears the scene of all hazards, including secondary devices, then establishes initial public safety boundaries around the scene, designates the area immediately surrounding the detonation point (~20 m (~65 ft) in extent) a crime scene, and initiates initial coordination with the Federal Bureau of Investigation (FBI) and other investigative agencies. These activities happen concurrently with the lifesaving rescue operations described in Tactic 6.

- Establish a safety perimeter for the initial Hot Zone at 250 m (~800 ft) in all directions around the detonation until radiological measurements that define the actual Hot Zone boundary are taken. This perimeter will protect the public and responders who are not involved in lifesaving rescue operations from the potential of acute internal or external exposure. Once radiological measurements are available, the Hot Zone perimeter should be re-established at contamination levels that exceed 10 mR/hr (0.1 mGy/hr) or 60,000 disintegrations per minute (dpm) / cm^2 at 1.5 cm (~0.5 inch) above the ground for beta and gamma, or 6,000 dpm/cm^2 at 0.5 cm (~0.25 inch) above the ground with an alpha probe.
    - Hot Zone entry should be limited to first responders conducting lifesaving rescue operations.
    - It is safe from a radiological standpoint to allow the general public to exit unsafe structures and move to shelter in structurally sound buildings. This relocation should be done along a path to minimize exposure.
- Until radiological measurements are available, enforce the initial Shelter-in-Place Zone set at 500 m (~1600 ft) in all directions from the point of detonation. When the direction of the contamination is confirmed by radiological measurements, extend the Shelter-in-Place Zone out to 2000 m (~1.2 miles) in the direction of the contamination to protect the public from low-level contamination and external radiation from fallout on the ground (see Figure 4). The direction of the contamination area will be determined by the results of measurements taken by Strike Teams 1 and 2 in Tactic 8: Measure and Map Radiation Levels, and will be communicated to law enforcement and emergency management.
    - First responders should continue to operate as needed in the Shelter-in-Place Zone, but all members of the general public should be instructed to remain indoors until notified when and how to leave the immediate area.
- The detonation point of approximately 20 m (~65 ft) in extent should be visually determinable by the center of the soot spot left where the fireball interacted with the

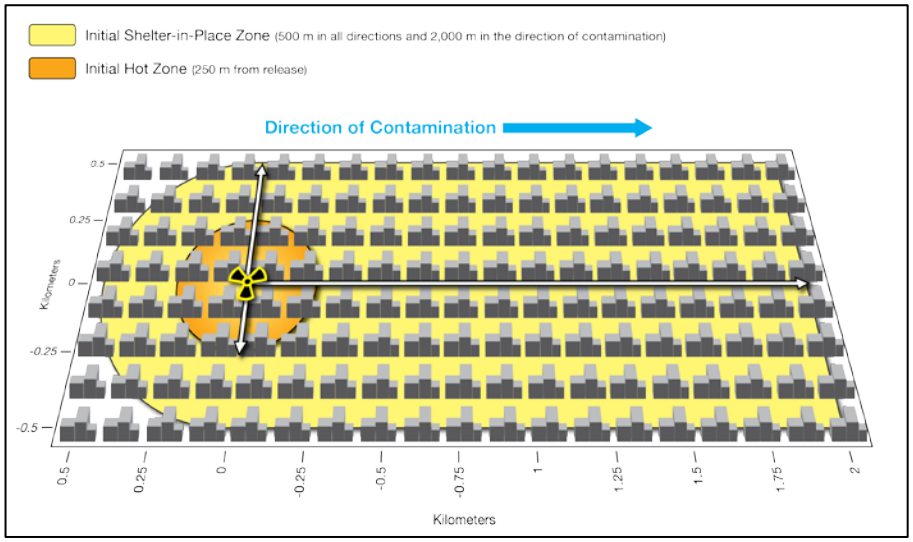


Figure 4: Initial Hot and Shelter-in-Place Zones, with Known Direction of Contamination

ground or other markings caused by the explosion. No radiological measurements should be taken in this area by local responders.

- Key law enforcement actions to secure the scene:
  - Characterize and clear the scene for all hazards including explosives, utilities, hazardous materials, and other structural concerns prior to operations that do not involve lifesaving.
  - Conduct crowd and traffic control and public safety operations to prevent persons and vehicles from entering potentially contaminated areas.
  - Direct persons to safest exits from the impacted area and identify injured and/or contaminated.
- Key law enforcement actions to manage the crime scene:
  - Unless there is an immediate life safety need, it is unnecessary for local first responders to enter the law enforcement controlled detonation point (~20 m (~65 ft)) to make measurements or collect forensic evidence. The immediate area around the point 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 on scene will vary based on incident location and specifics.
    - It will be necessary in the first 100 minutes for responders to take radiological measurements in the area directly outside the law enforcement controlled detonation point and out to 250 m (~800 ft), as described in Tactic 8: Measure and Map Radiation Levels – Detonation Site. These measurements are critical to determining the direction of contamination caused by the prevailing wind direction at the time of detonation, and will require taking radiological measurements as close as ~20 m (~65 ft) from the detonation point.
  - Identify and preserve evidence to support the investigation:
    - With respect to characterization of the environment to support public and responder safety, RDD response plans should be specific that radiation measurements or samples collected by local agencies in the first 100 minutes are intended for public health decision-making and not investigative purposes. These measurements may later become evidence, but were purposefully taken to inform immediate shelter-in-place and response operations.
    - Do not withhold data that may obstruct gaining situational awareness for health and safety decision-making.
    - If the scene includes radioactive ballistic fragments, first responders on scene should avoid moving or relocating any pieces, and instead mark and establish boundaries around this debris to ensure the health and safety of responders.
- Follow local protocols to communicate initial findings, measurements and other situational information with the FBI and state investigative agencies as they arrive on scene to ensure a coordinated and jointly managed incident.
- During RDD response planning and preparedness activities, local jurisdictions should work with their local FBI field office (located throughout the country) to identify the point of contact for their WMD Coordinator and coordinate their jurisdiction-specific response operations.

MEASURE AND MAP radiation levels at the detonation site, in the near field and downwind to initially characterize and visualize the extent of the radiological contamination.

Tactic 8: Measure and Map Radiation Levels

Guidance: The Incident Commander assembles three strike teams, in two sequential phases, to conduct an initial characterization of radiological contamination, locate non-uniform high radiation areas, and provide survey data for mapping. The EOC consolidates and maps field data that visualizes the extent of contamination to support analyst decision making on hazard boundaries and refining protective actions based on actual radiological measurements.

In the Field

All of the radiological measurements taken in the first 100 minutes are to understand the qualitative 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. 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. When taking radiological measurements, first responders should be alert for any possible localized high radiation levels due to partially or non-dispersed radioactive sources.

RadResponder Action:
Record Radiological Measurements

Strike teams should record all survey measurements in RadResponder as measurements are collected. It is important to record, at a minimum, the following information into RadResponder:
- Location of survey or observation
- Instrument type
- Units of measure

The Incident Commander should collect radiological incident data by assigning strike teams to take radiological measurements in two phases, outlined in priority order in Table 3, and as resources are available. All measurements taken by the strike 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 the Incident Commander for public health and safety decisions. See Annex 4: Advanced Tactics and Data Analyst Decision Support Guide for additional information.

Table 3: Phases of Initial Radiological Contamination Assessment

Phase 1	Phase 2
• Detonation Site • Transect at 1 km (~0.5 miles) downwind based on the direction of contamination near the point of detonation	• Nearfield • 10-Point Monitoring Plan: Areas farther downwind if presence of contamination is detected at 1 km (~0.5 miles) Transect • Outlying Areas

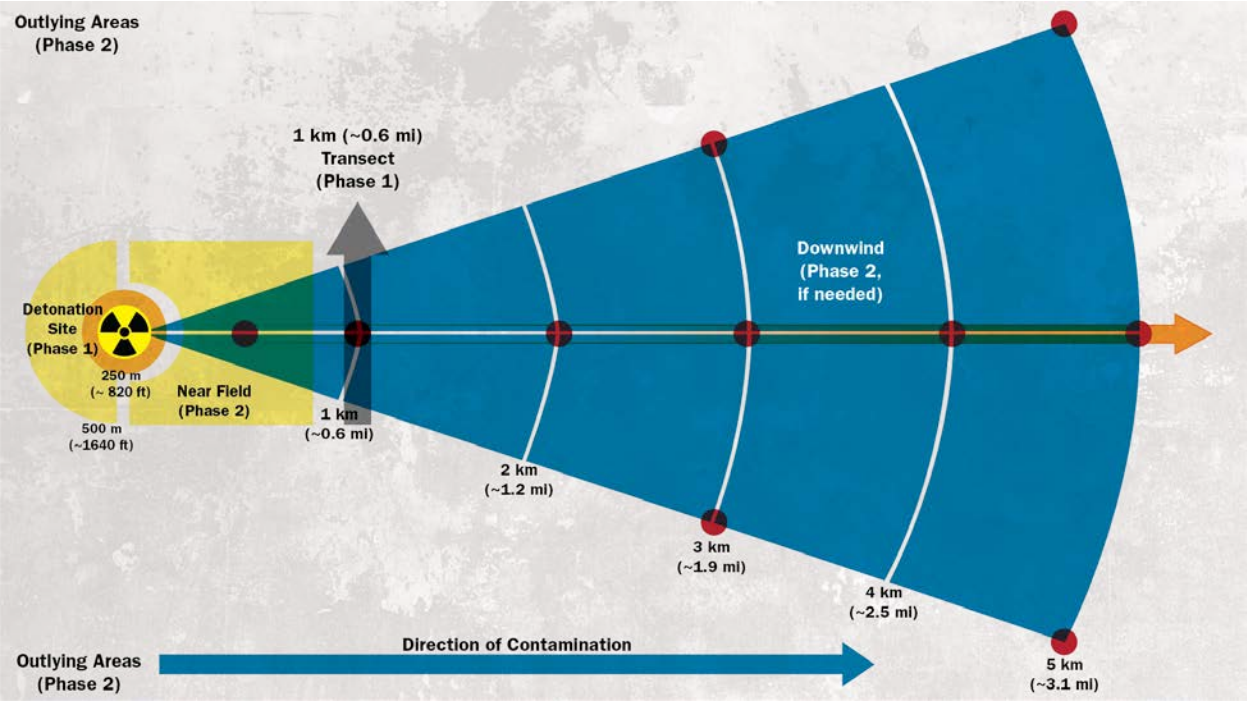


Figure 5: Initial Survey Areas with Phases

Phase 1: Detonation Site and Transect

Detonation Site

The objective of the first phase of radiological measurement 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 wind direction at the time of detonation may differ from the observed wind direction when first responders arrive on scene, even if only a few minutes have passed. Similarly, the weather data from fixed locations, such as a nearby airport, may not correspond to the conditions before or after the time of detonation and should not be used for decision making.

The Incident Commander assigns the first specialized hazardous materials team that arrives on scene as Strike Team 1, with the responsibility for collecting radiological data, determine areas that may be Dangerous Radiation Zones (10 R/hr (0.1 Gy/hr)), estimate the general direction and magnitude of radiological contamination, and rule in or out the presence of alpha contamination at the incident scene. Table 4 below outlines the decision points and the possible outcomes from these measurements.

Table 4: Strike 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 this point and move to a low background area. • Marking and moving away from Dangerous Radiation Zones will ensure responder safety and to keep exposures ALARA
Discernable direction from detonation site with highest radiological contamination indicates the direction and magnitude of radiological contamination (if aerosol dispersion)	• Preliminary indication of aerosol ("smoke") or fragmentation ("BBs") dispersal. • Determine which direction is downwind, and where the 1 km Transect will be conducted.
Determine if there is alpha contamination	• 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 0.5 cm (~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 Strike Team 1: It is unnecessary for responders taking measurements to enter the detonation point (~20 m (~65 ft) around the center of the soot spot or markings caused by explosion) to collect data. The measurement and mapping of the detonation site excludes this ~20 m (~65 ft) circle as a law enforcement controlled crime scene.

- Strike Team 1 should take a handful of measurements approaching the detonation site starting at ~100 m (~330 ft) out until they are ~20 m (~65 ft) away from the detonation point or 10 R/hr (0.1 Gy/hr), whichever comes first. Strike Team 1 should then repeat the measurements from four or more different directions/approaches that span the 360 degrees around the detonation site (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 should be taken at 1 m (~ 3 ft) above the ground.

- If Strike Team 1 measures radiation at or above 10 R/hr (0.1 Gy/hr), they should stop, mark this point and move to a low background area. Areas bounded by 10 R/hr (0.1 Gy/hr) will be designated the Dangerous Radiation Zones.
- Strike Team 1 should continue measuring outwards from 100 m (~330 ft) in multiple directions if no discernable directional pattern is found.
- Strike Team 1 should take measurements using alpha and beta contamination probes at 0.5 cm (~0.25 inch) above the ground to help characterize the radioactive material and determine what Hot Zone boundaries should be established past the initial boundary.

RadResponder 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 RadResponder should be classified as an RDD event and the wind direction should be added into RadResponder. Classifying an event in RadResponder 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.

As an advanced tactic, secondary to determining the magnitude and direction of contamination and if alpha contamination is present, Strike Team 1 may take shielded and unshielded measurements to determine the pattern of contamination at the detonation site. This can be done using a shield (such as a lead sheet, an engine block, or other dense piece of material) placed between the detector and the detonation site. These shielded measurements can be compared to other characterization measurements (unshielded) to give insight into how the radiological material was distributed outward by the explosion and how much remained close as a "hot spot." See Annex 4 for additional information on this advanced tactic.

Transect at 1 km (~0.5 miles) Downwind

Once the direction of highest contamination is identified (referred to as "downwind"), the Incident Commander assigns the second specialized hazardous materials team that arrives on scene as Strike Team 2, with the responsibility for surveying the Transect at 1 km (~0.5 miles) downwind to determine if the RDD dispersed radiation downwind through smoke. Table 5 below outlines the decision points and possible outcomes from these measurements.

RadResponder Action:
Adding the 1 km (~0.5 miles) Transect

If an event is categorized in RadResponder as an RDD and direction of contamination is known, a 1 km transect (~0.5 miles) downwind will automatically highlight on top of the Shelter-in-Place Zone. This allows responders to visually see the 1 km (~0.5 miles) transect and determine starting and end points that require radiological monitoring.

Table 5: Strike Team 2 Decision Points

Decision Points	Outcomes
Assess the extent of contamination downwind	• If radiation measurements at the 1 km (~0.5 miles) Transect are at background levels, it indicates that either the device did not result in a significant amount of smoke or the identified direction of contamination is incorrect. • If radiation measurements at the 1 km (~0.5 miles) Transect are elevated, it indicates that radiological material was dispersed through smoke downwind and Phase 2 measurements further downwind are required.
Determine if there is alpha contamination	• 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 0.5 cm (~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 Strike Team 2:

- Strike Team 2 should walk along the 1 km (~0.5 miles) Transect and take measurements using low-range exposure rate meters at 1 m (~3 ft) above the ground in the center of intersections and the halfway point between intersections. If no intersections exist, first responders should aim to take measurements approximately every 50 m (~150 ft), which should result in about 20 measurements (see Figure 6).
- Strike Team 2 should also take measurements with beta contamination probes at 1.5 cm (~0.5 inch) above the ground and with alpha contamination probes at 0.5 cm (~0.25 inch) above the ground.

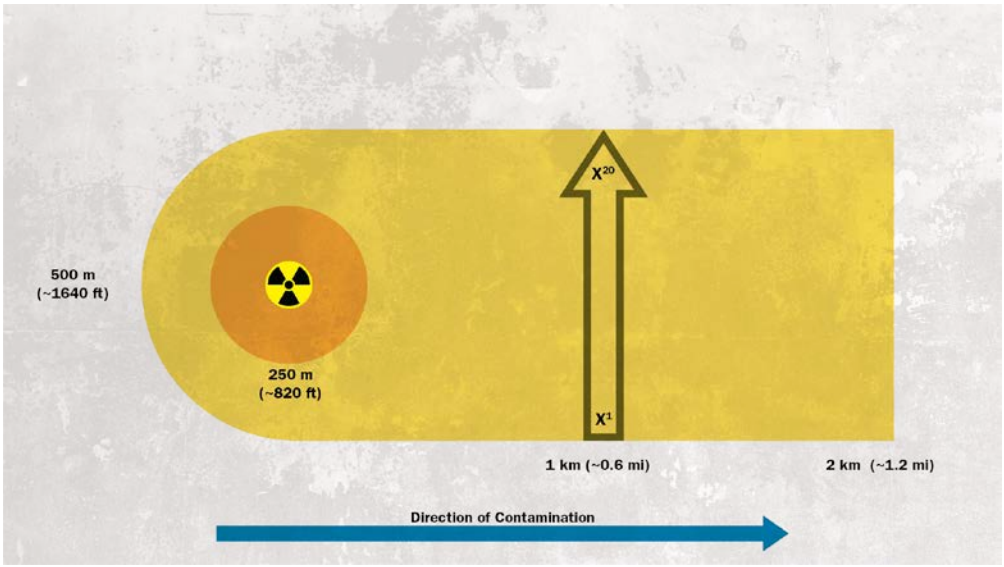


Figure 6: 1 km (~0.5 miles) Transect

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 extent of area that is greater than 10 mR/h (0.1 mGy/hr) will likely be less than the initial 250 m (~800 ft) established in the initial Hot Zone, but it will be a complex and chaotic footprint due to urban wind fields and urban 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 Strike Team 3

- Strike Team 3 surveys the area between the detonation area and approximately 1 km (~0.5 miles) in the direction of contamination.
- Strike Team 3 should collect measurements parallel to the wind direction (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.

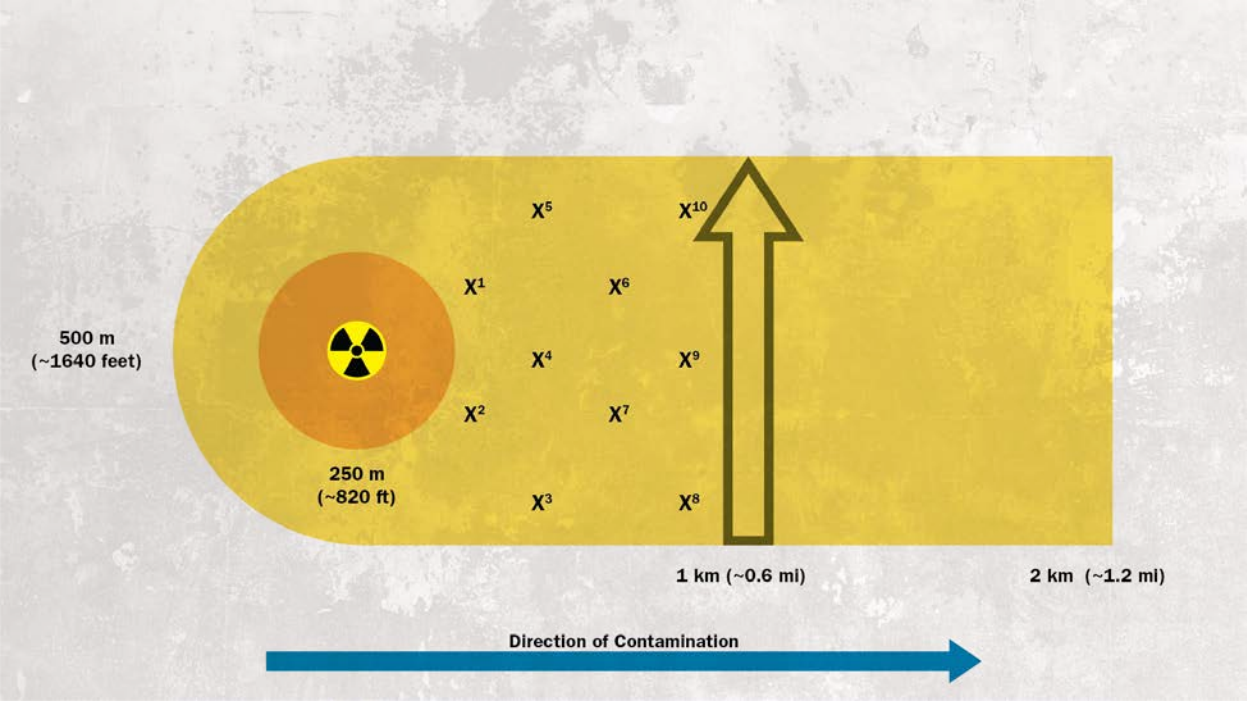


Figure 7: Near Field

10-Point Monitoring Plan

RadResponder Action: Adding the 10 Point Monitoring Plan

A 10-Point Monitoring Plan layer can be added into RadResponder to allow first responders to visualize the suggested points for monitoring on a map.

If radiological contamination is detected at the 1 km (~0.5 miles) Transect, first responders should initiate the 10-Point Monitoring Plan (see Figure 9) based on the direction of contamination as confirmed while collecting radiological measurements at the Transect. The Transect and Near Field surveys will provide measurements for two of the 10 points, thus only eight additional points are needed. Data do not need to be obtained by sending out a strike 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 1 m (~3 ft) 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).

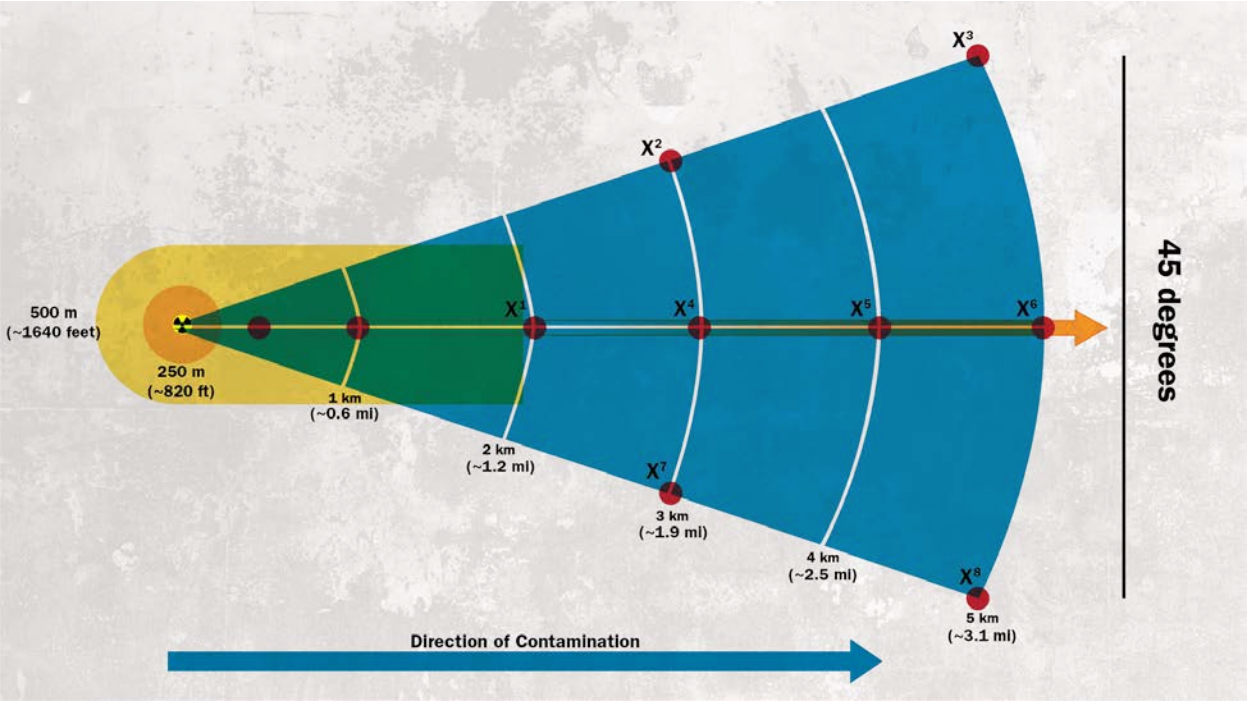


Figure 8: 10-Point Monitoring Plan

Table 6 below 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., smartphone, computer, or radio/phone call to EOC). Responders may use some suitable and calibrated preventive radiological and nuclear detection equipment if exposure rate meters are not readily available to complete the necessary measuring and mapping of radiological data. This should be pre-determined by jurisdictions to support appropriate use during the response.

Outlying Areas

The objective of measuring the outlying areas, which are the areas outside any of the survey areas, is to confirm that radiation is *not* present in these areas. These outlying measurements of background (no contamination) will be important to map and critical when messaging hazard areas to the public.

Steps (does not require a specific strike team to conduct field measurements)

- Incident Command assigns a team of two agency representatives 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 strike team. Instead agency representatives should 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 1 m (~3 ft) above the ground (see Figure 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) should drive around the jurisdiction and surrounding areas and confirm background radiation measurements.

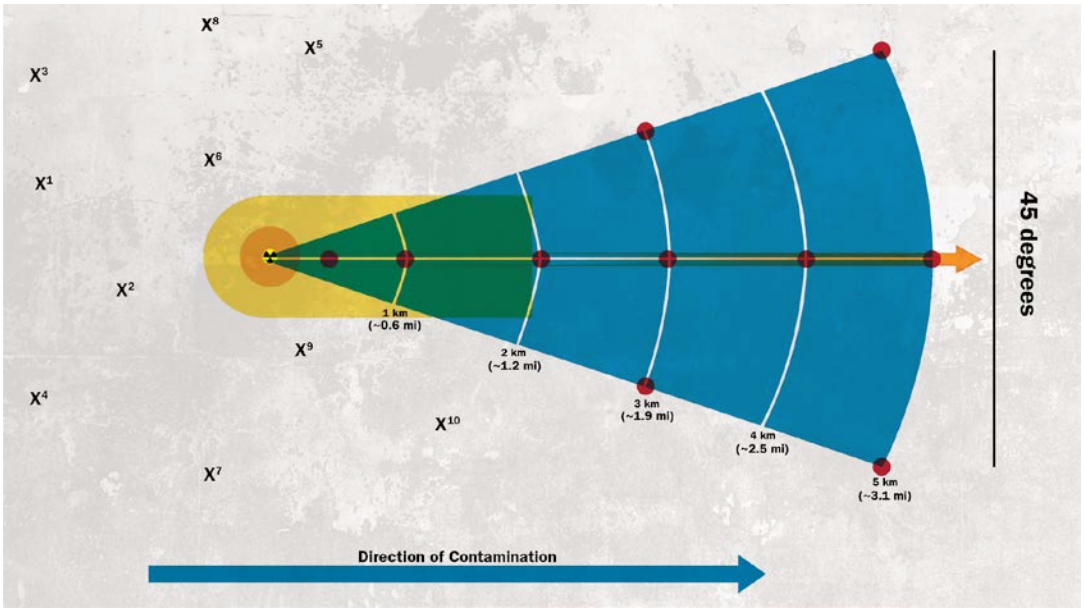


Figure 9: Outlying Areas

Table 6: Summary Requirements to Implement Tactic 8

Phase	Survey Area (see **Figure 5**)	Objectives	Equipment Needs	Minimum Personnel Requirements
Phase 1	**Detonation Site** Includes the area 360 degrees around the area immediately surrounding the point of detonation (does not include the detonation point)	Identify discernable direction from detonation point with highest radiological contamination to determine the direction and magnitude of radiological contamination (if aerosol dispersion) Assess the pattern of contamination in the immediate area around the detonation site 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	High (R/hr) and low (microR/hr) range exposure rate meters, and alpha and beta contamination probes	Two first responders with highest level of proficiency to operate radiation detection equipment
	1 km Transect Includes the area at 1 km (~0.5 miles) in the direction of contamination	Determine if the RDD dispersed radiation downwind through smoke Determine if surface contamination is due to alpha or beta radiation	Exposure rate meter, preferably low range meters reading in micro-R/hr (micro-Gy/hr), and alpha and beta contamination probes	Two first responders with highest level of proficiency in operating radiation detection equipment

Table 6: 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 point of detonation and the 1 km Transect	Define the Hot Zone boundary of 10 mR/hr (0.1 mGy/hr) or 60,000 dpm/cm^2 at 1.5 cm (~0.5 inch) above the ground for beta and gamma (if no alpha contamination is present) and the deposition of the plume	Low-range exposure rate meters	Two first responders proficient in operating low-range exposure rate meters
	10-Point Monitoring Plan Includes the area from 1 to 5 km (~0.5 to 3 miles) outwards in the direction of the prevailing wind	If the Transect indicated the presence of contamination, assess the extent and magnitude of downwind contamination	Exposure rate meter, preferably low-range meters reading in micro-R/hour (micro-Gy/hr), and with alpha and beta contamination probes	Either a team working from a command center and collecting radiological measurements from fixed locations (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	Either a team working from a command center and collecting radiological measurements from fixed locations (police stations and fire houses) OR two first responders with proficiency in using radiation detection equipment

In the EOC

Mapping

- Emergency management and other agencies in the EOC will aggregate data collected from all strike teams into the incident data map and create a single integrated visualization of the extent of contamination for the entire jurisdiction.
- Updated contamination mapping should be shared with all agencies operating on the scene and federal assets arriving in the field and in the EOC.
- An analyst, with expertise in interpreting radiological data for safety and protection, should review all the measured and mapped radiological data and provide recommendations to the Incident Commander and EOC for public health and safety decisions. The DOE CMHT can be accessed remotely at all times for support to analyze radiological data. See Annex 4: Advanced Tactics and Data Analyst Decision Support Guide for additional information.

RadResponder Action: Evaluating, Validating and Analyzing Data

As strike teams at the Detonation Site, in the Near Field and downwind collect radiological data and upload it into RadResponder, analysts in the ICP and EOC should evaluate data in RadResponder 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 RadResponder and make recommendations for additional responder health and safety, evacuations, and additional protective actions. The DOE CMHT is available remotely to support analysis of radiological data.

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

Tactic 9: Commence Phased Evacuations

Guidance: First responders establish evacuation routes based on radiological measurements taken in the field that avoid evacuating populations through heavily contaminated areas. Emergency management organizes a press conference with updates on the response, evacuation and self-decontamination instructions (Public Message #3).

- Channel evacuees that have sheltered-in-place in the Hot Zone to a limited number of exit points ensuring that evacuees do not travel through heavily contaminated areas or close to other hazards on scene.
- Confirm uncontaminated areas and phase the release of populations who are sheltered-in-place within these areas to ensure an orderly evacuation.
- Expect mass self-evacuations from all over the jurisdiction regardless of whether populations are in the impacted areas or not.
- If it is determined that there was an aerosol ("smoke") release, expect the size of the evacuation zone contaminated by smoke to continue to be refined after ground deposition is further mapped. Be prepared for the possibility that the area 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.
- 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. Information from the press conference should be pushed through all available media outlets as well. See Annex 2: Public Messaging for more information on press conference content.

Public Message #3: Press Conference

An explosion has occurred at [Location] that released radioactive particles. Emergency personnel are on scene providing care to those in need and assessing the extent of the contamination. If you have been asked to shelter-in-place, stay inside a building with the windows and doors closed until instructed by responders that it is safe to evacuate. If you are outside of the area, please stay clear to allow emergency personnel to do their work.

Radioactive particles settle like dust on your clothing, your body and other exposed 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).*
- *Seal 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. Do not use conditioner because it may cause radioactive material to stick to your hair and skin.*
- *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.*

Tactic 10: Monitor and Decontaminate

Guidance: First responders perform quick screening and decontamination of individuals at exits from the Hot Zone, to the extent practical, without unduly slowing down the evacuation. Emergency management begins to identify possible locations to open CRCs.

- Begin to identify locations for setting up CRCs for further monitoring and decontamination 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)).
- If no specific CRC plan has been developed, consider leveraging planning already developed by local or state health departments for points of dispensing or sheltering.
- **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 decontamination of people who were in the Hot Zone, as practical, without slowing down the evacuation. (At a minimum, advise evacuees to remove external clothing, if feasible, and use wet wipes to clean exposed skin).
  - Initiate procedures to control the spread of contamination as practical.
  - Separate out those who may need further evaluation (due to internal contamination) by looking for people who exhibit external contamination on their head, hair and clothing on the upper body.
    - Assume that those that do not exhibit significant external upper body contamination, especially around the nose and mouth, did not receive a significant internal dose that would require further evaluation.
  - Direct evacuees requiring further evaluation to CRCs.
- At CRCs:
  - Perform screening and decontamination.
  - CRCs will direct/refer people that need medical treatment due to internal contamination to the appropriate healthcare facility.
  - For people requiring treatment note that:
    - Decorporation therapy is a medical priority, not a medical emergency, and should begin within 24 hours of exposure.
    - Additional information on the 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://www.remm.nlm.gov/
    - Though shelters are not an ideal place to provide monitoring or treatment, they should be prepared to do so if there are no adequate CRCs.
  - Information on setting up CRCs is available at http://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf
  - Information on operating a public shelter in a radiation emergency is available at http://emergency.cdc.gov/radiation/pdf/operating-public-shelters.pdf
- Do not decontaminate motor vehicles at this time in the response.
- Do not waste effort trying to contain contaminated wash water.

ANNEXES

Annex 1: Glossary of Terms

1 km Transect	An initial survey at approximately 1 km from the point of release that is orthogonal to the prevailing wind direction. It is used to establish an indication of long range 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 to help local first responders prioritize subsequent monitoring of affected areas, and provide data that are needed to refine dispersion modeling of deposition and 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	**A**s **L**ow **A**s **R**easonably **A**chievable (ALARA); radiation safety concept for minimizing dose.
Background	Naturally occurring radiation level that varies with geography and altitude.
BBs (Fragmentation) Scenario	A large fraction of the radioactive material in the device disperses as large particles (~100-500 μm) and/or ballistic fragments (> 1 cm). The large particles are deposited in the vicinity of the detonation of an explosive radiological dispersal device (RDD).
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).
Decorporation Therapy	Removal of radioactive isotopes from the body using specific drugs called "decorporation agents."
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 fallout of radioactive particles deposited on the ground after passage of the aerosol plume.
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 1.5 cm (~0.5 inch) and 6,000 dpm/cm^2 at 0.5 cm (~0.25 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 glasses and shoes, earplugs or muffs, hard hats, respirators, coveralls, vests or full body suits.

Plume	The column or cloud of smoke emanating from the mount of a continuously emitting chimney or smoke stack is called plume. In the case of an explosive RDD the plume would be due to a "puff" release of material.
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.
Shelter-in-place	The use of a structure and its indoor atmosphere to temporarily separate individuals from a hazardous outdoor atmosphere.
Shelter-in-Place Zone	The extent of an area defined by the Incident Commander or public health official to protect the public from an environmental radiation hazard.
Smoke (Aerosol) Scenario	A device that converts a large fraction of the radioactive material into aerosol (< 100 μm), which deposits locally and at long distance by a plume in accordance with the meteorological conditions at the time of the release.

Annex 2: Public Messaging Guidance

Keeping the public informed during the first few hours of a radiological dispersal device (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 those of their loved ones. Consistent, clear and timely messages are important throughout the response and every effort should be made to continue to provide updated messaging to the public as the response progresses.

This annex provides suggested public messaging that local government can issue to the public based on the operations and activities being conducted in the field. Included in this annex are: the operation or field activity; a suggested message; suggested media for the message to be released through; and why the message is important at the particular phase of the response. Although no timing for message release is included in this annex, first response agencies should aim to have the first shelter-in-place message out as soon as a large explosion with smoke and debris is confirmed, ideally within 10 minutes after the initial detonation. The remaining messages should be used progressively as the response moves from lifesaving rescue operations to incident stabilization.

It is recommended that a public information officer (PIO) working in the Emergency Operations Center (EOC) or the Joint Information Center (JIC), if established, be responsible for releasing these messages in coordination with activities occurring in the field. Pre-written messages should be developed in multiple languages, and consideration should be given to the development of passive messaging that can be made available to members of the public who call non-emergency information services (such as 311).

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

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 you cannot get inside a building, place a dry cloth over your nose and mouth and quickly move away from the area. Please stay clear of [Location.]

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. Emergency personnel are on scene and making a determination of the cause of the explosion as quickly as they can. Regardless of the cause, a shelter-in-place message is appropriate for any large explosion to protect the public from smoke inhalation and falling debris. If it is then found that radiation is present on scene, the public has already been notified to shelter-in-place. To facilitate an efficient and effective emergency response, emergency personnel need the unaffected public to avoid the impacted area so the emergency personnel can focus their attention on mitigating the hazard, lifesaving rescue operations, and protecting property and infrastructure.

Wireless Emergency Alert (WEA) message: Imminent Threat: Explosion at XX St & X Ave in X. Move inside a building ASAP & stay inside.

Message type: Emergency Alert System (EAS), WEA System, text/SMS, email notification, all social media platforms, press release, Reverse 911, Radio, TV

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

Why this message: At this point in the response, emergency personnel on scene have confirmed the presence of radiation and have notified their Command and other appropriate personnel. The public should be told to shelter-in-place. If they cannot shelter-in-place, placing a dry cloth over their nose and mouth as they evacuate the area will offer a protection of as much as a factor of 10. Also notify the public not to go towards the impacted area to allow for the emergency personnel on scene to execute response operations.

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 you cannot get inside a building, place a dry cloth over your nose and mouth and quickly move away from the area. Please stay clear of [Location.]

WEA message: Imminent Threat: Explosion at XX St & X Ave in X. Move inside a building ASAP & stay inside.

Message type: EAS, WEA System, text/SMS, email notification, all social media platforms, press release, Reverse 911, Radio, TV

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 on the scene, while also reinforcing the shelter-in-place order.

Message type: EAS, text/SMS, email notification, all social media platforms, press release

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

An explosion has occurred at [Location] that released radioactive particles. Emergency personnel are on scene and firefighting, assisting those in need with medical care and evacuation assistance, and providing law enforcement. Personnel are also working to promptly identify unaffected areas. If you are inside a building in this [Location], stay where you are until further instructions are provided by authorities. If you are away from the impacted area, please stay clear to allow emergency personnel to do their work.

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. Information from the press conference should be pushed through all available media outlets as well

Message type: Press conference, then released through text/SMS, email notification, all social media platforms, press release

Public Message #3: Press Conference

An explosion has occurred at [Location] that released radioactive particles. Emergency personnel are on scene providing care to those in need and assessing the extent of the contamination. If you have been asked to shelter-in-place, stay inside a building with the windows and doors closed until instructed by responders that it is safe to evacuate. If you are outside of the area, please stay clear to allow emergency personnel to do their work.

Radioactive particles settle like dust on your clothing, your body and other exposed 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).*
- *Seal 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. Do not use conditioner because it may cause radioactive material to stick to your hair and skin.*
- *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.*

Sample Full Press Conference Remarks

Note: This is a sample of remarks that could be given during a press conference that 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 is offered as guidance and should be amended as needed.

I am providing information on the explosion that occurred at [Location] about one hour ago. This is initial information as we begin to conduct a full investigation into what happened.

An explosion occurred at [Location] at [Time] – we believe this was caused by a dirty bomb, or radiological dispersal device, that released radioactive particles. We recommend everyone in the [Shelter-in-Place] boundaries go inside a structurally sound building, and close the windows and doors to minimize exposure to radiation. Remain sheltered until instructed by emergency personnel to leave.

If you were outdoors and inside the [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 clothing, your body and other exposed objects:

- First, remove your outer layer of clothing. Removing this layer can remove almost 90% of radioactive material. 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.
- Seal 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 at this point to prevent potential spread of contamination.
- Next, take a warm shower with plenty of soap and wash your hair with shampoo or soap and water. Do not use conditioner because it may cause radioactive material to stick to your hair and your skin. Be sure not to 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 closed drawer is clean. If you do not have clean clothes, shake or brush off your outer layer of clothing and redress. Be careful to not breathe in dust like particles.

Lifesaving rescue operations are ongoing in the impacted area. Firefighters, police officers and emergency medical service personnel have rescued people from the buildings and the streets, and have transported those 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. 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 our investigators.

At this time, we [Do/Do Not] have estimates on those 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.

If you have a loved one who you believe was in the impacted area, we ask that you please do not try to go into the areas that have been impacted and connect with them. We have asked everyone who was inside the area at the time of the explosion to shelter-in-place until emergency personnel deem it is safe for them to leave. There are a number of schools within the damaged area that are sheltering-in-place. Please know that your children are being cared for by the school staff and teachers 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.
- Drinking water everywhere is safe to drink and for use in showers and for washing hands.
- City, state and federal offices outside of the impacted area are [Open/Closed].

We will continue to update you as the response continues.

Public Message #4: Evacuation Assistance *(Note that this message is not included in any of the 10 Tactics).*

Why this message: For populations who are sheltered in place, evacuation instructions should come directly from emergency personnel on the scene.

Public Message #4: Evacuation Assistance

An explosion has occurred at [Location] that released radioactive particles. Emergency personnel have identified areas where it is safe to evacuate. Only evacuate when you are directed to do so by emergency personnel and follow instructions by emergency personnel on areas where it is safe to evacuate to.

Message type: EAS, text/SMS, email notification, Facebook, Twitter, press release

Public Message #5: Populating Monitoring *(Note that this message is not included in any of the 10 Tactics).*

Why this message: This message directs the public who self-evacuated to community reception centers (CRCs) once they have opened. This is not included in any of the Tactics of the first 100 minutes as it is not anticipated that CRCs will be established in this time frame.

Message type: EAS, WEA System, text/SMS, email notification, Facebook, Twitter, press release, Reverse 911

Public Message #5: Population Monitoring

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 smoke or radiation, you may visit a community reception center where you can be screened for radiation exposure and receive needed services.

- *Community reception centers are located at the following: [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 blast and believe you were exposed to smoke from the blast.*

References

Department of Homeland Security. 2013. Improvised Nuclear Device Response and Recovery: Communicating in the Immediate Aftermath.

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 a terrorist explosion. In addition to radiation, there are other hazards that could result from a terrorist device and there will likely be dangers from the explosion itself.

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. Although this groundshine due to contamination is a concern for emergency personnel, the most significant hazard within the first 15 minutes of the response will be from airborne radioactivity in the undiluted plume of aerosol. Factors, such as when emergency personnel arrive on scene, the location in which they are operating, and the type of dispersal, will guide the appropriate PPE that should be used when conducting lifesaving rescue operations.

In general, emergency personnel should always practice the As Low As Reasonably Achievable (ALARA) principle to mitigate the hazards associated with radiation. Maximizing distance, minimizing time and using appropriate shielding will reduce the intake of airborne radioactivity and minimize external radiation dose.

Airborne Radioactivity

Acute levels of airborne radioactivity 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 can be dangerous without respiratory protection. 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 are unlikely to encounter dangerously high airborne concentrations that could result in an acute internal dose. Emergency personnel who first encounter the plume downstream 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 re-suspension will have relatively low concentrations.

Whole Body Exposure

Although not as significant as inhalation exposure, groundshine due to removable contamination or fragments deposited on the ground is a concern for emergency personnel. Depending on the quantity of radioactivity and the design of the device, there may be high radiation levels in the vicinity of the detonation, but not such that responders cannot enter before radiation instruments and personal dosimeters are brought to 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 not likely to exceed occupational levels of dose, 5 rem (50 mGy), 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 (250 mGy), before radiation instrumentation is available. Any type of dose rate instrument that is not off scale 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 (for example, smoke from a fire). Other hazards at the scene may dictate the need for additional equipment. The recommendations are summarized below.

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

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 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 dry cloth or handkerchief placed over the nose and mouth should be used to escape from the area and take shelter in an indoor area. Sheltering will avoid inhalation of a high concentration of airborne radioactivity. **In some cases, wet/damp material 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 cause inhalation of particles. The smoke plume after an explosion is a visual reference where there may be high airborne concentrations near the point of detonation.

Respiratory Protection – Responders on Scene in First Approximately 15 Minutes

Use of positive-pressure Self Contained Breathing Apparatus (SCBA) to the extent practical is recommended only for the first to 10 – 15 minutes after the detonation. Use of SCBA protects responders from inhaling airborne radioactivity, while assuring an optimal immediate response to the incident.

Recognizing that wearing an SCBA may not be possible while driving a vehicle, drivers should wear a full-face air-purifying respirator with a P-100 filter or a High-Efficiency Particulate Air (HEPA) filter instead. To further minimize the 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 for upper body contamination, especially around the nose and mouth, and if contamination is found should be referred for medical evaluation.

Respiratory Protection – Responders on Scene After 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 re-suspension, will be relatively low. Using an air-purifying respirator (APR) is sufficient for respiratory protection. Half-face APR or N95 respirator (many responders typically use a full-face one that affords more protection) are recommended. Supplied air respirators are excessive for this level of airborne radiation hazard.

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.

Removable Contamination – All Times

With the exception of bunker gear, first responders wearing a duty uniform have little exposed skin. In addition, they should wear regular duty uniform, protective eyewear 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 instrumentation to help minimize external exposures, enable the responder to locate low background areas to stage operations, control the time spent in higher levels, and increase the distance from known hot spots in areas where responders are operating.

Minimum Recommended PPE for Responders in Initial RDD Response			
Equipment	**Hazard**	**Protection**	**Timeframe in the Response**
APRs (any type)	Airborne Radioactivity	If SCBA is not available, protects responders from inhalation of airborne particles	For the first 15 minutes of the response (if SCBA is not available)
Positive Pressured SCBA	Airborne Radioactivity	Protects responders from inhalation of airborne particles	For the first 15 minutes of the response
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 degrades ability to conduct operations (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
Equipment	**Hazard**	**Protection**	**Timeframe in the Response**
N95 Respirator	Low-level Airborne Radioactivity	Protects responders from inhalation of airborne particles	After the first 15 minutes
Protective Eyewear	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

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.

Musolino, SV, Harper, FT. Emergency Response Guidance for the First 48 Hours After the Outdoor Detonation of an Explosive Radiological Dispersal Device, Health Physics, 90:377-385, 2006.

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

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 Analyst Decision-Support Guide

During the first 100 minutes of a response to a radiological dispersal device (RDD) detonation, a number of key decisions will need to be made to protect the health and safety of both first responders and the public. This decision-making should be driven by analysis of data collected by responders in the field. It is critical to identify which local agency possesses enough expertise in radiological health and safety to analyze the data and support decisions based on incident specifics as the radiological environment is mapped. The table below is a quick guide to help local data analysts understand their role in the first 100 minute response. The data analyst position is likely not the decision-maker, but is instead the person within the incident command system or the jurisdiction's response who advises the decision-maker based on radiological subject matter expertise.

For reference:

- Initial upwind shelter-in-place recommendation is 500 m (~1600 ft)
- Initial downwind shelter-in-place recommendation is 2000 m (~1.2 miles)

Objective	Field Activity	Decision	Analyst	Outcomes
Presence of radiation	First responders on scene take two radiological measurements at two locations using two different instruments that show radiation levels are above background level	Confirm that a radiological incident has occurred	Hazmat Unit	• Activate the jurisdiction's RDD response protocol • Issue Public Messaging #1/1a/2 with default shelter-in-place boundaries of 500 m (~1600 ft) in all directions
Direction and magnitude of radiological contamination	From multiple approaches, Strike Team 1 moves from 100 m (~330 ft) out from the detonation point to 20 m (~65 ft) out from the detonation point and stops if they reach a Dangerous Radiation Zone of 10 R/hr (0.1 Gy/hr)	Discernable direction from detonation site with highest radiological contamination indicates the direction and magnitude of radiological contamination	Hazmat Unit (Strike Team 1)	• Determine where to conduct the 1 km (~0.5 miles) Transect • Indicates potential magnitude of radiological contamination • Preliminary indication of aerosol dispersal ("smoke") versus fragmentation dispersal ("BBs")

Objective	Field Activity	Decision	Analyst	Outcomes
Presence of alpha contamination	Strike Teams 1 and 2 conduct surface contamination measurements with alpha and beta probes	Determine if there is alpha contamination	Radiation Control Department / Hazmat Unit	• If no alpha is found, Strike Teams 1 and 2 can discontinue alpha monitoring • If alpha is found, first responders can begin to define the boundary of the Hot Zone based on 6,000 dpm/cm^2 at 0.5 cm (~0.25 inch) 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), 60,000 dpm/cm^2 at 1.5 cm (~0.5 inch) beta and gamma criteria • First responders should continue gamma measurements
Pattern of contamination at the detonation site	Strike Team 1 takes shielded and unshielded measurements at 100 m (~330 ft) upwind; the results are **different** by a significant margin	Consider reducing the distance for upwind shelter-in-place from 500 m (~1600 ft) to 250 m (~800 ft)	Hazmat Unit	• Indicates that there is a significant hot spot in the direction of the detonation site but little radiological material in other directions • Indicates that few or no BBs dispersed upwind • Expect little radiological cleanup necessary upwind from detonation site
	Strike Team 1 takes shielded and unshielded measurements at 100 m (~330 ft) upwind; the results are **similar**	Maintain the upwind shelter-in-place boundary of 500 m (~1600 ft) until further measurements are taken	Hazmat Unit	• Indicates that there could be BBs dispersed upwind • Expect cleanup efforts and other response activity to be required upwind from the detonation site

Objective	Field Activity	Decision	Analyst	Outcomes
Assess the extent of contamination downwind	Strike Team 2 takes radiological measurements along the 1 km Transect and finds radiation at background levels	There is no contamination present at or beyond 1 km	Radiation Control Department	• Indicates that device did not result in a significant amount of smoke • Response and recovery efforts will be focused close to the detonation site
	Strike Team 2 takes radiological measurements along the 1 km (~0.5 miles) Transect and finds radiation at background levels and Strike Team 1 takes radiological measurements at 100 m (~330 ft) in the upwind direction from detonation site and finds radiation at background levels	Consider releasing all populations that are sheltering in place	Radiation Control Department	• Indicates that device contained very little radioactive material or dispersed very little radiological material; or device may have malfunctioned • Response and recovery efforts will focus close to the detonation site
Assess the extent of contamination downwind and confirm initial assessment of wind direction	Strike Team 2 takes radiological measurements along the 1 km (~0.5 miles) Transect and confirms that surface contamination exists	There is contamination beyond 1 km (~0.5 miles) and likely further downwind	Radiation Control Department	• Indicates that radiological material was dispersed through smoke downwind • The highest point of the surface contamination on the 1 km (~0.5 miles) Transect will indicate direction of contamination

Annex 5: RadResponder Integration

RadResponder is the national standard and whole community solution for the management of radiological data during an emergency. The RadResponder Network is the product of collaboration among the Federal Emergency Management Agency (FEMA), Department of Energy (DOE)/National Nuclear Security Administration (NNSA) and Environmental Protection Agency (EPA). RadResponder 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. RadResponder can be accessed on smartphones, tablets (iOS, Android, Windows) and via the Web (www.radresponder.net), allowing it to be seamlessly and rapidly employed at all levels of government during a response to a radiological or nuclear emergency. For more information, please contact RadResponder at support@radresponder.net.

Using RadResponder in the first 100 minutes of a radiological dispersal device (RDD) detonation response will allow first responder agencies to manage and map radiological data collected in the field and provide response organizations with a common operating picture of the radiological environment. Integrated throughout this Planning Guidance are tips and action items for first responder agencies to take to effectively use RadResponder during the response. In this annex, additional information is included on how to use RadResponder to achieve some of the objectives outlined throughout the Tactics. This annex assumes that first responder agencies in the field have RadResponder accounts at the time of the incident and data analysts in the Emergency Operations Center (EOC) are also equipped with RadResponder 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 RadResponder document library, accessible via www.radresponder.net.

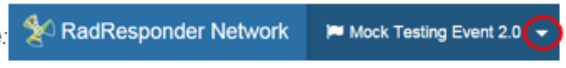
Tactic 3: Give Report from the Scene

RadResponder 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 RadResponder and includes the following points:

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

1. Log in to www.radresponder.net
2. In the top menu bar, click the down arrow next to the event that is currently listed (this may read "Select an Event").

   Example: 

3. Click "Create an Event"
4. Complete at least the required fields, marked with an *
5. Click "Save Changes"

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

Tactic 5: Notify Partners and Request Assistance

RadResponder Action: Share Event with Partners

Share the event in RadResponder 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 RadResponder partnerships to better facilitate this process during an actual incident. For information on establishing standing partnerships, view the RadResponder User Guide, located in the Document Library under the Resources tab on the RadResponder website (www.radresponder.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 the Event Dashboard page, click the Partners tab
2. Click Manage then + Add Partner
3. Use the Quick Search field to search for the organization(s) with whom you would like to share data, then click + Add next to those organizations' names
4. Click Continue then click "Save Changes"

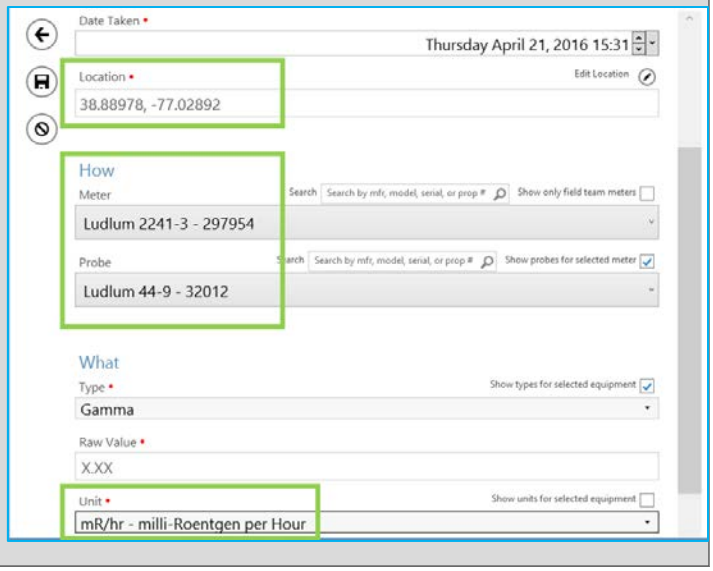
Tactic 8: Measure and Map Radiation Levels

RadResponder Action: Record Radiological Measurements

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

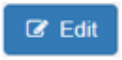
- Location of survey or observation (this can be done using smartphone location enabled technology or through a "pin drop" at specific street locations)
- Instrument type
- Units of measure

For one-page job aids on collecting data using the RadResponder mobile applications, visit the Document Library, located under the Resources tab, on the RadResponder website (www.radresponder.net).

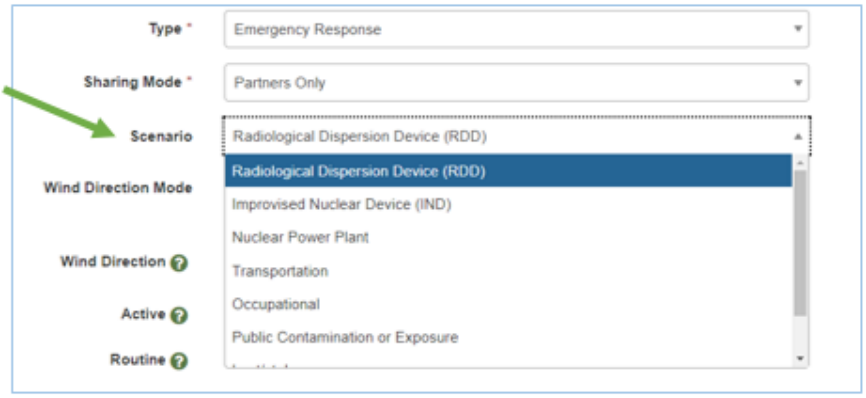


RadResponder Action: Classify Event as an RDD and Use Geo-shapes for Initial Protective Action Boundaries

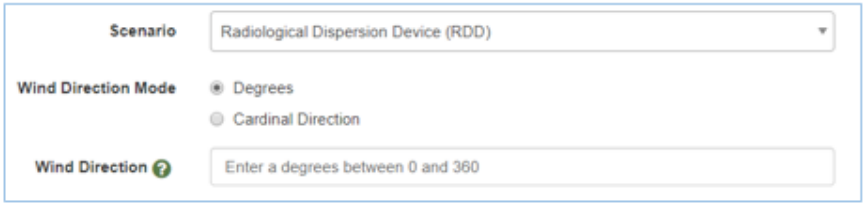
Once the direction of contamination is established, the event in RadResponder should be classified as an RDD event and the wind direction should be added into RadResponder. Classifying an event in RadResponder as an RDD will allow users to add geo-shapes onto the map of the initial Hot Zone and Shelter-in-Place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

1. From the Event Details page, click 

2. Change Scenario to RDD

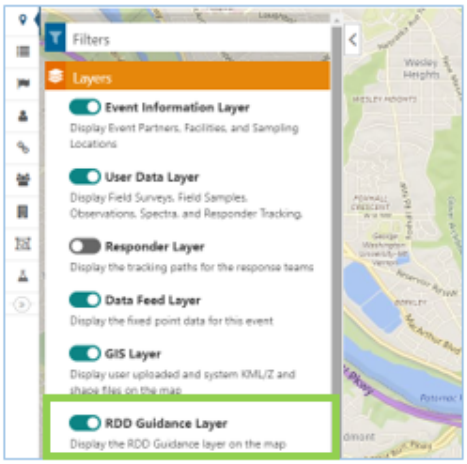


3. Choose Wind Direction Mode and input Wind Direction. Hover over the question mark for an explanation of how Wind Direction degrees are determined.



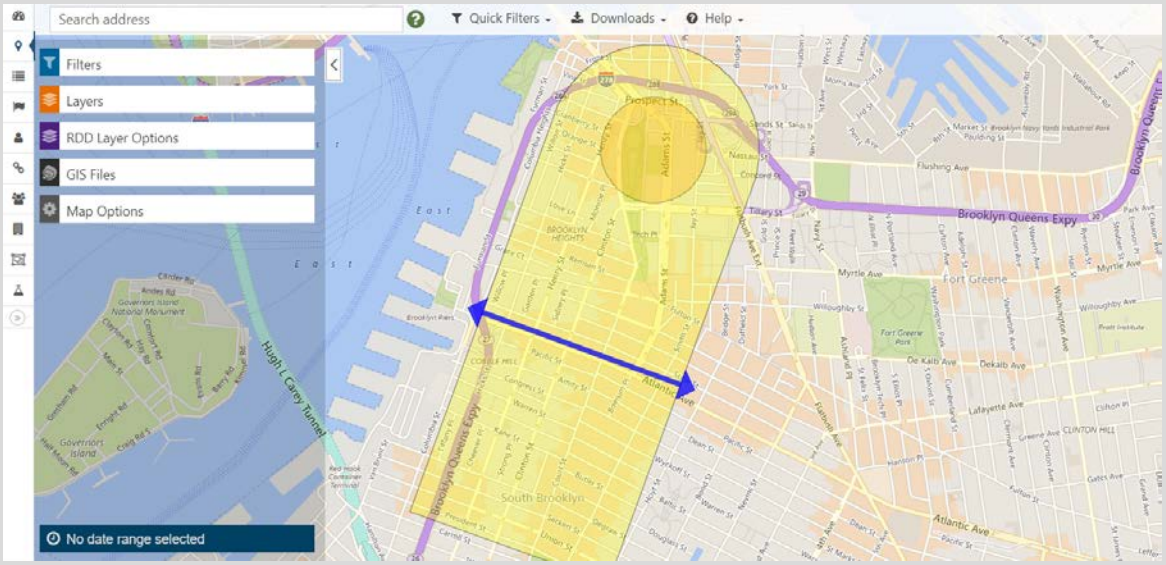
4. Click "Save Changes"
5. In the left panel menu, click 

6. In the Layers menu, turn on the RDD Guidance layer to display the geoshapes.



RadResponder Action: Adding the 1 km (~0.5 miles) Transect

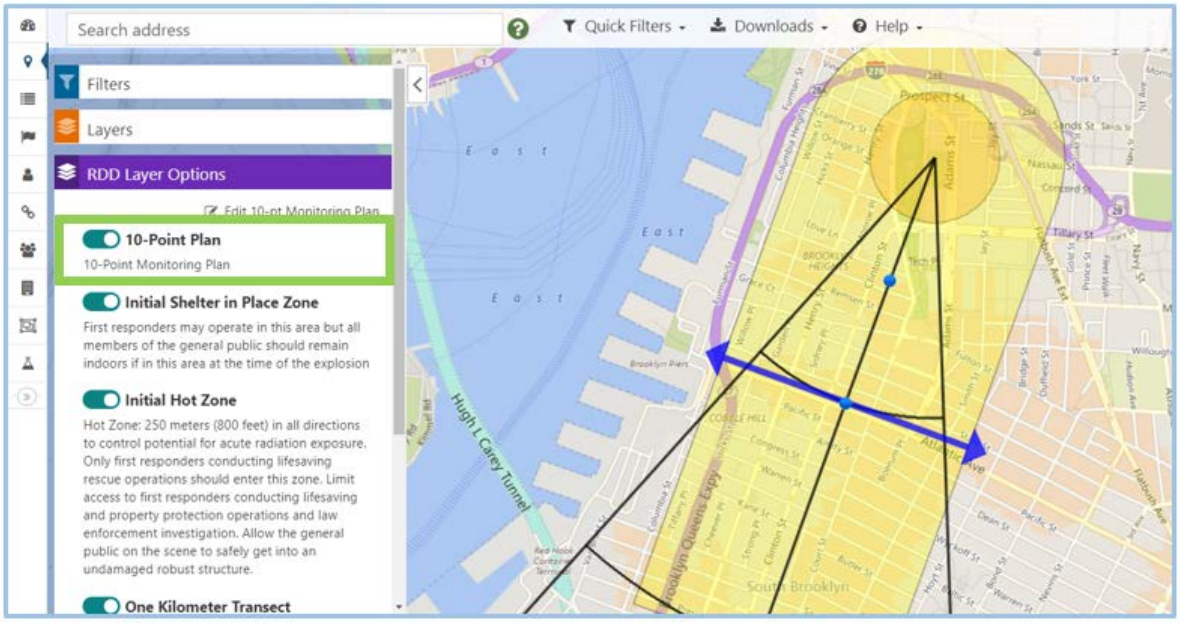
If an event is categorized in RadResponder as an RDD and direction of contamination is known, a 1 km transect (~0.5 miles) downwind will automatically highlight on top of the Shelter-in-Place Zone. This allows responders to visually see the 1 km (~0.5 miles) transect and determine starting and end points that require radiological monitoring.



RadResponder Action: Adding the 10 Point Monitoring Plan

A 10 Point Monitoring Plan layer can be added into RadResponder to allow first responders to visualize the suggested points for monitoring on a map.

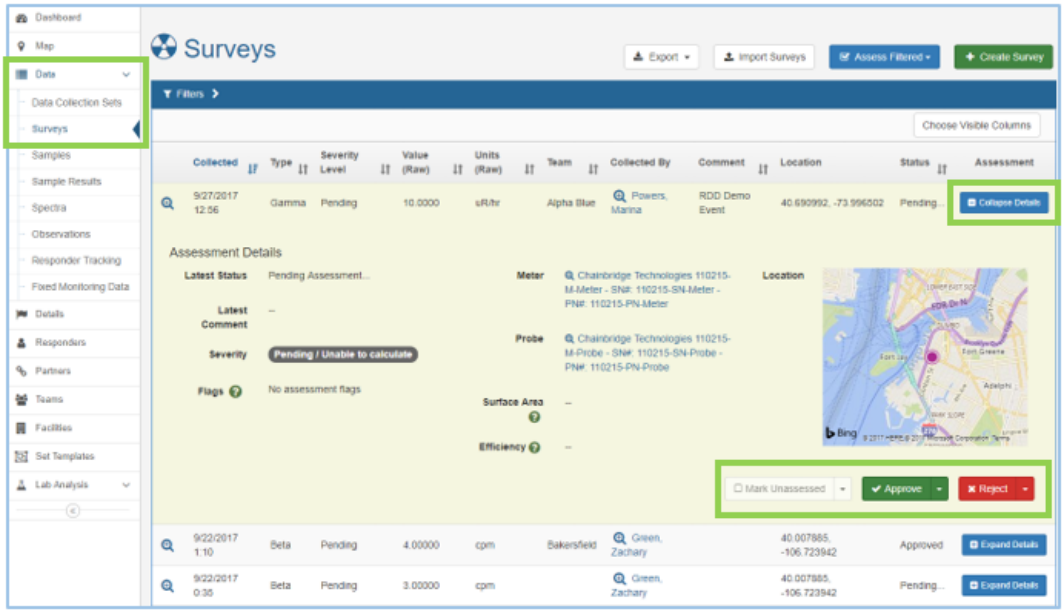
1. On the Event Map select the "RDD Layer Options" menu
2. Turn on "10-Point Plan"



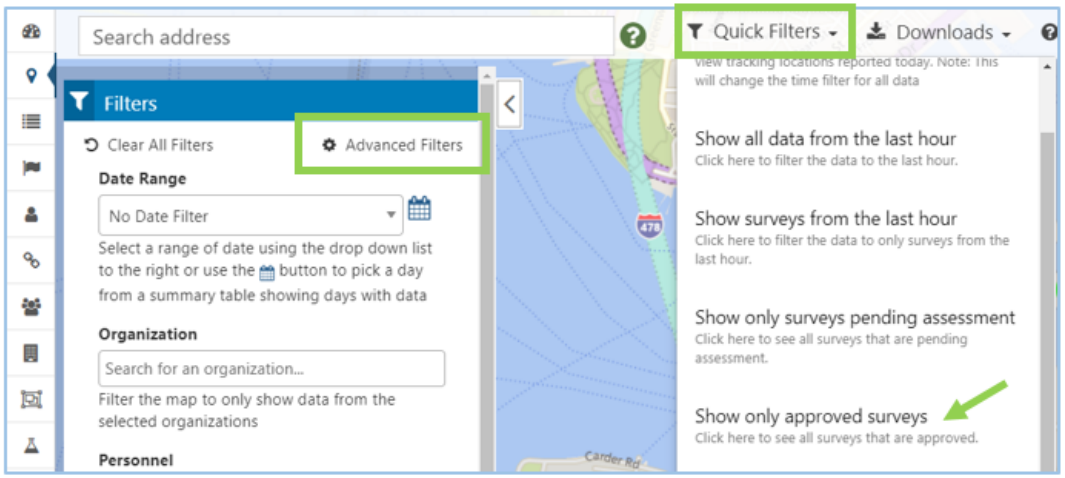
RadResponder Action: Evaluating, Validating and Analyzing Data

As strike teams at the Detonation Site, in the Near Field, and downwind collect radiological data and upload it into RadResponder, analysts in the Incident Command Post and EOC should evaluate data in RadResponder 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 analyze the data in RadResponder and make recommendations for additional responder health and safety, evacuations, and additional protective actions. The DOE's Consequence Management Home Team is available remotely to support analysis of radiological data.

Assess (approve or reject) data on the data details pages on the Event Map, or via the Data Tables.



On the Event Map, analysts may use the Advanced Filters or Quick Filters to filter to only data that has been approved, rejected, or is pending review.



Annex 6: Protocol for Conducting 10-Point Monitoring Plan

Objective

The protocol for the 10-Point Monitoring Plan during the emergency phase is intended to standardize a method for rapidly obtaining initial radiological information after a dispersion of radioactive material. The use of a standardized protocol facilitates two principle endpoints when a large aerosol fraction is released by a source that results in deposited material downwind 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 10):

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

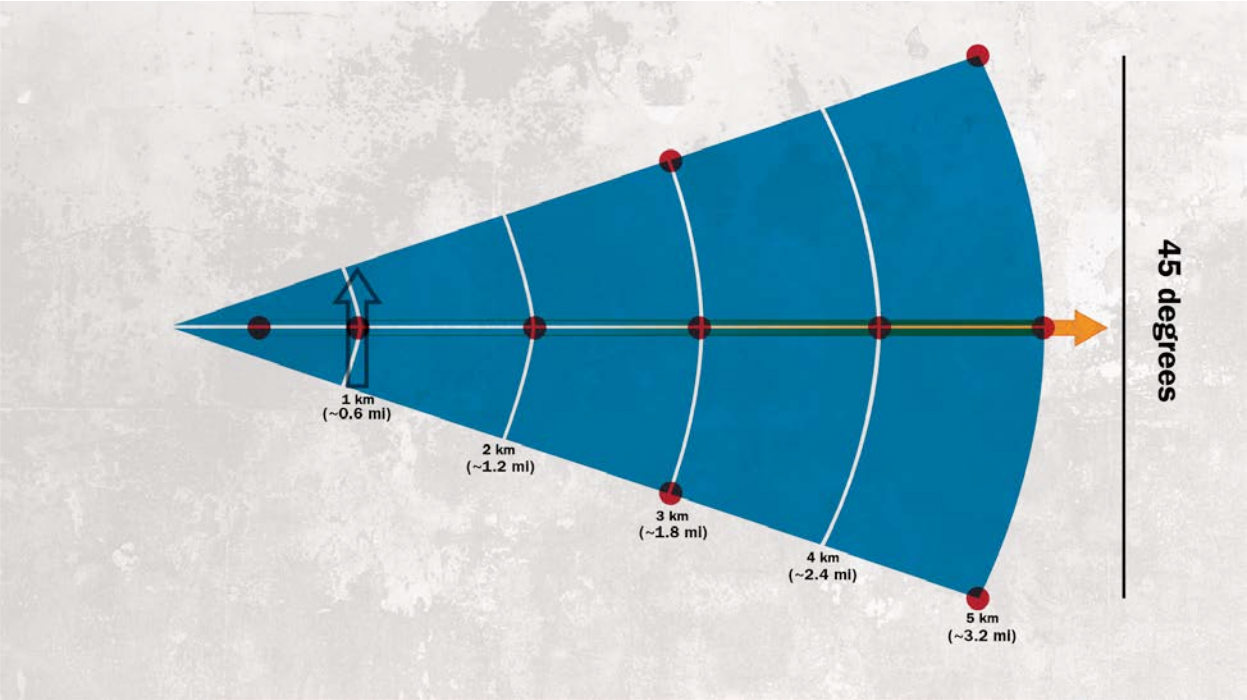


Figure 10: 10-Point Monitoring Plan

A grid of monitoring points can be generated using a number of tools, including RadResponder and CMweb, which is the Department of Energy (DOE) National Nuclear Security Administration (NNSA) Office of Nuclear Incident Response *Consequence Management* web portal. Each of these tools will provide specific locations for each of the 10 points; however, the actual points where measurements are taken do not need to be 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.***

The measurement should be collected only at ground level and not on the tops of buildings in urban areas. This is important because current National Atmospheric Release Advisory Center (NARAC) operational models that will incorporate these measurements do not resolve to individual buildings. These radiological measurements can be collected by a survey 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 RadResponder (See Annex 5 for more information on RadResponder integration).

In this characterization phase, surface measurements at 0.5 cm (~0.25 inch) 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 probe measurements.

Centerline Confirmation

Before the 10-Point Monitoring Plan is commenced, it is recommended to gather data on the actual centerline and associated azimuth of the plume, as conducting the 10-Point Monitoring Plan based on an *assumed* prevailing wind direction could result in an unproductive, time consuming, and null survey. To that end, a survey team should initially conduct a Transect at approximately 1 km (~0.5 miles) 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 1 km (~ 0.5 miles) Transect and the detonation site. Alternatively, if resources permit, two strike teams can be mounted – one can commence the 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 strike teams exist, a Transect at 3 km (~2 miles) should be considered to gather more information about the plume centerline location. ***Record the make/model of instruments and probes and probe efficiencies.***

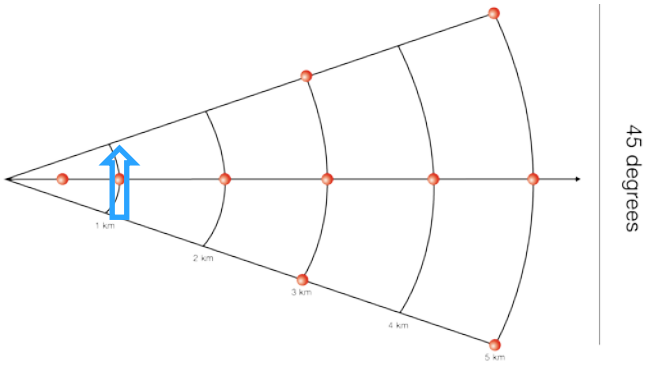


Figure 11: Transect of the Assumed Centerline of the Plume

Potential Outcomes from Survey

There are several potential outcomes from the initial monitoring in the area downwind:

- 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 5 km (~3 miles)?
  - Was the assumed prevailing wind direction inaccurate?
- The selected points were not accessible:
  - This could happen near bodies of water, private property or for other reasons.
- 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).
- Higher contamination levels were found at points more distant than close:
  - Expand the distances used in the template from 5 to 7 km and augment the monitoring by adding four additional points, one on the centerline at 6 km and three at 7 km at 22.5, 0, and -22.5 degrees azimuth.

Figure 12: 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 sampled without the surface contamination probes. Based on where and how many points are sampled 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 1 m (~3 ft) above the ground.
- Alpha contamination at 0.5 cm (~0.25 inch) above the ground (not required for points beyond the 1 km Transect).
- Beta contamination at 1.5 cm (~0.5 inch) above the ground (not required for points beyond the 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 first 100 minutes of a response to an RDD detonation. The questions may prompt jurisdictions to identify roles and responsibilities, and help determine existing or new resources needed for this type of response. Further use of this annex may include helping jurisdictions identify gaps in their radiological preparedness efforts to improve response and recovery operations.

Tactic 1: Initial Response & On Scene Recognition

(Timeline: Explosion + 1 minute)

1) What agencies respond to the report of an explosion? What are the first agencies on scene? _____
2) For these agencies first arriving on scene, what are the first operational assignments of responders? _____
3) Are the first assets on scene equipped (personnel or vehicles) with radiological detection equipment? YES or NO

YES

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

_____

b) What type of instrument(s) are they equipped with? _____

_____

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

_____

d) Are there protocols for ensuring equipment is calibrated and in a "ready-state"? _____

NO

a) What agency would the first responders on scene call to take a radiological reading? _____
b) How soon can an agency with radiological detection equipment arrive on scene? _____
c) What is the protocol for requesting this team to the scene of an explosion?

_____

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

Tactic 2: Confirm the Presence of Radiation

(Timeline: Explosion + 5 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? _____

Tactic 3: Give Report from the Scene

(Timeline: Explosion + 6 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 these arriving agencies or units en route to the incident notified before arriving on scene that radiation was present? How? _____
   _____
5) Will any agencies on scene be collecting the following data? If yes, how will they be collecting it, what units will be used, and who will they give it to?
    a) Radiation readings with specific locations _____
    b) Prevailing wind direction and approximate wind speed _____
    c) Extent of damage to surrounding buildings, including broken windows _____
       _____
    d) 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 (RadResponder, 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? _____

Tactic 4: Issue Protective Action to the Public

(Timeline: Explosion + 7 minutes)

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

1) How is Public Message #1 released?

a) What agency/agencies will release Message #1? _____

a) What media do they use to issue message? _____

b) At what time in the response can you anticipate disseminating this message to the public? _____

c) Can anything be done in advance to reduce your time estimate for when this message can be released to the public? _____

d) What information do you require to disseminate this message?

_____

e) Who provides this essential information? _____

Tactic 5: Notify Partners and Request Assistance

(Timeline: Explosion + 10 minutes)

Assumption: Local agencies do not have enough technical or operational capabilities to fully assess and manage the mid-to-long term environmental impacts of an RDD and should immediately request state/federal assets. Some support assets will respond on their own authority. Some assets can support immediately, but will not be on scene (example: Interagency Modeling Atmospheric and Assessment Center / National Atmospheric Release Advisory Center (IMAAC/NARAC).

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? _____

_____

5) What agency is responsible for writing pre-scripted requests for state and federal RDD support assets? _____

6) What, if any, pre-scripted mission requests with the state do you have? _____

_____

Tactic 6: Initiate Lifesaving Rescue Operations

(Timeline: Explosion + 2 minutes)

Assumptions: Responders are on the scene of the explosion and beginning to 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? 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) What media do they use to issue 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? _____

Tactic 7: Secure and Manage the Scene

(Timeline: Explosion + 10 minutes)

Assumptions: Responders are conducting lifesaving rescue operations. An initial identification of the Shelter-in-Place Zone and Hot Zone is defined and law enforcement is on scene blocking intersections, directing traffic and providing crowd control. Law enforcement is 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 agencies on scene ensure that lifesaving rescue operations can continue during this mission? _____

Tactic 8: Measure and Map Radiation Levels

(Timeline: Explosion + 15 minutes)

Assumptions: Initial Hot Zone and Shelter-in-Place Zone are set and the public is sheltering in place. Responders are on scene conducting lifesaving rescue operations. Additional responders are on 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 phased 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 strike teams can the agencies pull together? _____

_____

5) How many responders are on each strike 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 (fire houses, police stations) will be used to take measurements, how will they be reported to the command element and the EOC? _____

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

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

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

_____

Tactic 9: Commence Phased Evacuations

(Timeline: Explosion + 60 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 scene to assist with population monitoring? _____

_____

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

_____

5) How will agencies notify 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 Sheltered-in-Place Zone? _____

8) What agency will arrange the press conference for release of Public Message #3?
   a) What agency/agencies will participate? _____
   b) What media do they use to issue 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? _____

Tactic 10: Monitor and Decontaminate

(Timeline: Explosion + 60 minutes)

Assumptions: Responders on 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 actually 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 (that includes staffing, contamination monitoring equipment and other resources, for example) 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? _____
6) What agencies will transport evacuating persons that require medical care to hospitals? _____
7) How will evacuating populations be notified of CRC locations? _____

Annex 8: Radiological Dispersal Device (RDD) Initial Report Form

RDD INITIAL REPORT FORM

Reported by (Name): Agency: Unit:	Date/Time (24 hrs):

LOCATION

Approximate Location:

RADIATION READINGS

Record any initial radiation readings from the scene

#	Responder Name	Reading w/ Unit of Measure	Instrument	Location (GPS Lat/Long)	Typical Background if Known
1					
2					
3					
4					

WEATHER

Record weather observations at the time units arrive on scene

Wind direction is from:	
Direction smoke is moving/went:	
Approximate wind speed:	
Precipitation:	

HAZARD AND DAMAGE ASSESSMENT

Record any observable damage from the explosion

Damaged or collapsed buildings:	
Extent of broken windows:	
Estimated number of casualties:	
Other hazards on scene (fire, chemical release, etc.):	
Infrastructure damage (roadways, public transit, water mains, etc.):	

Annex 9: Key References

This Planning Guidance is focused on the initial 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 additional planning for the response and recovery from a radiological dispersal device (RDD). The links 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

Conference of Radiation Control Program Directors, Inc. 2006. *Handbook for Responding to a Radiological Dispersal Device First Responder's Guide – the First 12 Hours.* http://www.crcpd.org/RDD_Handbook/RDD-Handbook-ForWeb.pdf

Federal Emergency Management Agency, Office of Response and Recovery, Planning and Exercise Division, National Planning Branch. 2016. *Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans.* https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf

Federal Emergency Management Agency. 2013. *National Response Framework: Second Edition*. https://www.fema.gov/media-library/assets/documents/32230

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.

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US Department of Homeland Security. 2013. *Improvised Nuclear Device Response and Recovery: Communicating in the Immediate Aftermath.* https://www.fema.gov/media-library-data/20130726-1919-25045-0892/communicating_in_the_immediate_aftermath__final_june_2013_508_ok.pdf

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://www.remm.nlm.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.* http://www.acq.osd.mil/ncbdp/narp/docs/pdf_Functional_Areas/Contamination%20Control_Rev1_bm122211.pdf

Public Health and Emergency Medical Services

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/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://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf

US Department of Health and Human Services. Centers for Disease Control and Prevention. 2015. *A Guide to Operating Public Shelters in a Radiation Emergency.* https://emergency.cdc.gov/radiation/pdf/operating-public-shelters.pdf

US Department of Health and Human Services. Radiation Emergency Medical Management. Guidance on Diagnosis and Treatment for Health Care Providers. *Managing Patients After a Nuclear Detonation – First Responders Key Initial Issues.* https://www.remm.nlm.gov/SummaryInitialActionsPostIND_EMSStaff.pdf

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Homeland Security

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