Los Angeles County
Multi-Agency Radiological Response Plan

Volume I

Responder Field Manual

For Official Use Only

February 2009

CAUTION!
This manual ONLY addresses radiation related matters. Other incident hazards must be considered when making health and safety decisions.

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Prepared for
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How to Use this Responder Field Manual

The structure and organization of the Los Angeles County Multi-Agency Radiological Response Plan is designed for practical use during an emergency. The Multi-Agency Radiological Response Plan is divided into two volumes. Volume I is a "Responder Field Manual" to provide the most important information, procedures, and considerations for a responder in the first 24 hours of an incident. Responders should use this manual during an incident, remove the various sections, and distribute them to appropriate individuals. The Responder Field Manual (Volume I) has eight sections as follows:

(1) Information Cards: contains refresher information for all responders
(2) Summary Tables: contains summary information regarding Activity Playbooks for Incident Commander
(3) Position Job Aids: contains guidance to individuals responsible for various Incident Command positions
(4) Activity Playbooks: contains guidance to responders responsible for performing various activities
(5) Standard Operating Guides: contains all Standard Operating Guides referenced in the Playbooks for easy removal and reproduction
(6) Instructions: contains all Instructions referenced in the Playbooks for easy removal and reproduction
(7) Forms: contains all Forms referenced in the Activity Playbooks for easy removal and reproduction
(8) Tables: contains all Tables referenced in the Activity Playbooks for easy removal and reproduction

Volume II contains the "Extended Plan," which follows the format of a traditional emergency operations plan and provides additional information to support and supplement Volume I. Use the Extended Plan if additional details for any Activity Playbook or other information is needed.

For consistency purposes, the table numbers in Volume I are the same as Volume II thus are not numbered in sequential order. The page numbers in the bottom left corner indicate the number of pages in that specific section so that if removed from the manual, the user will know how many pages should constitute a complete section.

Position Job Aids and Activity Playbooks should be removed and given to appropriate responders.

Note that when the plan references Los Angeles County, Department of Public Health, Radiation Management, those actions may also be performed by the California Department of Public Health, Radiologic Health Branch. These programs integrate and respond as one entity during a radiation incident.

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First 30 Minutes of Radiological Response

This information card provides guidance that responders should consider during the first 30 minutes of a response to a radiological incident.

- Rescue victims without exceeding radiation decision points, unless approved by the Incident Command/Unified Command.
- Do not delay medical treatment of victims with life-threatening injuries to perform decontamination.
- Wear appropriate personal protective equipment until directed otherwise.
- Wear a dosimeter if available (not required).
- Notify Los Angeles County, Department of Public Health, Radiation Management at 213-351-7897 during work hours or 213-974-1234 after hours.
- Contamination is a secondary concern to critical operations (lifesaving and protection of critical infrastructure).
- Begin setting up radiation control zones. Until those zones are established, assume an isolation/evacuation zone of 1,650 feet (500 meters).
- The plume from a radiological dispersal device (RDD) should settle within the first 10 to 20 minutes.
- Do not contain decontamination runoff.
- A person exposed to radiation is not necessarily contaminated.

Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!

Contamination is not immediately life-threatening.

Cross contamination issues are a secondary concern if the incident affects a large population.

Radiation dose to workers is of paramount importance but can be managed so responders can complete critical activities.

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Radiological Response Rules of Thumb

This information card summarizes important rules of thumb related to responding to a radiological incident.

1. Responders should minimize their exposure to radiation and contamination while performing emergency response functions by utilizing Time, Distance, and Shielding principals.
2. For outdoor explosions, most airborne radioactive dust will settle to the ground within about 10 to 20 minutes.
3. Individuals should wear appropriate personal protective equipment until further direction from the incident Safety Officer. However, at least a dust mask and disposable overshoes, if available, should be worn.
4. If a radiation instrument is not available, evacuate to 1,650 feet (500 meters) from the detonation or release site in all directions.
5. Check to determine the presence or absence of alpha radiation. Alpha is an inhalation and ingestion hazard. See *Standard Operating Guide No. 2: How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter* and Playbooks 6 and 7.
6. Removing outer clothing may eliminate up to 90% of contamination.
7. For large incidents, release contaminated runoff to the stormwater or sewer system.
8. Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!
9. Exposure to radiation without contamination does not require decontamination.
10. Universal precautions should be used in any situation where the presence of radioactive materials is suspected to help prevent the spread of contamination from injured victims to emergency personnel. However, contamination on victims is not an immediate health risk to emergency personnel.
11. Protect the public from direct exposure to radiation, especially for gamma and beta radiation. Stay as far away as possible from radiation sources and contaminated areas. The public in these areas should seek shelter indoors rather than stay outside.
12. Avoid inhalation and ingestion of contamination. This is particularly important for materials that emit alpha radiation. Responders should use a respirator. Public should use a folded handkerchief or cloth over their mouths and noses.
13. Suggested release levels using a Pancake Geiger-Mueller detector at 1-inch from a person's body are:
    - In general, it is not necessary to decontaminate people to less than 10,000 cpm (beta/gamma), unless the number of people is small compared to decontamination resources. With approval, allow people with contamination up to 100,000 cpm to leave if sufficient resources are not available. Instruct released people to go home and take a shower.
    - People contaminated to levels greater than 100,000 cpm are likely to have internal contamination and should be identified as a priority for decontamination and follow-up evaluation for internal contamination.
14. Identify the areas with the highest suspected radiation and control access to these areas. Unless necessary to save lives or protect critical infrastructure, do not enter these areas.
15. The word "limit" is not used in the context of this Multi-Agency Radiological Response Plan for pre-established health and safety parameters. Instead dose, exposure rate, and contamination values are provided as guidance and called "levels" or "decision points." Radiation protection principles should be followed, and responders should strive to minimize their radiation dose in the performance of their duties. However, a dose greater than an occupational regulatory limit of 5 rem in a year may be warranted for critical actions such as rescue of a victim.
16. Set Decision Points at lowest levels initially and increase as necessary.
17. If possible, manage responder doses to ensure that individuals do not reach a dose level that requires them to be temporarily taken out of service.

Radiological Response Rules of Thumb (continued)

The following are additional important information. These are a compilation of most text boxes found throughout Volume I and Volume II.

- Position Job Aids and Activity Playbooks summarize the most important radiological information a responder needs to complete critical actions and should be removed and given to appropriate responders.
- Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!
- Lifesaving activities take priority over decontamination.
- Radioactive contamination is rarely an immediate health threat. Two exceptions are the fallout from a nuclear detonation and radioactive shrapnel embedded in a person.
- Use tongs or hemostats to remove highly radioactive shrapnel from a victim, if it can be done safely.
- Cross contamination issues are a secondary concern if the incident affects a large population.
- Surveys for radiation must be performed in an area with background levels that are at least one tenth or 10% (preferably one hundredth or 1%) of the contamination release level; i.e., a contamination release level of 10,000 cpm requires a background area of less than 1,000 cpm and ideally below 100 cpm.
- A person has external contamination when radioactive materials are on their skin, hair, or clothing.
- A person has internal contamination when radioactive materials are inhaled, ingested, injected, or absorbed through the skin or a wound.
- Removing the outer layer of clothes from a person should remove 80 to 90% of external contamination.
- Do NOT contain decontamination fluids; release to stormwater/sewer system.
- Radiation dose to workers is of paramount importance, but can be managed so responders can complete critical activities.
- Practice radiation protection methods to reduce exposure as much as possible by reducing exposure time, increasing distance from contamination, and using shielding when possible.
- Respiratory protection is mandatory in the Exclusion Zone during the initial phase!
- Standard fire fighting gear and respiratory protection is protective for skin and internal contamination but not protective for external exposure to gamma radiation.
- For the purposes of this plan, 1 R (roentgen) = 1 rem = 1 rad.
- Memory Aid for Radiation Measurements: µR = OK, mR = Maybe, R = Rethink
- Radiation Technical Specialists should be integrated into Incident Command System as soon as possible.
- Never separate family members from each other.

Radiological Instrument Summary

This information card is a quick reminder or primer on radiological instrumentation types, uses, and cautions.

Detector: Pancake Geiger-Mueller
Detects: Alpha, Beta, Gamma
Typical Uses: Contamination surveys
Cautions: Not very efficient for gamma radiation. Detector window has a thin mylar cover that holds a gas inside the detector, if punctured the reading will drop to zero and the detector will not function; it cannot be repaired in the field.

Detector: Sodium Iodide (a crystal) scintillator
Detects: Gamma radiation only
Typical Uses: Exposure rate (µR/hr) and activity (cpm) measurements
Cautions: Detector crystal and electronics are shock sensitive

Detector: Zinc Sulfide scintillator
Detects: Alpha radiation only
Typical Uses: Confirm presence or absence of, and measures, alpha radiation
Cautions: Detector window has a thin mylar cover to prevent detection of light. If punctured, false readings are obtained when exposed to light. Repair by replacing the mylar cover but ensure the mylar density is the same or the detection sensitivity of the detector will change.

Detector: Electronic real time dosimeter (typically an energy compensated Geiger-Mueller detector)
Detects: Gamma radiation only
Typical Uses: Approximate accumulated dose (R or rem) and exposure rate (µR/hr) measurements
Cautions: Dose should be zeroed before entering Exclusion Zone.

Detector: Ion chamber
Detects: Gamma radiation only, if meter has a beta window slide, it can detect high energy beta radiation in the open position.
Typical Uses: Highest accuracy instrument for exposure rate (µR/hr) or dose rate (mrem/hr) measurements.

Detector: Portal Monitor
Detects: Gamma radiation only
Typical Uses: Scan a large number of people, including non-ambulatory victims. Portal Monitor can be configured to scan the sides of vehicles.
Cautions: Instrument cannot detect alpha radiation.

Detector: microR or microrem meter
Detects: Gamma only
Typical Uses: Measure low (micro-levels) radiation field rates. Very sensitive to gamma. Can be used for contamination surveys on people or property.
Caution: Cannot be used in high radiation fields.

Instrument Considerations:
Detectors without anti-saturation circuitry may falsely read zero in a high radiation field. A detector, other than an alpha zinc sulfide scintillator, that reads zero is cause for caution that the detector may have malfunctioned.

Memory Aid for Radiation Measurements

µR = OK

mR = Maybe

R = Rethink

Table 1: Summary of Agencies Responsible for Implementing Activity Playbooks

Activity Playbook	Rad Mgmt*	Fire Hazmat	Fire	Law Hazmat	EPA	DOE	FBI	Coroner	Public Health	Law	CHP	Med
1. Exclusion Zone Operations	NL	**1**	**2**	**3**	NL	NL	NL	NL	NL	NL	NL	NL
2. Initial Incident Control Zones	**1**	**2**	NL	**3**	**4**	NL	NL	NL	NL	NL	NL	NL
3. Monitoring Responders and Equipment for Contamination	**1**	**2**	**3**	**6**	**4**	**5**	NL	NL	NL	NL	NL	NL
4. Monitoring Injured Victims for Contamination	**1**	**2**	**3**	NL	**4**	NL	NL	NL	NL	NL	NL	NL
5. Monitoring Uninjured Victims for Contamination	**1**	**2**	**3**	NL	**4**	**5**	NL	NL	NL	NL	NL	NL
6. Advanced Radiation Measurements	**1**	NL	NL	NL	**2**	**3**	NL	NL	NL	NL	NL	NL
7. Alpha Radiation Detection and Considerations	**1**	**2**	NL	**3**	**4**	**5**	NL	NL	NL	NL	NL	NL
8. Crime Scene Investigations	NL	NL	NL	**1**	NL	NL	**2**	**3**	NL	NL	NL	NL
9. Monitoring People for Contamination at Public Reception Centers	**1**	**2**	**3**	NL	**5**	**6**	NL	NL	**4**	NL	NL	NL
10. Monitoring Public Property for Contamination	**1**	**2**	**3**	NL	**4**	**5**	NL	NL	NL	NL	NL	NL
11. Public Protective Action Guides – Evacuation and Shelter-in-Place	**1**	NL	NL	NL	**2**	**3**	NL	NL	NL	NL	NL	NL
12. Traffic Control and Considerations	NL	NL	NL	NL	NL	NL	NL	NL	NL	**1**	**2**	NL
13. Hospital-Based Operations and Medical Considerations	NL	NL	NL	NL	NL	NL	NL	NL	**2**	NL	NL	**1**

***Rad Mgmt** Los Angeles County, Department of Public Health, Radiation Management; California Radiologic Health Branch will respond with Radiation Management. Note that Radiation Management has a limited number of staff, and they will be more likely to provide oversight, rather than actually conduct the activity.

Fire Hazmat All fire department hazardous materials teams

Fire All fire departments

Law Hazmat All law enforcement hazardous materials teams

EPA United States Environmental Protection Agency

DOE United States Department of Energy

FBI Federal Bureau of Investigations

Coroner Los Angeles County Coroner's Officer

Public Health Los Angeles County Department of Public Health and/or public health agencies

Law All law enforcement agencies

CHP California Highway Patrol

Med Medical Organizations including Emergency Medical Services

NL Not Listed as a primary, secondary, tertiary, etc. resource to perform activity.

Note: The primary agency to conduct each particular activity is listed with a "1", the secondary with a "2", and so on. If the primary agency is not available to conduct the activity, the secondary agency should be tasked and so on. Two or more agencies may be required to conduct a particular activity given the incident circumstances.

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Table 2: Summary of Activity Playbooks Applicable to Radiological Scenarios

Activity Playbook	RMR	RED	RDD
1. Exclusion Zone Operations	Yes	Yes	Yes
2. Initial Incident Control Zones	Yes	Yes	Yes
3. Monitoring Responders and Equipment for Contamination	Yes	No	Yes
4. Monitoring Injured Victims for Contamination	Yes	No	Yes
5. Monitoring Uninjured Victims for Contamination	Yes	No	Yes
6. Advanced Radiation Measurements	Yes	Partial	Yes
7. Alpha Radiation Detection and Considerations	Yes	No	Yes
8. Crime Scene Investigations	Maybe	Yes	Yes
9. Monitoring People for Contamination at Public Reception Centers	Yes	Partial	Yes
10. Monitoring Public Property for Contamination	Yes	No	Yes
11. Public Protective Action Guides – Evacuation and Shelter-in-Place	Yes	No	Yes
12. Traffic Control and Considerations	Yes	No	Yes
13. Hospital-Based Operations and Medical Considerations	Yes	Yes	Yes

RMR Radioactive Material Release (accidental release of materials by fire, transportation accident, etc.)

RED Radiological Exposure Device (accidental or deliberate act to expose people to contained radioactive material)

RDD Radiological Dispersal Device (deliberate act to spread radioactive materials via explosive, fire, or direct release)

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Incident Commander Job Aid

First Priority (actions may occur concurrently)

- Ensure Exclusion Zone and Extreme Caution Area operations are appropriate and authorized (Playbook 1)
  - Ensure safety of responders
  - Rescue of victims is top priority
  - Remove members of the public from the radiation area if possible; shelter-in-place those you cannot.
- Establish initial incident control zones (Playbook 2)
  - Establish an Operational Area around the incident—it may be larger than the Exclusion Zone
- Notify Medical Alert Center that a radiological incident has occurred and victims may require medical attention at local hospitals (Playbook 13). In addition, provide incident radiological characteristics as requested.
- Request Radiation Technical Specialist resources; e.g., Los Angeles County Radiation Management and integrate them into the Incident Command System.
- Establish contamination release levels for responders (and equipment), victim's (and personal property), and public (and personal property) —see guidance in Playbooks
- Ensure proper monitoring of responders and equipment for contamination (Playbook 3)
- Ensure proper monitoring of injured victims for contamination (Playbook 4)
- Ensure monitoring of uninjured victims for contamination (Playbook 5)
- Conduct advanced radiation measurements (Playbook 6)
- Determine the presence or absence of alpha radiation (Playbook 7)
- Establish public reception center(s) for monitoring people for contamination (Playbook 9)
- Perform monitoring of public property for contamination (Playbook 10)
- Determine need for and implement public protective actions, i.e., shelter-in-place and evacuation (Playbook 11)
- Consider traffic control actions (Playbook 12)
- Control and contain radioactive materials as practicable
- Coordinate public messages; Radiation Technical Specialists can assist with developing messages.

Second Priority (actions may occur concurrently)

- Ensure safety during crime scene investigation (Playbook 8)
- Develop plan for ingress and egress into incident for follow-on responders
- Develop plan to mitigate radiological contamination for critical infrastructure
- Develop plan to mitigate radiological contamination or worker exposure at vulnerable/critical facilities
- Determine location of follow-on responder staging area(s) considering incident contamination, exposure levels, and possible extended logistical support (staging of resources are addressed in local plans)
- Establish data management and reporting protocols for radiological data

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Operations Section Chief Job Aid

First Priority (actions may occur concurrently)

- Conduct critical operations in the Exclusion Zone or Extreme Caution Areas such as rescue, evacuation, shelter-in-place, protection of critical infrastructure, crime scene investigations, and other authorized activities (Playbook 1)
  - Ensure safety of responders
  - Rescue of victims is top priority
  - Remove members of the public from the radiation area if possible; shelter-in-place those you cannot
- Establish initial incident control zones during initial entries; i.e., Support Zone, Contamination Reduction Zone, Exclusion Zone, and Extreme Caution Areas (Playbook 2)
  - Establish an Operational Area around the incident—it may be larger than the Exclusion Zone
- Conduct contamination surveys for responders and equipment (Playbook 3)
  - Setup separate decontamination station for responders, if practicable
- Conduct contamination surveys for injured victims and personal property (Playbook 4)
- Conduct contamination surveys for uninjured victims and personal property (Playbook 5)
- If large numbers of individuals are contaminated, consider releasing them to perform decontamination at home; provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* (Playbooks 5 and 9)
- Conduct advanced radiation measurements (Playbook 6)
- Determine the presence or absence of alpha radiation (Playbook 7)
- Conduct decontamination and monitoring at public reception centers (Playbook 9)
- Conduct contamination surveys of public property (Playbook 10)
- Determine need for and recommend protective actions for the public, including advice for evacuation and shelter-in-place areas (Playbook 11)
- Implement traffic control, if necessary (Playbook 12)
- Provide radiological characteristics, as requested, to Medical Alert Center and hospitals receiving patients (Playbook 13)

Second Priority (actions may occur concurrently)

- Ensure safety during crime scene investigations (Playbook 8)
- Implement plan to mitigate contamination or exposure to sensitive/special populations
- Implement plan for ingress and egress into incident for local and non-local responders
- Reduce spreading and contain radioactive materials as practicable
- Register responders, victims, and the public
- Implement plan to mitigate contamination at critical infrastructure
- Implement plan to mitigate contamination or worker exposure at vulnerable/critical facilities
- Verify law enforcement exposures at control perimeter are below Decision Points
- Provide radiological data to Planning Section

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Planning Section Chief Job Aid

First Priority (actions may occur concurrently)

- Track and document incident radiation levels and include them in the Incident Action Plan
- Make notifications; verify Los Angeles County, Radiation Management has been contacted at 213-351-7897 during work hours or 213-974-1234 after hours.
- Develop decontamination plans (Playbooks 3, 4, 5, 9, and 10)
  - Ensure decontamination stations are at a sufficiently low background area
  - Establish contamination release levels for victims and public—see guidance in Playbooks
  - Identify separate decontamination stations for responders and victims, if possible
  - Adjust contamination release levels, if necessary
- Develop Site Safety and Control Plan
  - Include radiation protection methodologies; see Section 3.2.5 of Volume II
  - Document the radiation levels for control zones (Playbook 2)
  - Track responder dose
  - Document dose/exposure rate decision points (Playbook 1)
  - Document justification to exceed the decision points (Playbook 1)
  - Consider advanced radiation measurements (Playbook 6)
  - Consider adjustments of alpha radiation is detected (Playbook 7)

Second Priority (actions may occur concurrently)

- Protection of public (Playbook 11)
  - Plan to implement protective actions, like evacuation or shelter-in-place, if projected dose to downwind populations exceeds Protective Action Guides (PAGs)
  - Plan for the establishment of public reception centers (Playbook 9)
  - Assist with development of public messages with incident Public Information Officer
  - Develop plan to mitigate contamination or exposure to sensitive/special populations
- Develop plan for ingress and egress into incident for follow-on responders (Playbook 12)
- Register responders, victims, and the public
- Make request to restrict airspace to allow responder access and prevent flights through the plume if release is on-going
- Make plan to mitigate contamination at damaged critical infrastructure
- Develop plan to mitigate contamination or worker exposure at vulnerable/critical facilities
- Plan for special operations (search and rescue, crime scene investigations, recovery of decedents) in Exclusion Zones and Extreme Caution Areas (Playbook 1 and 8)
- Develop strategy for sustained operations in elevated radiation areas, if needed
- Decontamination of public property (Playbook 10)
  - Develop strategy for release of contaminated public vehicles
  - Develop strategy for release of contaminated personal property
- Determine location of non-local responder staging area(s)
- Establish radiological data management and reporting protocols

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Public Information Officer Job Aid

See Volume II, Attachment 5 for pre-scripted Los Angeles County Department of Public Health Draft Public Information Statements, Situational Statements, General Statements, and Answers and Questions.

Initial talking points are:

- The area of contamination is limited and is being defined by emergency response personnel.
- Stay where you are and listen to the news for further instructions. Updates will be given periodically.
- The safest place for you is to stay indoors unless specifically directed by public officials.
- Tap water is safe to drink and bath in.
- Food inside your house is safe to eat.
- If you are concerned that you may have radioactive dust on you, remove your clothes and place them in a plastic bag, take a shower, and wash your hair, but do not use conditioner because it can trap radioactive dust onto your hair.
- Public reception centers where you can go to be checked for radiation will be established as soon as possible. Officials will announce the locations of these centers.
- Do not go to the hospital unless you have a medical reason to do so. Do not go to a hospital if you believe that you have been exposed or have radioactive dust on you, as it is not a medical emergency.

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Safety Officer Job Aid

- Monitor responders' dose closely.
- If responders reach dose decision points quickly, consider adjusting operations to reduce dose (Playbook 1).
- Practice radiation protection methods.
- The word "limit" is not used in the context of the Multi-Agency Radiological Response Plan for pre-established health and safety standards. Instead dose, exposure rate, and contamination release values are provided as guidance and called "levels" or "decision points." Responders should strive to reduce their dose to the lowest level possible. Sometimes a dose greater than an occupational limit of 5 rem in a year may be warranted for critical actions like rescue of a victim.
- Set Decision Points at the lowest level possible and increase as necessary (Playbook 1).
- Ensure responders wear respirators (self-contained breathing apparatus, powered air purifying respirator, or air purifying respirator). Inhalation/ingestion exposure is most significant for alpha emitting radioactive materials.
- Ensure responders set their real-time dosimeters to zero and wear it before entry. One dosimeter per team is acceptable, except for entry into Extreme Caution Areas, where each person must wear their own dosimeter.
- Ensure contamination release levels are appropriate for the incident and adjust as necessary (Playbooks 3, 4, 5, 9, and 10)
- Ensure radiation levels for control zones are appropriate for the incident and adjust as necessary (Playbook 2).
- If large quantities of decontamination fluids are generated, do not contain the fluids, instead release to stormwater/sewer system.

Cross contamination issues are a secondary concern if the incident affects a large population.

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Liaison Officer Job Aid

The following agencies and organizations are likely to respond to or provide **radiological** assistance to a significant radiological incident. Whether an agency provides assistance, what assets they provide, and what their specific roles will be is dependant on the incident conditions and/or requests for assistance from the Incident Command/Unified Command. List is in alphabetical order.

Local Agencies and Organizations

- Fire Department Hazmat teams
- Law Enforcement Hazmat teams
- Los Angeles County, Department of Public Health
- Los Angeles County, Department of Public Health, Radiation Management

State Agencies and Organizations

- California Department of Public Health, Radiologic Health Branch
- California Highway Patrol (CHP)
- California National Guard, Weapons of Mass Destruction Civil Support Team (CST), 9th and 25th

Federal Agencies and Organizations

- Armed Forces Radiobiology Research Institute (AFRRI), Medical Radiobiology Advisory Team (MRAT)
- Department of Energy (DOE)
- Department of Homeland Security (DHS)
- Environmental Protection Agency (EPA)
- Federal Bureau of Investigations (FBI)
- Federal Emergency Management Agency (FEMA)
- United States Coast Guard (USCG)

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Decontamination Team Leader Job Aid

- Reference Playbooks 3, 4, 5, 9, and 10 for specific information pertaining to decontamination and contamination surveys
- Establish decontamination stations per hazmat procedures
- Identify contaminated responders and equipment and decontaminate as appropriate
- Identify contaminated victims/public (and personal property) and pets, and decontaminate as appropriate (if victim is capable, they should decontaminate their own pets)
- Supervise decontamination operations
- Maintain control of people/equipment movement in Contamination Reduction Zone
- Ensure contamination surveys are performed correctly
- Ensure contamination release levels are followed
- Implement new contamination release levels if adjusted by Radiation Technical Specialists
- Coordinate transfer of contaminated victims requiring medical attention to the Medical Group/Sector
- Coordinate handling, storage, and transfer of contaminants within the Contamination Reduction Zone
- Do not retain large volumes of decontamination fluids, release to stormwater/sewer system

Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!

Do NOT contain decontamination fluids; release to stormwater/sewer system.

Removing the outer layer of clothes from a person should remove 80 to 90% of external contamination.

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Playbook 1: Exclusion Zone Operations

Activity: Conduct critical operations in the Exclusion Zone or Extreme Caution Areas such as rescue, evacuation, shelter-in-place, protection of critical infrastructure, and other authorized activities.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Fire Department Hazmat Teams
2. Fire Departments
3. Law Enforcement Hazmat Teams

What to Do: See Section 3.2.1 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Activities in the Exclusion Zone and Extreme Caution Areas should be restricted to essential activities only; see Table 3 for definition of control zones. In particular, activities in the Extreme Caution Areas must be carefully planned and dose to responders monitored. Ensure dosimeter alarm levels are set correctly; see Table 6. Review Table 7 for stay time determination and Table 5 for health effects if exceeding a dose level in Table 4. If Los Angeles County Radiation Management staff is present, they should accompany persons entering the Extreme Caution Areas to assist with radiation safety monitoring and decisions.

Conduct rescue of victims

Responders should rescue victims in the Exclusion Zone without hesitation per standard procedures. Responders should monitor dose periodically; i.e., every 30 minutes. If operations extend for more than one hour, responders should check dosimeters against the Decision Points in Table 4. Contact the Safety Officer and a Radiation Technical Specialist if dose reaches any of the levels in Table 4.

Rescue of victims in the Extreme Caution Areas requires personal dosimetry and short stay times; see Table 7. Responders should monitor dose approximately every 5 to 10 minutes. After 30 minutes, check dose against the Decision Points in Table 4. Avoid exceeding a dose of 50 rem unless specifically directed and authorized by Incident Command. For extended operations, change out teams on a frequent basis, if necessary. Contact the Safety Officer and a Radiation Technical Specialist if dose reaches any of the levels in Table 4.

If potential cumulated dose to a victim within an Extreme Caution Area is estimated to be more than 1,000 rem, the victim may not be viable.

Note that air purifying respirators are preferred in areas that do not require supplied air respiratory protection (due to the presence of another hazard such as low oxygen, chemical vapors, etc.).

Protect critical infrastructure

Responders should protect critical infrastructure in the Exclusion Zone without hesitation per standard procedures. Responders should monitor dose periodically; i.e., every 30 minutes. If operations extend for more than one hour, responders should check dosimeters against the Decision Points in Table 4. Contact the Safety Officer and a Radiation Technical Specialist if dose reaches any of the levels in Table 4.

Protection of critical infrastructure in the Extreme Caution Areas requires personal dosimetry and short stay times. Responders should monitor dose approximately every 5 to 10 minutes. After 30 minutes, check dose against the Decision Points in Table 4. Avoid exceeding 10 rem unless specifically directed

and authorized by Incident Command. For extended operations, change out teams on a frequent basis, if necessary. Contact the Safety Officer and a Radiation Technical Specialist if dose reaches any of the levels in Table 4.

Note that air purifying respirators are preferred in areas that do not require supplied air respiratory protection (due to the presence of another hazard such as low oxygen, chemical vapors, etc.).

Other authorized activities

Other authorized activities that do not involve lifesaving or protection of critical infrastructure should be pre-planned to reduce responder dose. Responders should monitor dose periodically; i.e., every 30 minutes. If operations extend for more than one hour, responders should check dosimeters against the Decision Points in Table 4. Contact the Safety Officer and a Radiation Technical Specialist if dose reaches any of the levels in Table 4.

Conducting authorized activities in the Extreme Caution Areas requires preplanning, personal dosimetry, and short stay times. Responders should monitor dose approximately every 5 to 10 minutes. After 30 minutes, check dose against the Decision Points in Table 4. Avoid exceeding 5 rem unless specifically directed and authorized by Incident Command. For extended operations, change out teams on a frequent basis, if necessary. Contact the Safety Officer and a Radiation Technical Specialist if dose reaches any of the levels in Table 4.

Note that air purifying respirators are preferred in areas that do not require supplied air respiratory protection (due to the presence of another hazard such as low oxygen, chemical vapors, etc.).

Step 1: Prepare for entry (Upon dispatch, turn on detectors in background area and conduct a functional check)

Turn on gamma exposure rate detector: Ion Chamber (preferred), Energy Compensated Geiger-Mueller detector like the Canberra Mini Radiac (second preference), or Sodium Iodide or "gamma" probe. If available, use appropriate instruments to determine the presence of alpha and beta radiation (see *Standard Operating Guide No. 2*: *How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter* and Playbooks 6 and 7*)*.

A. If applicable, verify that the meter detector switch is set for the gamma detector.
B. Don personal protective equipment including a respirator.
C. Zero the dose on a real-time dosimeter and wear it so you can check the dose periodically.

Step 2: Conduct entry

D. Walk slowly into the Exclusion Zone while holding the gamma detector held at waist level and at an arm's length.
E. Monitor the gamma detector readings frequently.
F. As exposure rate increases stay alert to accumulated dose on the dosimeter.
G. If accumulated dose reaches 5 rem, report to the Safety Officer via radio.
H. If accumulated dose reaches 10 rem, report to the Safety Officer via radio.
I. If dose reaches 40 to 45 rem, prepare to leave the area; avoid exceeding 50 rem, unless specifically directed and approved by Incident Command.
J. If entering an Extreme Caution Area, stay alert and monitor both the exposure rate and accumulated dose. As exposure rate increases so will accumulated dose.

Step 3: Exit Exclusion Zone/Extreme Caution Area

K. After exiting the Exclusion Zone/Extreme Caution Area and completing decontamination, ensure dose is recorded on a *Form No. 3: Responder Dose Log*.
L. Before making another entry determine total dose for the incident. Avoid exceeding 50 rem for lifesaving, 10 rem for critical infrastructure protection activities, or 5 rem for other activities.

Considerations:

- Operations within the Extreme Caution Area must be carefully planned and monitored.
- If possible, practice radiation protection principles and reduce dose by limiting time in the Exclusion Zone/Extreme Caution Areas, increasing distance from areas with high exposure rates, and using available shielding as practicable; i.e., buildings, vehicles, etc.
- Set Decision Points at lowest reasonable level possible and increase as necessary.
- The word "limit" is not used in the context of the Multi-Agency Radiological Response Plan for pre-established health and safety standards. Instead dose, exposure rate, and contamination values are provided as guidance and called "levels" or "decision points." Sometimes a dose greater than an occupational limit of 5 rem in a year may be warranted for critical actions like rescue of a victim.

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 4: Decision Points

Activities	Exposure Rate (mR/hr)	Cumulative Dose[2] (mrem)
All	Up to 10[1]	Up to 5,000 (5 rem)[1, 3]
Critical infrastructure protection	Up to 10,000 (10 R/hr)[1]	Up to 10,000 (10 rem)[1]
Lifesaving or protection of large populations	Up to 200,000 (200 R/hr)[1] **TURN BACK LIMIT**	Up to 50,000 (50 rem)[1,4]

[1] Gross gamma radiation measured with an ion chamber, or energy compensated Geiger-Mueller probe, or, if necessary, a sodium iodide or Pancake Geiger-Mueller (PGM) with the beta radiation shield closed; i.e., use the backside of the PGM, at approximately one meter (3.3 feet) above the ground.

[2] Effective Dose Equivalent for external dose only. Dose level for eyes is three times the values listed above. Dose limit for any other organ (including skin and extremities) is 10 times the values listed above.

[3] EPA 1992, 29CFR1910.1096(b)(1), and Cal-OSHA (see Volume II for specific citation)

[4] A 50 rem dose will result in an increase in the theoretical cancer mortality risk from the background rate of approximately 24% to approximately 28% (Volume II, Attachment 1, Table 5). Doses above 50 rem are acceptable with approval of the Incident Command/Unified Command, Safety Officer, and a Radiation Technical Specialist in extreme cases. Responders that may receive doses up to this level should be a volunteer, well informed of the risks, and have proper training and detection equipment. For example, a 100 rem dose will result in an increase in the theoretical cancer mortality risk from the background rate of approximately 24% to approximately 32%. See Volume II, Attachment 1, Table 5 for risk values for other doses. This dose should be restricted to a once in a life-time event. However, if a future event requires use of these individuals, they may be used; however, their previous dose must be considered. If the IC/UC allows higher than recommended dose or exposure rate levels, documentation should justify the reasons, and the factors in Volume II, Section 3.2.3, should be considered.

Note: The word "limit" is not used in the context of the Multi-Agency Radiological Response Plan for pre-established health and safety standards. Instead dose, exposure rate, and contamination values are provided as guidance and called "levels" or "decision points." As noted in the above table, doses greater than the occupational limit of 5 rem in a year may be warranted for critical response actions.

mrem millirem
mR/hr milliroentgen per hour
rem roentgen equivalent man
R/hr roentgen per hour

References: CRCPD 2006, NCRP 2005, NCRP 2001, and DHS 2008b (see Volume II for specific citation)

Table 5: Dose and Potential Health Effects

Short-Term[1] Whole-Body Dose (rem)	Acute Death[2] from Radiation without Medical Treatment (%)	Acute Death from Radiation with Medical Treatment (%)	Acute Symptoms (nausea and vomiting within 4 hours) (%)	Lifetime Risk Fatal Cancer without Radiation Exposure (%)	Excess Lifetime Risk of Fatal Cancer Due to Short-Term Radiation Exposure[3] (%)
1	0	0	0	24	0.08
10	0	0	0	24	0.8
50	0	0	0	24	4
100	< 5	0	5 – 30	24	8
150	< 5	< 5	40	24	12
200	5	< 5	60	24	16
300	30 – 50	15 – 30	75	24	24[4]
600	95 – 100	50	100	24	> 40[4]
1,000	100	> 90	100	24	> 50[4]

[1] Short-term refers to the radiation exposure during the initial response to the incident. The acute effects listed are likely to be reduced by about one-half if radiation exposure occurs over weeks.

[2] Acute deaths are likely to occur from 30 to 180 days after exposure and few if any after that time. Estimates are for healthy adults. Individuals with other injuries, and children, will be at greater risk.

[3] Most cancers are not likely to occur until several decades after exposure; although leukemia has a shorter latency period of less than five years.

[4] Applies to those individuals that survive Acute Radiation Syndrome.

rem roentgen equivalent man
< less than
> greater than
% percentage

(Adapted from NCRP 2005; see Volume II for specific citation)

Table 6: Responder Alarm Levels

Alarm Level	Exposure Rate[1] (mR/hr)	Cumulative Dose[2] (mrem)
First Alarm	2	10
Second Alarm	10,000 (10 R/hr)	25,000 (25 rem)

[1] Gross gamma radiation measured with an appropriate real time dosimeter at 1 meter (3.3 feet) above the ground. External dose only.
[2] Effective dose equivalent for external dose only.

mR/hr milliroengten per hour
R/hr roengten per hour
mrem millirem
rem roengten equivalent man

Table 7: Stay Time Table

Radiation Meter Gamma Exposure Rate		Time to Receive This Dose (Times rounded. Table only calculates dose from external sources.)									
		All Emergency Responder Activities Under Emergency Conditions				Protect Property	Lifesaving		Volunteer Only	Potentially Lethal	
		100 mrem	1 rem	2 rem	5 rem	10 rem	25 rem	50 rem	100 rem	300 rem	500 rem
CONTAMINATION REDUCTION ZONE / SUPPORT ZONE	10 µR/hr	1 yr									
	50 µR/hr	12 wk	2 yr								
	100 µR/hr	6 wk	1 yr								
	500 µR/hr	8 dy	12 wk	24 wk	1 yr						
	750 µR/hr	5.5 dy	8 wk	16 wk	40 wk	1.5 yr					
	1 mR/hr	4 dy	6 wk	12 wk	30 wk	1 yr					
	2 mR/hr	50 hr	3 wk	6 wk	15 wk	30 wk	74 wk				
	5 mR/hr	20 hr	8 dy	16 dy	6 wk	12 wk	30 wk	1 yr			
	7.5 mR/hr	13 hr	5.5 dy	11 dy	4 wk	8 wk	20 wk	40 wk	80 wk		
	10 mR/hr	10 hr	4 dy	8 dy	3 wk	6 wk	15 wk	30 wk	1 yr		
EXCLUSION ZONE CAUTION	20 mR/hr	5 hr	2 dy	4 dy	10 dy	3 wk	7 wk	15 wk	30 wk	2 yr	
	30 mR/hr	3.3 hr	33 hr	3 dy	1 wk	2 wk	5 wk	10 wk	20 wk	60 wk	
	40 mR/hr	2.5 hr	1 dy	2 dy	5 dy	11 dy	4 wk	8 wk	15 wk	1 yr	
	50 mR/hr	2 hr	20 hr	40 hr	4 dy	8 dy	3 wk	6 wk	12 wk	35 wk	1 yr
	75 mR/hr	80 min	13 hr	1 dy	3 dy	5.5 dy	2 wk	4 wk	8 wk	24 wk	40 wk
	100 mR/hr	1 hr	10 hr	20 hr	2 dy	4 dy	10 dy	3 wk	6 wk	18 wk	30 wk
	200 mR/hr	30 min	5 hr	10 hr	1 dy	2 dy	5 dy	11 dy	3 wk	9 wk	15 wk
	300 mR/hr	20 min	3 hr	7 hr	16 hr	32 hr	3 dy	1 wk	2 wk	6 wk	10 wk
	400 mR/hr	15 min	2.5 hr	5 hr	12 hr	1 dy	2.5 dy	5.5 dy	11 dy	31 dy	52 dy
	500 mR/hr	12 min	2 hr	4 hr	10 hr	19 hr	2 dy	4 dy	8 dy	25 dy	40 dy
	750 mR/hr	8 min	78 min	2.6 hr	6.5 hr	13 hr	33 hr	3 dy	5.5 dy	16 dy	4 wk
	1 R/hr	6 min	1 hr	2 hr	5 hr	10 hr	25 hr	50 hr	4 dy	12 dy	3 wk
	1.5 R/hr	3 min	40 min	78 min	3.5 hr	6.5 hr	16.5 hr	33 hr	3 dy	8 dy	14 dy
	2 R/hr	3 min	30 min	1 hr	2.5 hr	5 hr	13 hr	25 hr	2 dy	6 dy	11 dy
	3 R/hr	2 min	20 min	40 min	100	200 min	8 hr	16 hr	1.5 dy	4 dy	1 wk
	4 R/hr	90 sec	15 min	30 min	75 min	2.5 hr	6.5 hr	13 hr	1 dy	3 dy	6 dy
	5 R/hr	72 sec	12 min	24 min	1 hr	2 hr	5 hr	10 hr	20 hr	2.5 dy	4 dy
	7.5 R/hr	48 sec	8 min	16 min	40 min	78 min	200 min	6.5 hr	13 hr	40 hr	3 dy
EXTREME DANGER AREA	10 R/hr	36 sec	6 min	12 min	30 min	1 hr	2.5 hr	5 hr	10 hr	30 hr	50 hr
	20 R/hr	18 sec	3 min	6 min	15 min	30 min	75 min	2.5 hr	5 hr	15 hr	1 dy
	30 R/hr	10 sec	2 min	4 min	10 min	20 min	50 min	96 min	3 hr	10 hr	17 hr
	40 R/hr	9 sec	90 sec	3 min	7.5 min	15 min	38 min	75 min	2.5 hr	7.5 hr	12 hr
	50 R/hr	7 sec	72 sec	80 sec	6 min	12 min	30 min	1 hr	2 hr	6 hr	10 hr
	75 R/hr	5 sec	50 sec	100 sec	4 min	8 min	20 min	40 min	80 min	4 hr	6.5 hr
	100 R/hr	4 sec	30 sec	1 min	3 min	6 min	15 min	30 min	1 hr	3 hr	5 hr
	200 R/hr	2 sec	18 sec	30 sec	90 sec	3 min	7 min	15 min	30 min	90 min	2.5 hr
GRAVE DANGER	300 R/hr	1 sec	10 sec	20 sec	1 min	2 min	5 min	10 min	20 min	1 hr	100 min
	400 R/hr	1 sec	9 sec	15 sec	45 sec	90 sec	3.5 min	7.5 min	15 min	45 min	75 min
	500 R/hr	1 sec	7 sec	15 sec	30 sec	72 sec	3 min	6 min	12 min	36 min	1 hr
	750 R/hr	1 sec	5 sec	9 sec	24 sec	48 sec	2 min	4 min	8 min	24 min	40 min
	1,000 R/hr	1 sec	3 sec	7 sec	18 sec	36 sec	90 sec	3 min	6 min	18 min	30 min

1 µR = 0.001 mR = 0.000001 R
1,000 µR = 1 mR = 0.001 R
1,000,000 µR = 1,000 mR = 1 R

µR microroentgen
mR milliroentgen
R roentgen
rem roentgen equivalent man

yr year
wk week
dy day

hr hour
min minute
sec second

Natural Background: about 10 µR/hr = 0.01 mR/hr = 0.00001 R/hr = 0.25 mR/day

Form No. 3: Responder Dose Log

Organization(s) _____ Incident Name _____ Date _____

Name (or ID#)	Dosimeter Type	Dosimeter Serial#	Dose Readings				Safety Officer Initials
			Start Reading *use units*	Time	End Reading *use units*	Time	

_____Units_____
uR = microR = microrem
mR = milliR = millirem
R = rem

Page _____ of _____ Safety Officer Signature _____

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Playbook 2: Initial Incident Control Zones

Activity: Establish initial incident control zones during initial entries—Support Zone, Contamination Reduction Zone, Exclusion Zone, and Extreme Caution Area.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. Fire Department Hazmat Teams
3. Law Enforcement Hazmat Teams
4. United States Environmental Protection Agency, Emergency Response Section

What to Do: See Section 3.2.2 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Step 1: Establish Support Zone/Contamination Reduction Zone Boundary and Control Points

Determine the Support Zone and Contamination Reduction Zone boundaries with available detectors. The procedure for establishing the Exclusion Zone boundary in Step 2 may be followed to establish and mark the Support Zone and Contamination Reduction Zone boundaries.

Step 2: Establish Exclusion Zone Boundary and Control Points (upon dispatch, turn on detectors in background area and conduct a functional check)

A. Turn on all detectors:
   1. Alpha detector (zinc sulfide scintillator)
   2. Beta/gamma detector (Pancake Geiger-Mueller)
   3. Gamma exposure rate detector: Ion Chamber (preferred), Energy Compensated Geiger-Mueller detector like the Canberra Mini Radiac (second preference), or Sodium Iodide or "gamma" probe (third preference)

B. If applicable, verify that the meter detector switch is set for the applicable detector.

C. Don personal protective equipment including a respirator (self contained breathing apparatus, air purifying respirator, or powered air purifying respirator, depending on hazards).

D. Zero the dose on a real-time dosimeter, if available, and wear it so you can check the dose periodically.

E. Walk slowly (about 1 foot per second) toward the incident while holding the gamma detector at waist level and at an arm's length.

F. Monitor the gamma detector readings.

G. When reading increases to 10 mR/hr, mark the location.

H. Verify alpha and beta ground surface levels at the location marked in Step G following the standard operating procedure for each applicable instrument; see Table 3 for alpha and beta levels. If necessary, adjust boundary based on alpha or beta measurements.

I. Continue to walk in a direction that keeps the gamma detector reading at approximately 10 mR/hr and mark the boundary about every 20 feet until the full extent of the Exclusion Zone boundary is delineated. Verify alpha and beta ground surface levels per Step H at each marked location and adjust boundary as needed.

J. Establish Control Points as needed.

K. Mark Exclusion Zone boundary with spray paint, barrier tape, traffic cones, or other visible indication. Record location of boundary on a map and give it to the Operations Section Chief. If possible, record the boundary using global positioning system (GPS) or with detectors integrated with a telemetry system.

Step 3: Establish Extreme Caution Area Boundary and Control Points

Note: Only delineate Extreme Caution Area boundaries to minimize the dose to responders performing lifesaving or critical infrastructure activities. Do not subject responders unnecessarily to dose only to determine the boundary.

L. Enter the Exclusion Zone with the gamma detector to locate areas above 10 R/hr.
M. Sweep the Exclusion Zone in a methodical manner to cover all areas inside the Exclusion Zone.
N. When reading increases to 10 R/hr, mark the location.
O. Verify alpha and beta ground surface levels at the location marked in Step N following the standard operating procedure for each applicable instrument; see Table 3 for alpha and beta levels. If necessary, adjust boundary based on alpha or beta measurements.
P. Only enter the Extreme Caution Areas with personal dosimetry, appropriate personal protective equipment, and to conduct a rescue, protect critical infrastructure, or execute other authorized activities.
Q. Continue to walk in a direction that keeps the meter reading at approximately 10 R/hr and mark the boundary about every 20 feet until the full extent of the Extreme Caution Area boundary is delineated. This activity must be performed as quickly as possible.
R. Establish Control Points as needed.
S. Mark Extreme Caution Area boundaries with spray paint, barrier tape, traffic cones, or other visible indication. Record location of boundary on a map and give it to the Operations Section Chief. If possible, record the boundary using global positioning system (GPS) or with detectors integrated with a telemetry system.
T. Limit time in radiation areas over 10 R/hr by changing staff, if possible.

Considerations:

- Lifesaving and critical infrastructure protection activities MAY occur within the Extreme Caution Areas. Avoid doses exceeding 50 rem for lifesaving or 10 rem for critical infrastructure property protection activities, unless specifically directed and authorized by Incident Command.
- Modification of the zone boundaries may be necessary depending on the incident specific conditions; a Radiation Technical Specialist should be consulted in such cases.
- Radiation fields and contamination are unlikely to be uniformly distributed. It is possible there may be several Extreme Caution Areas within the Exclusion Zone due to fragments. Some areas may only be a few feet in diameter. Each area should be marked as noted above.
- Operations within the Extreme Caution Area must be carefully planned and monitored.
- If possible, practice radiation protection principles and locate all operations within the Support Zone/Contamination Reduction Zone at the lowest level of ground contamination and gamma exposure rate possible.
- Zone boundaries can change due to wind, rain, or movement of people/equipment, so verify boundaries periodically and inform Incident Command when they change.
- Use natural barriers (buildings, freeways, etc.) or topographic features (waterways, steep inclines, etc.) as zone boundaries if convenient and levels in Table 3 are met.

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

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Playbook 3: Monitoring Responders and Equipment for Contamination

Activity: Conduct contamination surveys of responders and responder equipment. Equipment includes personal protective equipment, tools, vehicles, and any object that is suspected to have contamination.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. Fire Department Hazmat Teams
3. Fire Departments
4. United States Environmental Protection Agency, Emergency Response Section
5. United States Department of Energy, Radiological Assistance Program
6. Law Enforcement Hazmat Teams

What to Do: See Section 3.3 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Step 1: Establish Decontamination Station

The following criteria should be considered in selection of the decontamination station location:

- Background radiation levels are below one hundredth (1%) of the release levels in Table 10, if possible. If this cannot be achieved or is not practicable, do not exceed one tenth (10%) of the release level.
- Contamination on the personnel performing the decontamination of others should not exceed contamination levels found on the ground at the decontamination station.

A hazmat decontamination station design is adequate for radiological incidents, except if there are large volumes of water, the water should not be contained. The water should be allowed to go into the stormwater or sewer system. If contamination is released to a sewer, make provisions for contamination monitoring at the applicable wastewater treatment plant.

Step 2: Conduct Decontamination

Conduct decontamination per standard hazmat procedures. Dry and wet decon systems are adequate for radiological contamination. Most equipment does not need to be decontaminated if reuse in the Exclusion Zone is planned and the item will remain in the Contamination Reduction Zone (once use of the item is discontinued it must be decontaminated).

Do NOT contain decontamination fluids; release to stormwater/sewer system.

Step 3: Survey for Contamination

After decontamination, conduct a contamination survey. Most equipment does not need a contamination survey if reuse in the Exclusion Zone is planned and the item will remain in the Contamination Reduction Zone (once use of the item is discontinued it must be surveyed for contamination). Responders must always be surveyed for contamination after decontamination. See *Standard Operating Guide No 1: Procedure for Performing a Radiation Contamination Survey* for more detail.

A. If portal monitors are available, set them up at the decontamination station and use them as described in the instructions attached to the monitor. However, portal monitors only detect gamma radiation; hand-held surveys with appropriate instrumentation are required to detect alpha or beta radiation.
B. If applicable, verify that the meter detector switch is set for the Pancake Geiger-Mueller detector.
C. Use a radioactive check source to verify that the Pancake Geiger-Mueller or microR meter is functional.
D. Turn the sound on or use head phones.
E. Hold the Pancake Geiger-Mueller or microR meter less than 1-inch from the responder or equipment and move detector at about 1-inch per second.
F. Survey the most likely contaminated and most critical areas first: Head, Shoulders, Hands, and Feet.
G. Check the meter reading and compare to Table 10. Try to achieve Level 1, if there are sufficient resources available and it can be done in a reasonable amount of time; otherwise, try to achieve Level 2. Do not release responders with contamination above Level 3.
H. If release levels are not exceeded, release the responder or equipment.
I. If contamination is found at any surveyed area above release levels, send back for further decontamination. (The additional decontamination should be limited to those areas identified as still contaminated.) After the second decontamination, resurvey the contaminated areas or have them walk through a portal monitor to verify decontamination was successful. However, portal monitors only detect gamma radiation; hand-held surveys with appropriate instrumentation are required to detect alpha or beta radiation. If the contamination levels are below the release levels, release responder or equipment; otherwise, consult a Radiation Technical Specialist for further instructions.
J. Release or clear for reuse equipment in accordance with Table 11. Equipment with Level 3 contamination should not be released or reused.

Considerations:

- If possible, practice radiation protection principles and locate decontamination stations within the Support Zone/Contamination Reduction Zone at the lowest level of ground contamination and gamma exposure rate possible, preferably near background.
- Decontamination stations can become contaminated with use. Attempt to reduce and maintain contamination levels as low as possible. Move the decontamination station if contamination levels exceed acceptable maximum background levels.
- Bag contaminated personal protective equipment or equipment that does not meet Table 11 release levels for future evaluation and further decontamination, or potential disposal.
- If equipment does not undergo decontamination and a contamination survey (because it will be reused in the Exclusion Zone) check the item periodically to ensure that contamination buildup is not creating an exposure hazard.
- Contamination may be located in the Support Zone (see Table 3) at significant levels above typical release levels; e.g., twice background. Equipment located in areas of contamination should be surveyed and decontaminated, if necessary, before demobilization or release from the Support Zone.
- Contact the incident Safety Officer and a Radiation Technical Specialist if Level 3 contamination is found on a responder's skin after decontamination so the Radiation Technical Specialist can review radiation controls and implement adjustments if necessary to prevent contamination at this level.
- For portal monitors that alarm at a set standard deviation (sigma) above background, set the monitor to alarm at four standard deviations above background.

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 10: Responder Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, if returning to duty station or if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	If responder is going directly home, decontaminate to Level 2 lower values, then release for home decontaminate in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home*. If not going directly home decontaminate as noted for Level 1. [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute mR/hr milliroentgen per hour µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 11: Responder Equipment Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist. Items returning to contaminated areas, including ambulances, may be reused during the incident with these contamination levels.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not reuse or release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Upon demobilization, high priority equipment, like an ambulance, should be given quicker attention for decontamination efforts to release at the lowest contamination level possible.

[6] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute mR/hr milliroentgen per hour µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination; see Playbook 7 to determine if alpha is present).

Make sure that the instruments have batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a radiation check source to verify the instrument is operating properly.

Screening Survey

If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, hands, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.

If only performing a screening survey, it is acceptable to hold the survey meter probe about 1 to 2 inches away from the body (instead of ½ inch), and move it twice as fast as the normal 1 to 2 inches per second. (If the probe is moved too quickly, its detection capability may be reduced.) If surveying for alpha radiation, hold the survey meter probe ½ inch away from the body and move it at 1 inch per second. Check with state/local radiation control personnel to determine the extent of contamination survey required.

Public that are not familiar with radiological instruments may become alarmed when they hear the "clicks" from the meter. Consider using head phones to listen to the "clicks" or turn the sound off. However, if the sound is turned off, the surveyor must look at the meter reading and watch the probe position at the same time. This will result in the surveyor taking a significantly longer time to survey an individual.

Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

Complete Whole Body Survey

If feasible, perform a complete, whole body contamination survey and record the findings on *Form No 1: Contamination Survey*. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a ½ inch away from the surface to be surveyed, slowly (1 to 2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination)
2. Front of the neck and shoulders
3. Down one arm (pausing at elbow), turn arm over
4. Backside of hands, turn over (pause at palms for about five seconds)
5. Up the other arm (pausing at elbow), turn arm over
6. Shoe tops and inside ankle area
7. Shoe bottoms (pause at sole and heel)

Standard Operating Guide No. 1 (continued)

As with the screening survey, return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

The most common mistakes made during the survey:

Holding the probe too far away from the surface (should be about 1 to 2 inches away for a screening survey or about ½ inch or less for a detailed survey).

Moving the probe too fast (should be about 2 to 4 inches per second for a screening survey or about 1 to 2 inches per second for a detailed survey.)

Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use the probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Recommended procedures for on-scene responders:

1. On-scene responders should wear gloves and a gown or other protective clothing. Each responder should be provided with a personal dosimetry device.
2. Medically unstable patients should be transported to a hospital immediately.
3. A radiological survey, decontamination procedures, or steps taken to contain the contamination may be performed in the ambulance provided these actions do not interfere with more immediate medical requirements of the patient.
4. If the patient is medically stable and conditions at the site permit, limit any further exposure to radiation by moving the patient to an area of low background. The outer clothing of the individual should be removed and the patient should be wrapped in a cloth sheet or blanket to permit handling. The wrapping should be loose to avoid hyperthermia and to allow easy access to the patient by medical personnel.
5. Treat the patient's injuries (i.e., burns, cuts, etc.) sustained in the incident and, if needed, provide symptomatic treatment for the radiation illness (e.g., the use of anti-emetics).
6. If an open wound is involved, cover the wound with a clean dressing.
7. Do not release a medically stable patient to ambulance personnel before a radiological survey has been performed. If contamination is confirmed, a preliminary decontamination should be performed. Record the results of the radiological survey and proceed to decontaminate the patient.
8. Decontaminate the medically stable patient by washing the individual with tepid water to remove any radioactive contamination, beginning with the areas of highest levels of contamination. Proceed gently, mindful that this is a preliminary decontamination and that a more thorough decontamination process will be performed at a medical facility. When finished, repeat the radiation survey of the patient and record the final results. Save all clothing and bedding and all metal objects (e.g., jewelry, coins, belt buckles, etc.). A nasal swab is also recommended to detect inhalation of radioactive contaminants. However, it may be more practicable for medical personnel to perform the nasal swab.
9. Tag each item with the patient's name, location, time, and date. Save each in appropriate containers; mark containers clearly with: "RADIOACTIVE—DO NOT DISCARD."
10. Transport patient to a medical facility for further treatment. The medical facility should be given advanced warning if they are going to receive patients exposed to radiation so that the facility can institute the appropriate medical protocols. Remember, individuals suffering from radiation injury may not be radioactive, but their skin and clothing could be contaminated with radioactive material. Protection of first responders should be focused on the source of the radiation.

(NCRP 2005, Adapted from the 1998 FBI Contingency Plan for Weapons of Mass Destruction FBI, 1998).

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Playbook 4: Monitoring Injured Victims for Contamination

Activity: Conduct contamination surveys of injured victims.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. Fire Department Hazmat Teams
3. Fire Departments
4. United States Environmental Protection Agency, Emergency Response Section

What to Do: See Section 3.4 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Victims should be triaged in accordance with standard medical and trauma criteria. General objectives in approximate order of importance for the management of contaminated, injured patients are listed below. Ideally, initial decontamination efforts can be integrated with resuscitative efforts; i.e., removing all contaminated clothing during the initial assessment, using universal precautions including a mask, and wrapping the victim in a sheet to contain any residual contamination.

1. First aid and resuscitation
2. Medical stabilization
3. Definitive treatment of serious injuries
4. Prevention/minimization of internal contamination
5. Assessment of external contamination and decontamination
6. Treatment of other injuries and illness.
7. See Playbook 13 or Section 3.4 in Volume II for further priorities

Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!

Use tongs or hemostats to remove highly radioactive shrapnel from a victim, if it can be done safely.

Prioritization of large numbers of Delayed or Minor category victims may be necessary to focus efforts on the most contaminated people. A simple order of priority is as follows:

1. Prioritize victims by proximity to the release location of the radioactive material. Individuals within approximately 1,650 feet (500 meters) of the release or within the Exclusion Zone should have the highest priority for decontamination and exposure evaluation as they are more likely to be contaminated.
2. If a victim has Level 3 contamination levels (see Table 12) and does not have life- or limb-threatening injuries, decontaminate them immediately. Medical attention should follow decontamination. Reevaluation of contamination should be performed before release.

3. If a victim is not grossly contaminated provide medical attention and either release them to decontaminate at home or evaluate for contamination. If decontamination is warranted and resources are available, the victim should be decontaminated to contamination levels as low as possible before release. If the victim is released without decontamination, provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home*.
4. If a victim refuses to be monitored or decontaminated, they should be informed that they could have become contaminated. If they want to leave the scene, a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* should be provided and the individual released in accordance with public health policy.

Step 1: Establish Decontamination Station

The following criteria should be considered when selecting the decontamination station location:

- Background radiation levels are below one hundredth (1%) of the release levels (see Table 12), if possible. If this cannot be achieved or is not practicable, do not exceed one tenth (10%) of the release levels.
- Contamination on the personnel performing the decontamination of others should not exceed contamination levels found on the ground at the decontamination station.

A hazmat decontamination station design is adequate for radiological incidents, except if there are large volumes of water, the water should not be contained. The water should be allowed to go into the stormwater or sewer system. If contamination is released to a sewer, make provisions for contamination monitoring at the applicable wastewater treatment plant.

Step 2: Conduct Decontamination

Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!

Conduct decontamination per standard hazmat procedures. Dry and wet decon systems are adequate for radiological contamination. Wet decon for some victims may not be appropriate depending on their condition, weather, and other factors. If possible, release victims to perform self decontamination at home. Use of cold water or fire hoses for gross decontamination is the least preferred method. A quick decontamination method is to remove outer clothing which should remove 80 to 90% of external contamination.

Removing the outer layer of clothes from a person should remove 80 to 90% of external contamination.

Step 3: Survey for Contamination

After decontamination, survey victim for contamination in accordance with the following procedure (see *Standard Operating Guide No 1: Procedure for Performing a Radiation Contamination Survey* for more detail):

A. If portal monitors are available, set-up and use according to the instructions on the monitor. However, portal monitors only detect gamma radiation; hand-held surveys with appropriate instrumentation are required to detect alpha or beta radiation. The portal monitors may be used with victims on a gurney, in addition to ambulatory victims.
B. If using a hand-held instrument, turn on meter with a Pancake Geiger-Mueller detector or use a microR meter.

C. If applicable, verify that the meter detector switch is set for the Pancake Geiger-Mueller detector.
D. Use a radioactive check source to verify that the Pancake Geiger-Mueller or microR meter is functional.
E. Turn the sound on or use head phones.
F. Hold the Pancake Geiger-Mueller or microR meter less than 1-inch from the victim and move at about 1-inch per second.
G. Survey the most likely contaminated and most critical areas first: Head/Face, Shoulders, Hands, and Feet.
H. If the frequency of the "clicks" increases (the radiation measurement increases to more than three times the background reading), check the meter reading and compare to Table 12. Try to achieve Level 1, if there are sufficient resources available in a reasonable amount of time; otherwise, try to achieve Level 2. Do not release victims with contamination above Level 3 unless they need immediate medical attention.
I. Document contamination levels on *Form No. 1: Contamination Survey*.
J. If release levels are not exceeded, release the victim.
K. If contamination is found above release levels, send back for more decontamination.
L. After the second decontamination, resurvey the contaminated areas or have them go through a portal monitor to verify decontamination was successful. However, portal monitors only detect gamma radiation; hand-held surveys with appropriate instrumentation are required to detect alpha or beta radiation. If the contamination is below the release levels, release victim; otherwise, contact a Radiation Technical Specialist for further instructions.
M. If possible, release levels for victims sent to a hospital should be as low as possible. Notify ambulance crew and hospital staff of potential radiological contamination of victims.
N. Release victim property that meets the levels in Table 13. Identification, credit cards, money, jewelry and other unique valuables can be bagged and returned to the owner if they cannot be decontaminated to release levels. Document contamination levels on *Form No. 2: Public Property Contamination Survey*.

Considerations:

- If possible, practice radiation protection principles and locate decontamination stations within the Support Zone/Contamination Reduction Zone at the lowest level of ground contamination and gamma exposure rate possible, preferably near background.
- Attempt to reduce and maintain contamination levels at decontamination stations as low as possible.
- Notify the ambulance crew and the receiving hospital(s) that incoming casualties may have contamination.
- Wrap victim in a blanket before placing in an ambulance to reduce cross contamination inside ambulance.
- Bag contaminated clothing for future evaluation and potential disposal.
- Contact the incident Safety Officer and a Radiation Technical Specialist if Level 3 contamination is found on a victim's skin after decontamination so the Radiation Technical Specialist can determine if further decontamination efforts are appropriate.
- A registry of affected victims should be established. The information collected should, at a minimum, include the person's name, address, phone number, Driver's License number if available, location during the incident, and general contamination levels measured by responders.
- If victims are waiting in a line to be decontaminated they should be provided a copy of *Instructions No.1: Public Waiting for Decontamination*.
- If a victim refuses to be monitored or decontaminated, inform them of possible contamination, give them a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* and release in accordance with public health policy.
- For portal monitors that alarm at a set standard deviation (sigma) above background, set the monitor to alarm at four standard deviations above background.

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 12: Victim and Public Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, but only if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Decontaminate to Level 2 lower values, then release for home decontamination in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home.* [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 13: Victim and Public Property Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Valuables should be returned to the owner, including credit cards, identification, money, jewelry, medicines, et. Bag items and notify owner that further evaluation will be required at a later time.

[6] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination; see Playbook 7 to determine if alpha is present).

Make sure that the instruments have batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a radiation check source to verify the instrument is operating properly.

Screening Survey

If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, hands, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.

If only performing a screening survey, it is acceptable to hold the survey meter probe about 1 to 2 inches away from the body (instead of ½ inch), and move it twice as fast as the normal 1 to 2 inches per second. (If the probe is moved too quickly, its detection capability may be reduced.) If surveying for alpha radiation, hold the survey meter probe ½ inch away from the body and move it at 1 inch per second. Check with state/local radiation control personnel to determine the extent of contamination survey required.

Public that are not familiar with radiological instruments may become alarmed when they hear the "clicks" from the meter. Consider using head phones to listen to the "clicks" or turn the sound off. However, if the sound is turned off, the surveyor must look at the meter reading and watch the probe position at the same time. This will result in the surveyor taking a significantly longer time to survey an individual.

Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

Complete Whole Body Survey

If feasible, perform a complete, whole body contamination survey and record the findings on *Form No 1: Contamination Survey*. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a ½ inch away from the surface to be surveyed, slowly (1 to 2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination)
2. Front of the neck and shoulders
3. Down one arm (pausing at elbow), turn arm over
4. Backside of hands, turn over (pause at palms for about five seconds)
5. Up the other arm (pausing at elbow), turn arm over
6. Shoe tops and inside ankle area
7. Shoe bottoms (pause at sole and heel)

Standard Operating Guide No. 1 (continued)

As with the screening survey, return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

The most common mistakes made during the survey:

Holding the probe too far away from the surface (should be about 1 to 2 inches away for a screening survey or about ½ inch or less for a detailed survey).

Moving the probe too fast (should be about 2 to 4 inches per second for a screening survey or about 1 to 2 inches per second for a detailed survey.)

Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use the probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Recommended procedures for on-scene responders:

1. On-scene responders should wear gloves and a gown or other protective clothing. Each responder should be provided with a personal dosimetry device.
2. Medically unstable patients should be transported to a hospital immediately.
3. A radiological survey, decontamination procedures, or steps taken to contain the contamination may be performed in the ambulance provided these actions do not interfere with more immediate medical requirements of the patient.
4. If the patient is medically stable and conditions at the site permit, limit any further exposure to radiation by moving the patient to an area of low background. The outer clothing of the individual should be removed and the patient should be wrapped in a cloth sheet or blanket to permit handling. The wrapping should be loose to avoid hyperthermia and to allow easy access to the patient by medical personnel.
5. Treat the patient's injuries (i.e., burns, cuts, etc.) sustained in the incident and, if needed, provide symptomatic treatment for the radiation illness (e.g., the use of anti-emetics).
6. If an open wound is involved, cover the wound with a clean dressing.
7. Do not release a medically stable patient to ambulance personnel before a radiological survey has been performed. If contamination is confirmed, a preliminary decontamination should be performed. Record the results of the radiological survey and proceed to decontaminate the patient.
8. Decontaminate the medically stable patient by washing the individual with tepid water to remove any radioactive contamination, beginning with the areas of highest levels of contamination. Proceed gently, mindful that this is a preliminary decontamination and that a more thorough decontamination process will be performed at a medical facility. When finished, repeat the radiation survey of the patient and record the final results. Save all clothing and bedding and all metal objects (e.g., jewelry, coins, belt buckles, etc.). A nasal swab is also recommended to detect inhalation of radioactive contaminants. However, it may be more practicable for medical personnel to perform the nasal swab.
9. Tag each item with the patient's name, location, time, and date. Save each in appropriate containers; mark containers clearly with: "RADIOACTIVE—DO NOT DISCARD."
10. Transport patient to a medical facility for further treatment. The medical facility should be given advanced warning if they are going to receive patients exposed to radiation so that the facility can institute the appropriate medical protocols. Remember, individuals suffering from radiation injury may not be radioactive, but their skin and clothing could be contaminated with radioactive material. Protection of first responders should be focused on the source of the radiation.

(NCRP 2005, Adapted from the 1998 FBI Contingency Plan for Weapons of Mass Destruction FBI, 1998).

Instructions No. 1: Public Waiting for Decontamination

You may have been exposed to radioactive materials ("dust"). The dust from the explosion may have gotten on your clothes or body. To protect your health, you may be asked to go to a place at the incident called a decontamination station at a place called a reception center to clean off. Do not panic; your health is not in immediate danger. Follow these directions to prepare for the reception center:

Step 1: Go to the designated decontamination area or reception center, as directed.
Step 2: Do not touch your face or put anything into your mouth.
Step 3: Enter the decontamination area or reception center and follow the instructions from the staff. You will likely be asked to stand for a screening (survey) of yourself with clothing. Workers will ask you questions about necessary personal information; please provide answers as best as you can.
Step 4: After you are screened, you will be directed to leave if minimal or no radioactive dust is present. If radioactive dust is found, you will be directed to the wash area or you may be sent home with instructions on how to clean yourself. This is called decontamination.
Step 5: If you are directed to enter the wash area, you will be segregated with individuals of the same gender. To the extent possible, families will be kept together through the decontamination process. Prepare to remove your outer clothes behind a privacy curtain. If radioactive dust is on your clothes, removing them will reduce the dust and decrease the chance that you breathe in or ingest the dust. Quick removal of outer clothing will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut the clothing off or prevent the outside from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling the clothing over your head.
Step 6: You will be provided with plastic bags. Place all of your clothing in one bag. You can wash most valuables. Anything that is plastic (including credit cards) or metal, identification, jewelry, and keys are easily washed off. Other types of materials can be wiped off carefully, like money, wallets, and purses. If something cannot be washed then place them in a separate plastic bag from your clothes and seal it. You may be asked to double bag your belongings to minimize the potential for bag breakage. You will be instructed on how to handle these items at a later time when more is known about the hazards of the radioactive dust.
Step 7: Pass through the wash area.
Step 8: When you reach the end of the wash station you will be given clothing to put on and directed to the final staging area. Do not leave without your valuables, even if they are not clean.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Instructions No. 2:
Instructions to Public on How to Perform Decontamination at Home

You may have been exposed to low levels of radioactive materials ("dust"). The dust may have gotten on your hair, skin, clothing, and personal property. Depending on your location, the radioactive dust could be on your vehicle, home, yard, lawn furniture, BBQ grill, or anything outside. The dust may have gotten on your jewelry, wallet or purse, or other personal belongings if you were near the incident. You are not in immediate danger from this radioactive dust; however, you need to go home or to another designated area to remove the dust, which is called decontamination. Because radiation cannot be seen, smelled, felt, or tasted, people at the site of an incident will not immediately know if they have been exposed to radioactive materials. Follow these instructions to limit your contamination.

Get out of the immediate area quickly. Go directly home, inside the nearest safe building, or to an area to which you are directed by law enforcement or health officials. *Do not go to a hospital unless you have a medical condition that requires treatment***.**

If radioactive dust is on your clothes, removing them as quickly as possible will remove up to 90% of the dust, while helping to prevent you from breathing in or ingesting the dust and will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut if off or prevent the outer layer from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling clothing over the head. Removal of clothes should be done in a garage or outside storage area if available, where the ground can be washed off easily. If an outside area is not available, the removal of clothing should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Clothing should be rolled up with the outside "in" to minimize spreading the dust.

If possible, place the clothing in a plastic bag (double bagging is best to reduce the chances of it breaking), and leave it in an out-of-the-way area, such as the corner of a room or garage. Keep people away from it to reduce their exposure to radiation. You may be asked to bring this bag for follow-up tests or for disposal at a later time.

Keep cuts and abrasions covered when handling anything you think has the radioactive dust on it to avoid getting radioactive material in the wound.

Shower and wash all of the exposed parts of your body and hair using lots of soap and lukewarm water to remove the dust. Simple washing will remove most of the radioactive dust. Do not use abrasive cleaners, or scrub too hard. Do not use hair conditioners in your hair because it could trap the radioactive dust onto your hair.

You can also wash your valuables and other personal property. You can wash off valuables and small items at the same time that you wash yourself. If an outside area is not available or if the items are small, the decontamination should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Wash the items with lots of water and soap. A scrub brush can be used to reach small spaces. Only decontaminate items that you can easily move to this location as other larger items can be washed off in place.

Instructions No. 2 (Continued)

For large items, decontamination should take place where the ground can be washed easily, like a sidewalk or driveway. Using a hose, wash off the roof of your home, hard surfaces (driveways, sidewalks, decks, patios), lawn furniture, grills, toys, and any other surface or item outside. You should NOT attempt to wash your lawn, gardens, or bare soil areas.

Clothes may be washed in your washing machine or at a commercial laundry mat. Any item that is water resistant can easily be washed by hand with water and soap, like jewelry, coins, paper money, credit cards, plastic identification cards, etc. Rinse all dust down the drain with lots of water.

Do not contain the used wash water; instead it should be flushed down the drain or if outside into the stormwater/sewer system. If the wash water pools outside, it should be swept into drainage areas.

If you are going to a reception center to be monitored for the radioactive dust, it is best to change clothes and shower *before* being monitored. Do not bring your valuables or personal property to the reception center.

Listen to the news for additional information and guidance.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Form No. 1: Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

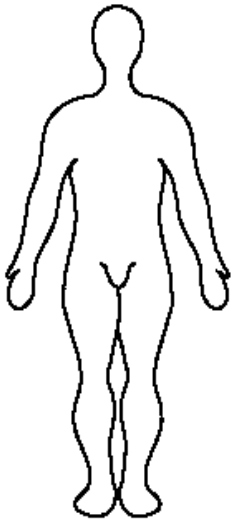
Location at Time of Incident: _____

Medical Radionuclides Received: _____

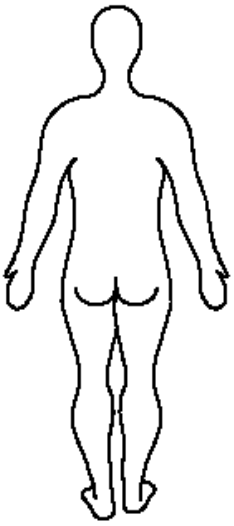
Survey Location: _____

Parent or Guardian (if child):_____

Mark contamination locations and survey reading on the diagrams below.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____ Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency: _____

Person sent to decontamination area: _____Yes _____No Clothing bag number: _____

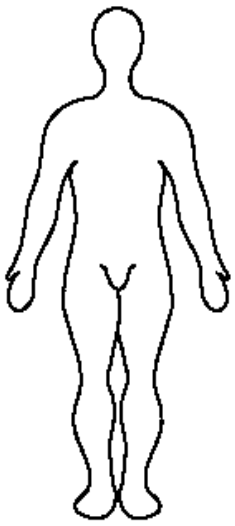
Nasal area reading of 100,000 cpm or 10 mR/hr: _____Yes _____No If Yes, refer to medical facility

Person sent to medical facility: _____Yes _____No

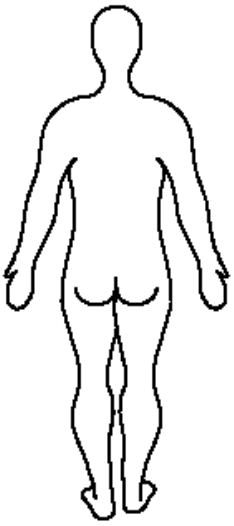
(Adapted from CRCPD 2006; see Volume II for specific citation)

Form No. 1: Contamination Survey (Continued)

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



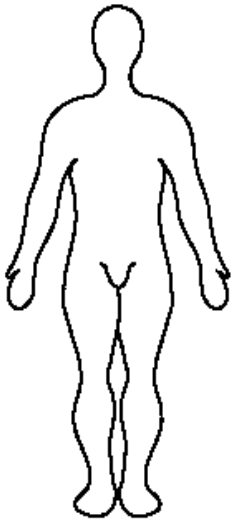
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



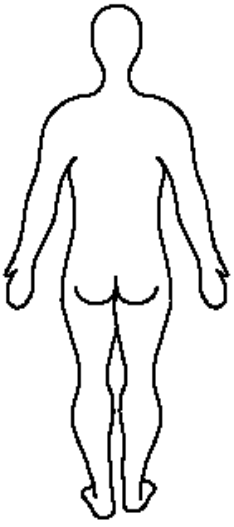
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Form No. 2: Public Property Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

Location at Time of Incident: _____

Survey Location: _____

Description of Property: _____

Draw diagram of property and mark contamination locations and survey reading.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency:_____

Playbook 5: Monitoring Uninjured Victims for Contamination

Activity: Conduct contamination surveys of uninjured victims.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. Fire Department Hazmat Teams
3. Fire Departments
4. United States Environmental Protection Agency, Emergency Response Section
5. United States Department of Energy, Radiological Assistance Program

What to Do: See Section 3.5 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

If there is a large population to be evacuated in an area of radiation levels of less than 1 mR/hr, consider releasing people to self-decontaminate at their home. Give them a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home.* If on-scene decontamination is performed, use the release levels in Table 12. Prioritization of large numbers of Delayed or Minor category victims may be necessary to focus efforts on the most contaminated people. A simple order of priority is as follows:

1. Prioritize victims by proximity to the release location of the radioactive material. Individuals within approximately 1,650 feet (500 meters) of the release or within the Exclusion Zone should have the highest priority for decontamination and exposure evaluation as they are more likely to be contaminated.
2. If a victim has Level 3 contamination levels (see Table 12) and does not have life- or limb-threatening injuries, decontaminate them immediately. Medical attention should follow decontamination. Reevaluation of contamination should be performed before release.
3. If a victim is not grossly contaminated provide medical attention and either release them to decontaminate at home or evaluate for contamination. If decontamination is warranted and resources are available, the victim should be decontaminated to contamination levels as low as possible before release. If the victim is released without decontamination, provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home.*
4. If a victim refuses to be monitored or decontaminated, they should be informed that they could have become contaminated. If they want to leave the scene, a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* should be provided and the individual released in accordance with public health policy.

Step 1: Establish Decontamination Station

The following criteria should be considered in selecting the decontamination station location:

- Background radiation levels are below one hundredth (1%) of the release levels (see Table 12), if possible. If this cannot be achieved or is not practicable, do not exceed one tenth (10%) of the release levels.
- Contamination on the personnel performing the decontamination of others should not exceed contamination levels found on the ground at the decontamination station.

A hazmat decontamination station design is adequate for radiological incidents, except if there are large volumes of water, the water should not be contained. The water should be allowed to go into the

stormwater or sewer system. If contamination is released to a sewer, make provisions for contamination monitoring at the applicable wastewater treatment plant.

Step 2: Conduct Decontamination

Note: If the victim was located in an area where they likely were not contaminated, it may be more practical to perform Step 3, Survey for Contamination, before Step 2.

Conduct decontamination per standard hazmat procedures. Dry and wet decon systems are adequate for radiological contamination. Wet decon for some victims may not be appropriate depending on their condition, weather, and other factors. If possible, release victims to perform self decontamination at home. Use of cold water or fire hoses for gross decontamination is the least preferred method. A quick decontamination method is to remove outer clothing which may reduce 80 to 90% of external contamination.

Removing the outer layer of clothes from a person should remove 80 to 90% of external contamination.

Step 3: Survey for Contamination

After decontamination, survey victim for contamination in accordance with the following procedure (see *Standard Operating Guide No 1: Procedure for Performing a Radiation Contamination Survey* for more detail):

A. If portal monitors are available, set up and operate per the instructions attached to the unit. However, portal monitors only detect gamma radiation; hand-held surveys with appropriate instrumentation are required to detect alpha or beta radiation.
B. If using a hand-held instrument, turn on meter with a Pancake Geiger-Mueller detector or microR meter.
C. If applicable, verify that the meter detector switch is set for the Pancake Geiger-Mueller detector.
D. Use a radioactive check source to verify that the Pancake Geiger-Mueller or microR meter is functional.
E. Turn the sound on or use head phones.
F. Hold the Pancake Geiger-Mueller or microR meter less than 1-inch from the victim and move at about 1-inch per second.
G. Survey the most likely contaminated and most critical areas first: Head/Face, Shoulders, Hands, and Feet.
H. Check the meter reading and compare to Table 12. Try to achieve Level 1, if there are sufficient resources available in a reasonable amount of time; otherwise, try to achieve Level 2. Do not release victims with contamination above Level 3.
I. Document contamination levels on *Form No. 1: Contamination Survey*.
J. If release levels are not exceeded, release the victim.
K. If contamination is found above release levels, send back for further decontamination.
L. After the second decontamination, resurvey the contaminated areas or have them walk through a portal monitor to verify decontamination was successful. However, portal monitors only detect gamma radiation; hand-held surveys with appropriate instrumentation are required to detect alpha or beta radiation. If the contamination is below the release levels, release victim; otherwise, contact a Radiation Technical Specialist for further instructions.
M. Release victim property that meets the levels in Table 13. Identification, credit cards, money, jewelry and other unique valuables can be bagged and returned to the owner if they cannot be decontaminated to release levels. Document contamination levels on *Form No. 2: Public Property Contamination Survey*.

Considerations:

- If possible, practice radiation protection principles and locate decontamination stations within the Support Zone/Contamination Reduction Zone at the lowest level of ground contamination and gamma exposure rate possible, preferably near background.
- Attempt to reduce and maintain contamination levels at decontamination stations as low as possible.
- Bag contaminated clothing for future evaluation and potential disposal.
- Contact the incident Safety Officer and a Radiation Technical Specialist if Level 3 contamination is found on a victim's skin after decontamination so the Radiation Technical Specialist can determine if further decontamination efforts are appropriate.
- A registry of affected victims should be established. The information collected should, at a minimum, include the person's name, address, phone number, Driver's License number if available, location during the incident, and general contamination levels measured by responders.
- If victims are waiting in a line to be decontaminated they should be provided a copy of *Instructions No.1: Public Waiting for Decontamination*.
- If a victim refuses to be monitored or decontaminated, inform them of possible contamination, give them a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home*, and release in accordance with public health policy.
- For portal monitors that alarm at a set standard deviation (sigma) above background, set the monitor to alarm at four standard deviations above background.

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 12: Victim and Public Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, but only if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Decontaminate to Level 2 lower values, then release for home decontamination in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home.* [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 13: Victim and Public Property Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Valuables should be returned to the owner, including credit cards, identification, money, jewelry, medicines, et. Bag items and notify owner that further evaluation will be required at a later time.

[6] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination; see Playbook 7 to determine if alpha is present).

Make sure that the instruments have batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a radiation check source to verify the instrument is operating properly.

Screening Survey

If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, hands, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.

If only performing a screening survey, it is acceptable to hold the survey meter probe about 1 to 2 inches away from the body (instead of ½ inch), and move it twice as fast as the normal 1 to 2 inches per second. (If the probe is moved too quickly, its detection capability may be reduced.) If surveying for alpha radiation, hold the survey meter probe ½ inch away from the body and move it at 1 inch per second. Check with state/local radiation control personnel to determine the extent of contamination survey required.

Public that are not familiar with radiological instruments may become alarmed when they hear the "clicks" from the meter. Consider using head phones to listen to the "clicks" or turn the sound off. However, if the sound is turned off, the surveyor must look at the meter reading and watch the probe position at the same time. This will result in the surveyor taking a significantly longer time to survey an individual.

Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

Complete Whole Body Survey

If feasible, perform a complete, whole body contamination survey and record the findings on *Form No 1: Contamination Survey*. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a ½ inch away from the surface to be surveyed, slowly (1 to 2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination)
2. Front of the neck and shoulders
3. Down one arm (pausing at elbow), turn arm over
4. Backside of hands, turn over (pause at palms for about five seconds)
5. Up the other arm (pausing at elbow), turn arm over
6. Shoe tops and inside ankle area
7. Shoe bottoms (pause at sole and heel)

Standard Operating Guide No. 1 (continued)

As with the screening survey, return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

The most common mistakes made during the survey:

Holding the probe too far away from the surface (should be about 1 to 2 inches away for a screening survey or about ½ inch or less for a detailed survey).

Moving the probe too fast (should be about 2 to 4 inches per second for a screening survey or about 1 to 2 inches per second for a detailed survey.)

Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use the probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Recommended procedures for on-scene responders:

1. On-scene responders should wear gloves and a gown or other protective clothing. Each responder should be provided with a personal dosimetry device.
2. Medically unstable patients should be transported to a hospital immediately.
3. A radiological survey, decontamination procedures, or steps taken to contain the contamination may be performed in the ambulance provided these actions do not interfere with more immediate medical requirements of the patient.
4. If the patient is medically stable and conditions at the site permit, limit any further exposure to radiation by moving the patient to an area of low background. The outer clothing of the individual should be removed and the patient should be wrapped in a cloth sheet or blanket to permit handling. The wrapping should be loose to avoid hyperthermia and to allow easy access to the patient by medical personnel.
5. Treat the patient's injuries (i.e., burns, cuts, etc.) sustained in the incident and, if needed, provide symptomatic treatment for the radiation illness (e.g., the use of anti-emetics).
6. If an open wound is involved, cover the wound with a clean dressing.
7. Do not release a medically stable patient to ambulance personnel before a radiological survey has been performed. If contamination is confirmed, a preliminary decontamination should be performed. Record the results of the radiological survey and proceed to decontaminate the patient.
8. Decontaminate the medically stable patient by washing the individual with tepid water to remove any radioactive contamination, beginning with the areas of highest levels of contamination. Proceed gently, mindful that this is a preliminary decontamination and that a more thorough decontamination process will be performed at a medical facility. When finished, repeat the radiation survey of the patient and record the final results. Save all clothing and bedding and all metal objects (e.g., jewelry, coins, belt buckles, etc.). A nasal swab is also recommended to detect inhalation of radioactive contaminants. However, it may be more practicable for medical personnel to perform the nasal swab.
9. Tag each item with the patient's name, location, time, and date. Save each in appropriate containers; mark containers clearly with: "RADIOACTIVE—DO NOT DISCARD."
10. Transport patient to a medical facility for further treatment. The medical facility should be given advanced warning if they are going to receive patients exposed to radiation so that the facility can institute the appropriate medical protocols. Remember, individuals suffering from radiation injury may not be radioactive, but their skin and clothing could be contaminated with radioactive material. Protection of first responders should be focused on the source of the radiation.

(NCRP 2005, Adapted from the 1998 FBI Contingency Plan for Weapons of Mass Destruction FBI, 1998).

Instructions No. 1: Public Waiting for Decontamination

You may have been exposed to radioactive materials ("dust"). The dust from the explosion may have gotten on your clothes or body. To protect your health, you may be asked to go to a place at the incident called a decontamination station at a place called a reception center to clean off. Do not panic; your health is not in immediate danger. Follow these directions to prepare for the reception center:

Step 1: Go to the designated decontamination area or reception center, as directed.
Step 2: Do not touch your face or put anything into your mouth.
Step 3: Enter the decontamination area or reception center and follow the instructions from the staff. You will likely be asked to stand for a screening (survey) of yourself with clothing. Workers will ask you questions about necessary personal information; please provide answers as best as you can.
Step 4: After you are screened, you will be directed to leave if minimal or no radioactive dust is present. If radioactive dust is found, you will be directed to the wash area or you may be sent home with instructions on how to clean yourself. This is called decontamination.
Step 5: If you are directed to enter the wash area, you will be segregated with individuals of the same gender. To the extent possible, families will be kept together through the decontamination process. Prepare to remove your outer clothes behind a privacy curtain. If radioactive dust is on your clothes, removing them will reduce the dust and decrease the chance that you breathe in or ingest the dust. Quick removal of outer clothing will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut the clothing off or prevent the outside from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling the clothing over your head.
Step 6: You will be provided with plastic bags. Place all of your clothing in one bag. You can wash most valuables. Anything that is plastic (including credit cards) or metal, identification, jewelry, and keys are easily washed off. Other types of materials can be wiped off carefully, like money, wallets, and purses. If something cannot be washed then place them in a separate plastic bag from your clothes and seal it. You may be asked to double bag your belongings to minimize the potential for bag breakage. You will be instructed on how to handle these items at a later time when more is known about the hazards of the radioactive dust.
Step 7: Pass through the wash area.
Step 8: When you reach the end of the wash station you will be given clothing to put on and directed to the final staging area. Do not leave without your valuables, even if they are not clean.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Instructions No. 2:
Instructions to Public on How to Perform Decontamination at Home

You may have been exposed to low levels of radioactive materials ("dust"). The dust may have gotten on your hair, skin, clothing, and personal property. Depending on your location, the radioactive dust could be on your vehicle, home, yard, lawn furniture, BBQ grill, or anything outside. The dust may have gotten on your jewelry, wallet or purse, or other personal belongings if you were near the incident. You are not in immediate danger from this radioactive dust; however, you need to go home or to another designated area to remove the dust, which is called decontamination. Because radiation cannot be seen, smelled, felt, or tasted, people at the site of an incident will not immediately know if they have been exposed to radioactive materials. Follow these instructions to limit your contamination.

Get out of the immediate area quickly. Go directly home, inside the nearest safe building, or to an area to which you are directed by law enforcement or health officials. *Do not go to a hospital unless you have a medical condition that requires treatment***.**

If radioactive dust is on your clothes, removing them as quickly as possible will remove up to 90% of the dust, while helping to prevent you from breathing in or ingesting the dust and will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut if off or prevent the outer layer from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling clothing over the head. Removal of clothes should be done in a garage or outside storage area if available, where the ground can be washed off easily. If an outside area is not available, the removal of clothing should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Clothing should be rolled up with the outside "in" to minimize spreading the dust.

If possible, place the clothing in a plastic bag (double bagging is best to reduce the chances of it breaking), and leave it in an out-of-the-way area, such as the corner of a room or garage. Keep people away from it to reduce their exposure to radiation. You may be asked to bring this bag for follow-up tests or for disposal at a later time.

Keep cuts and abrasions covered when handling anything you think has the radioactive dust on it to avoid getting radioactive material in the wound.

Shower and wash all of the exposed parts of your body and hair using lots of soap and lukewarm water to remove the dust. Simple washing will remove most of the radioactive dust. Do not use abrasive cleaners, or scrub too hard. Do not use hair conditioners in your hair because it could trap the radioactive dust onto your hair.

You can also wash your valuables and other personal property. You can wash off valuables and small items at the same time that you wash yourself. If an outside area is not available or if the items are small, the decontamination should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Wash the items with lots of water and soap. A scrub brush can be used to reach small spaces. Only decontaminate items that you can easily move to this location as other larger items can be washed off in place.

Instructions No. 2 (Continued)

For large items, decontamination should take place where the ground can be washed easily, like a sidewalk or driveway. Using a hose, wash off the roof of your home, hard surfaces (driveways, sidewalks,
decks, patios), lawn furniture, grills, toys, and any other surface or item outside. You should NOT attempt to wash your lawn, gardens, or bare soil areas.

Clothes may be washed in your washing machine or at a commercial laundry mat. Any item that is water resistant can easily be washed by hand with water and soap, like jewelry, coins, paper money, credit cards, plastic identification cards, etc. Rinse all dust down the drain with lots of water.

Do not contain the used wash water; instead it should be flushed down the drain or if outside into the stormwater/sewer system. If the wash water pools outside, it should be swept into drainage areas.

If you are going to a reception center to be monitored for the radioactive dust, it is best to change clothes and shower *before* being monitored. Do not bring your valuables or personal property to the reception center.

Listen to the news for additional information and guidance.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Form No. 1: Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

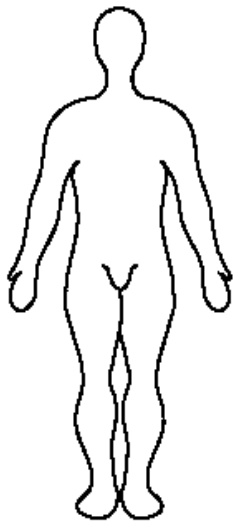
Location at Time of Incident: _____

Medical Radionuclides Received: _____

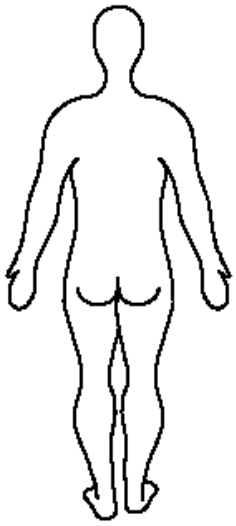
Survey Location: _____

Parent or Guardian (if child):_____

Mark contamination locations and survey reading on the diagrams below.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____ Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency: _____

Person sent to decontamination area: _____Yes _____No Clothing bag number: _____

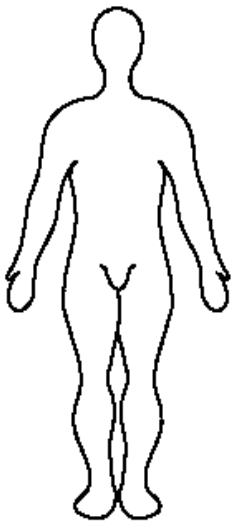
Nasal area reading of 100,000 cpm or 10 mR/hr: _____Yes _____No If Yes, refer to medical facility

Person sent to medical facility: _____Yes _____No

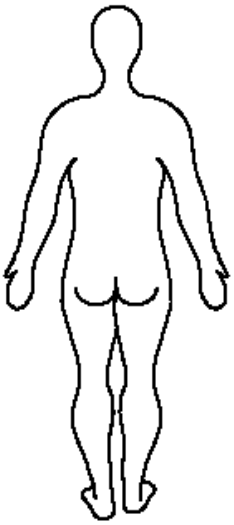
(Adapted from CRCPD 2006; see Volume II for specific citation)

Form No. 1: Contamination Survey (Continued)

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



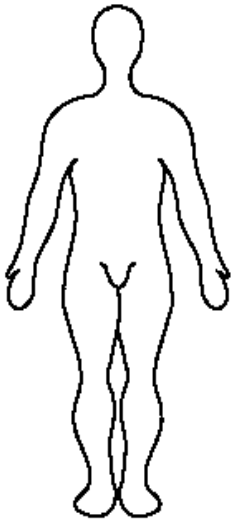
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



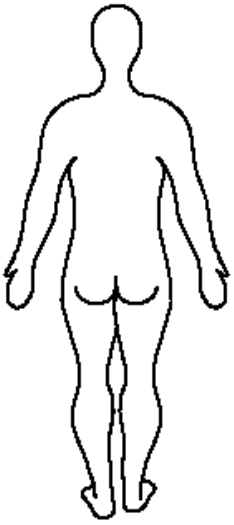
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Form No. 2: Public Property Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

Location at Time of Incident: _____

Survey Location: _____

Description of Property: _____

Draw diagram of property and mark contamination locations and survey reading.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency:_____

Playbook 6: Advanced Radiation Measurements

Activity: Conduct advanced radiation measurements to accomplish seven primary objectives and provide guidance to the Incident Command/Unified Command.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. United States Environmental Protection Agency, Emergency Response Section and Radiological Emergency Response Team
3. United States Department of Energy, Radiological Assistance Program

What to Do: See Section 3.6 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

The seven primary objectives are necessary for health and safety evaluations, for protection of responders, and to assist in decision making for protection of public health and safety.

Objective 1: Verification of the Presence of Radiation

Verify the presence of radiation by determining if exposure rates or contamination levels are greater than twice background. Use appropriate instrumentation, including specialized detectors for alpha, beta, gamma, and neutrons.

Objective 2: Verification of Control Zones

Verify external exposure rates and contamination levels in the Support Zone/Contamination Reduction Zone, Exclusion Zone, and Extreme Caution Areas with appropriate instrumentation. The location of the zones should be adjusted, if necessary, and reported to Incident Command/Unified Command for dissemination to all responders. Verify exposure rates and contamination levels at decontamination stations, the Incident Command Post, staging areas, and perimeter control locations, and if any operation requires relocation due to unsafe radiation levels or non-compliance with radiation protection practices, notify Incident Command/Unified Command immediately.

Appropriate radiological instruments used for gamma exposure rate measurements must have a detection range up to a minimum of 10 R/hr. Materials that emit alpha radiation are of particular importance and require specialized detectors; i.e., alpha scintillator. Likewise, a radioactive material that emits only beta, like strontium-90, will require a beta scintillator or Pancake Geiger-Mueller for accurate measurement.

Objective 3: Determine Type of Radiation

Determine the presence and levels of all types of radiation (alpha, beta, gamma, and neutrons) with appropriate instrumentation. See Playbook 7 for additional information on the determination of alpha radiation.

Objective 4: Determine Amount of Removable Contamination

Determine the presence and activity of removable contamination for alpha and beta radiation. The following procedure is one method.

Step 1: Mark out an area 10 centimeters by 10 centimeters (or an equivalent area representing 100 square centimeters which is about the size of a dollar bill) on a surface suspected of removable contamination.

Step 2: With a piece of 47 mm diameter filter paper (or equivalent), use moderate pressure to wipe the 100 square centimeter area. Use caution when collecting a swipe sample from rough surfaces, e.g., concrete, brick, etc., which may tear the swipe.

Step 3: Field screen the filter paper with an appropriate alpha and beta detector.

Step 4: If removable contamination is greater than 20% of the alpha or beta values in Tables 3, 10, 11, 12, and 13, or the detector efficiency is significantly greater or less than 10%, adjustments of the alpha or beta values in these tables may be warranted.

Objective 5: Identification of Radionuclide(s)

Identify the radionuclide(s) present. Potential radionuclides of concern are summarized in Table 14.

Use field gamma spectroscopy instrumentation to identify the radionuclide(s). Once a spectrum is captured, it should be sent to Los Angeles County Radiation Management for spectra interpretation. The secondary contact is the United States Department of Energy's Radiological Assistance Program at 925-447-8941 (24 hours) who has spectroscopy experts for interpretation through their reach back system.

For non-gamma emitting radionuclides, identification may not be possible with field instrumentation. In such a case, samples of the radioactive material should be collected and analyzed by a laboratory. Samples should not be highly radioactive; i.e., laboratories do not need high activity material to identify the radionuclides. Los Angeles County Radiation Management has agreements with laboratories located in Los Angeles County to analyze samples quickly during an emergency. After collection, the samples should be delivered to a laboratory as soon as possible.

Objective 6: Determine Extent and Level of Contamination

Determine if control zones have been properly established in accordance with Playbook 2 and Volume II, Section 3.2.2. Efforts to delineate the extent and level of contamination outside of the Exclusion Zone/Contamination Reduction Zone/Support Zone should occur when sufficient resources are available. This activity involves determining the extent or "footprint" of the plume or release and location of radioactive sources.

Objective 6-1: Extent of Contamination Maps

There are three methods for determining the extent of contamination of a plume or release of radioactive material: field teams that collect measurements in the plume area (ground truthing), aircraft based detection systems to provide a quick assessment, and plume modeling to provide an initial prediction. All three methods should be utilized in concert to determine the extent of wide spread contamination.

Ground Truthing: Los Angeles County Radiation Management plume mapping teams use a telemetry system to relay radiation measurements to a central database so the measurements can be displayed on a map. The map is automatically updated with new measurements as they are collected and is viewable from any computer with internet access and applicable software. Radiation Management protocol upon notification of an incident that activates the Multi-Agency Radiological Response Plan is to send teams to delineate the extent of contamination. These teams will self-deploy to the downwind area of the plume to collect measurements with appropriate detectors depending on the suspected radionuclide.

Aircraft: Los Angeles County Sheriff's Department and Los Angeles City Police Department can deploy rotary aircraft with sensitive radiation detection capabilities. The detection systems have a telemetry system that downloads data to the same central database used by the ground teams. These aircraft are expected to provide data within a few hours after a request for assistance.

Plume Modeling: Los Angeles County Radiation Management can provide an initial plume model using HOTSPOT. The United States Department of Energy's National Atmospheric Release Advisory Center (NARAC) in Livermore, California at 925-422-9100 (24 hours) also has staff expertise in modeling a wide variety of releases.

Objective 6-2: Location of Radioactive Source

Using appropriate instrumentation for the radionuclides of concern, determine the location of radioactive sources, if applicable. Once locations of sources are determined, a plan to contain or remove the sources from the incident may be necessary to safely conduct further activities in the Exclusion Zone; e.g., crime scene investigations.

Objective 7: Determine the Presence of Airborne Radioactivity

Air sampling should take place in areas where responders are not wearing respiratory protection; i.e., in the Support Zone/Contamination Reduction Zone. Downwind air sampling may be used to establish or terminate shelter-in-place or evacuation zones.

Los Angeles County Environmental Health industrial hygienists will conduct air sampling and collect air filters. Los Angeles County Radiation Management will field screen the filters for alpha and beta radiation.

Considerations:

- If possible, practice radiation protection principles and locate decontamination stations within the Support Zone/Contamination Reduction Zone at the lowest level of ground contamination and gamma exposure rate possible, preferably near background.
- Attempt to reduce and maintain contamination levels at decontamination stations as low as possible.
- Objectives can be worked on concurrently by different radiological teams. However, careful coordination of activities and data management is necessary.

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 10: Responder Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, if returning to duty station or if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	If responder is going directly home, decontaminate to Level 2 lower values, then release for home decontaminate in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home*. If not going directly home decontaminate as noted for Level 1. [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute mR/hr milliroentgen per hour µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 11: Responder Equipment Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist. Items returning to contaminated areas, including ambulances, may be reused during the incident with these contamination levels.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not reuse or release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Upon demobilization, high priority equipment, like an ambulance, should be given quicker attention for decontamination efforts to release at the lowest contamination level possible.

6 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute mR/hr milliroentgen per hour µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 12: Victim and Public Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, but only if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Decontaminate to Level 2 lower values, then release for home decontamination in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home.* [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 13: Victim and Public Property Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Valuables should be returned to the owner, including credit cards, identification, money, jewelry, medicines, et. Bag items and notify owner that further evaluation will be required at a later time.

6 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 14: Radionuclides of Concern

Radionuclide	Half-Life	Primary Radiation[1] Type
Americium-241 (Am-241)	430 years	Alpha, Gamma
Am-241/Beryllium	430 years	Alpha, Gamma, Neutron
Cesium-137 (Cs-137)	30 years	Beta, Gamma
Cobalt-60 (Co-60)	5.3 years	Beta, Gamma
Iridium-192 (Ir-192)	74 days	Beta, Gamma
Plutonium-238 (Pu-238)	86 years	Alpha, Gamma
Plutonium-239 (Pu-239)	24,400 years	Alpha, Beta, Gamma
Pu-239/Beryllium	24,400 years	Alpha, Beta, Gamma, Neutron
Radium-226 (Ra-226)	1,600 years	Alpha, Beta, Gamma
Ra-226/Beryllium	1,600 years	Alpha, Beta, Gamma, Neutron
Strontium-90 (Sr-90)	29.1 years	Beta, Bremsstrahlung (low energy x-rays)
Uranium-235 (U-235)	700,000,000 years	Alpha, Beta, Gamma
Uranium-238 (U-238)	4,500,000,000 years	Alpha, Beta, Gamma

[1] Includes primary radiation emitted from daughter products

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Playbook 7: Alpha Radiation Detection and Considerations

Activity: Determine the presence or absence of alpha radiation.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. Fire Department Hazmat Teams
3. Law Enforcement Hazmat Teams
4. United States Environmental Protection Agency, Emergency Response Section
5. United States Department of Energy, Radiological Assistance Program

What to Do: See Section 3.6.3 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Step 1: Instrument Setup

A. Turn on ratemeter with an appropriate alpha specific detector, like a zinc sulfide scintillator.
B. If applicable, verify that the meter detector switch is set for the alpha detector.
C. Use a radioactive alpha check source to verify that the alpha detector is functional. Ensure detector does not have a light leak; i.e., if light gives a reading.
D. Turn the sound on or use head phones.

Step 2: Test for Alpha Radiation at Incident Command Post

E. Begin testing for alpha radiation in the area of the Incident Command Post. Ensure detector does not have a light leak; i.e., if light gives a reading.
F. Hold the alpha detector less than ½ inch from a smooth, hard surface and note reading on meter. Any reading above zero is an indication of the potential presence of alpha radiation.
G. If alpha radiation is not detected, conduct a scanning survey by moving the detector at approximately 1 inch per second over a few square feet.
H. If alpha radiation is again not detected, move to another location and repeat steps F and G.
I. Compare measurements with the alpha values for the Support Zone/Contamination Reduction Zone in Table 3. Notify Incident Command/Unified Command of results and advise adjustment to control zones if necessary.

Step 3: Test for Alpha Radiation in the Support Zone/Contamination Reduction Zone

J. Enter the Support Zone/Contamination Reduction Zone. Ensure detector does not have a light leak; i.e., if light gives a reading.
K. Collect measurements at various locations within the Support Zone/Contamination Reduction Zone in accordance with steps F through H. Select locations where responders are conducting operations.
L. Compare measurements with the alpha values for the Support Zone/Contamination Reduction Zone in Table 3. Notify Incident Command/Unified Command of results and advise adjustment to control zones if necessary.

Step 4: Test for Alpha Radiation in the Exclusion Zone

M. Don appropriate personal protective equipment and direct reading dosimeter, if available.
N. Enter the Exclusion Zone after obtaining permission from the Operations Section Chief.
O. Collect measurements in accordance with steps F through H.
P. Compare measurements with the alpha values for the Exclusion Zone in Table 3. Notify Incident Command/Unified Command of results and advise adjustment to control zones if necessary.

Step 5: Considerations for Beta Radiation Cross Talk

Q. For alpha/beta detectors, radiation can cause false positive detections; this is called beta cross talk. If possible test the same locations in Steps 2 through 4 with a beta specific detector (plastic scintillator) to determine the activity of beta radiation.
R. If sufficient beta radiation is present, alpha measurements may need to be corrected for beta cross talk.
S. Determine the beta cross talk for the alpha/beta detector with a calibrated beta check source.
T. Correct the alpha measurements from Steps 2 through 4.
U. Compare measurement with the alpha values in Table 3. Notify Incident Command/Unified Command of results and advise adjustment to control zones if necessary.

Considerations:

- Moist, oily, dusty, and dirty surfaces will stop most if not all alpha radiation. Therefore, test only dry surfaces; this includes personnel, equipment, victims, and the public. If wet decontamination has been used, dry off surfaces before testing.
- Rough and porous surfaces can attenuate alpha radiation. Therefore, if possible, test on hard, smooth surfaces.
- Alpha detectors have a thin mylar film to prevent light from causing false detections. Sharp objects can easily puncture the mylar and cause a light leak. If a measurement above zero is obtained when the detector is held to a light source, the mylar is probably damaged and requires repair.
- Portal monitors only detect gamma radiation; hand-held surveys with appropriate instrumentation are required to detect alpha or beta radiation.
- Conducting alpha radiation contamination surveys on any object, person, or animal is very time consuming! The detector must be held less than ½ inch from the surface of interest. The detector scan rate should not exceed 1 inch per second.
- Presence of alpha radiation can be a serious health threat. However, it is only an internal threat. Prevent inhalation of alpha contamination by taking protective actions (wear respirators, decontaminate the area, wet the area to suppress resuspension of particulates, conduct activities in a different location, etc.)

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

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Playbook 8: Crime Scene Investigations

Activity: Conduct crime scene investigations in the Exclusion Zone or Extreme Caution Areas.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Law Enforcement Hazmat teams
2. Federal Bureau of Investigations
3. Los Angeles County Coroner's Office (for recovery of decedents)

What to Do: See Section 3.7 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Activities in the Exclusion Zone and Extreme Caution Areas should be restricted to essential activities only; see Table 3 for definition of control zones. In particular, activities in the Extreme Caution Areas must be carefully planned and dose to responders monitored. If Los Angeles County Radiation Management staff is present, they should accompany persons going into the Extreme Caution Areas to assist with health and safety monitoring.

Conduct crime scene investigation

Conduct crime scene investigations in the Exclusion Zone per standard operating procedures. Monitor dose periodically; i.e., every 30 minutes. If operations extend for more than one hour, check dosimeters against the Decision Points in Table 4 and monitor dose frequently thereafter.

Conducting crime scene investigations in the Extreme Caution Areas requires preplanning, personal dosimetry, and short stay times. Monitor dose periodically; i.e., every 5 to 10 minutes.

After an hour, check dose against the Decision Points in Table 4. If possible, use aircraft to collect detailed photography in the area under investigation. Additionally, robotic assets can retrieve items of interest to prevent unnecessary dose. Avoid exceeding 5 rem unless specifically authorized by Incident Command/Unified Command. For extended operations, change out teams on a frequent basis if necessary. Contact the Safety Officer and a Radiation Technical Specialist if dose reaches any of the levels in Table 4.

Recover decedents in the Exclusion Zone per standard operating procedures. Decedent recovery in Extreme Caution Areas must be carefully planned and responder dose monitored. The dose to a responder recovering a decedent should not exceed 5 rem. If operations are expected to exceed this value consider alternative recovery methods (robotics) or reduce the radiation exposure rates before recovery is attempted.

Note that air purifying respirators are preferred in areas that do not require supplied air respiratory protection (due the presence of another hazard such as low oxygen, chemical vapors, etc.).

Step 1: Prepare for entry

A. Turn on gamma detector: Ion Chamber (preferred), Energy Compensated Geiger-Mueller detector like the Canberra Mini Radiac (second preference), or Sodium Iodide or "gamma" probe. If available use appropriate instruments to determine the presence of alpha and beta radiation.
B. If applicable, verify that the meter detector switch is set for the gamma detector.
C. Don personal protective equipment including a respirator.
D. Zero the dose on a real-time dosimeter and wear it so you can check the dose periodically.

Step 2: Conduct entry

E. Walk slowly into the Exclusion Zone while holding the gamma detector held at waist level and at an arm's length.
F. Monitor the gamma detector readings frequently.
G. As exposure rate increases stay alert to accumulated dose on the dosimeter.
H. When accumulated dose reaches 5 rem, report to the Safety Officer via radio.
I. If entering Extreme Caution Areas, stay alert and monitor both the exposure rate and accumulated dose. As exposure rate increases so will accumulated dose.

Step 3: Exit Exclusion Zone/Extreme Caution Area

J. After exiting the Exclusion Zone/Extreme Caution Area and completing decontamination, ensure dose is recorded on *Form No. 3, Responder Dose Log*.
K. Release of contaminated evidence collected by law enforcement agencies will require evaluation on a case by case basis.
L. Before making another entry determine total dose for the incident. Avoid exceeding 5 rem, unless specifically authorized by Incident Command/Unified Command.

Considerations:

- Operations within the Extreme Caution Areas must be carefully planned and monitored.
- If possible, practice radiation protection principles and reduce dose by limiting time in the Exclusion Zone/Extreme Caution Area as much as possible, increasing distance from areas with high exposure rates and using available shielding as practicable; i.e., buildings, vehicles, etc.

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 4: Decision Points

Activities	Exposure Rate (mR/hr)	Cumulative Dose[2] (mrem)
All	Up to 10[1]	Up to 5,000 (5 rem)[1, 3]
Critical infrastructure protection	Up to 10,000 (10 R/hr)[1]	Up to 10,000 (10 rem)[1]
Lifesaving or protection of large populations	Up to 200,000 (200 R/hr)[1] **TURN BACK LIMIT**	Up to 50,000 (50 rem)[1,4]

[1] Gross gamma radiation measured with an ion chamber, or energy compensated Geiger-Mueller probe, or, if necessary, a sodium iodide or Pancake Geiger-Mueller (PGM) with the beta radiation shield closed; i.e., use the backside of the PGM, at approximately one meter (3.3 feet) above the ground.

[2] Effective Dose Equivalent for external dose only. Dose level for eyes is three times the values listed above. Dose limit for any other organ (including skin and extremities) is 10 times the values listed above.

[3] EPA 1992, 29CFR1910.1096(b)(1), and Cal-OSHA (see Volume II for specific citation)

[4] A 50 rem dose will result in an increase in the theoretical cancer mortality risk from the background rate of approximately 24% to approximately 28% (Volume II, Attachment 1, Table 5). Doses above 50 rem are acceptable with approval of the Incident Command/Unified Command, Safety Officer, and a Radiation Technical Specialist in extreme cases. Responders that may receive doses up to this level should be a volunteer, well informed of the risks, and have proper training and detection equipment. For example, a 100 rem dose will result in an increase in the theoretical cancer mortality risk from the background rate of approximately 24% to approximately 32%. See Volume II, Attachment 1, Table 5 for risk values for other doses. This dose should be restricted to a once in a life-time event. However, if a future event requires use of these individuals, they may be used; however, their previous dose must be considered. If the IC/UC allows higher than recommended dose or exposure rate levels, documentation should justify the reasons, and the factors in Volume II, Section 3.2.3, should be considered.

Note: The word “limit” is not used in the context of the Multi-Agency Radiological Response Plan for pre-established health and safety standards. Instead dose, exposure rate, and contamination values are provided as guidance and called “levels” or “decision points.” As noted in the above table, doses greater than the occupational limit of 5 rem in a year may be warranted for critical response actions.

mrem millirem
mR/hr milliroentgen per hour
rem roentgen equivalent man
R/hr roentgen per hour

References: CRCPD 2006, NCRP 2005, NCRP 2001, and DHS 2008b (see Volume II for specific citation)

Form No. 3: Responder Dose Log

Organization(s) _____ Incident Name _____ Date _____

Name (or ID#)	Dosimeter Type	Dosimeter Serial#	Dose Readings				Safety Officer Initials
			Start Reading *use units*	Time	End Reading *use units*	Time	

_____Units_____
uR = microR = microrem
mR = milliR = millirem
R = rem

Page _____ of _____ Safety Officer Signature _____

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Playbook 9: Monitoring People for Contamination at Public Reception Centers

Activity: Conduct monitoring for contamination at public reception centers.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. Fire Department Hazmat Teams
3. Fire Departments
4. Los Angeles County, Department of Public Health
5. United States Environmental Protection Agency, Emergency Response Section and Radiological Emergency Response Team
6. United States Department of Energy, Radiological Assistance Program

What to Do: See Section 3.8 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

The primary objectives when receiving people at a reception center are:

Provide medical treatment for individuals.
Evaluate contamination levels on individuals and, as practicable, personal property.
Provide for decontamination, if necessary.
Recommend ways to minimize future health consequences resulting from radiation exposure.
Register potentially affected individuals.

This section assumes a large number of people will visit the reception centers, but the instructions are scalable. Try to allocate the public to a specific reception center to reduce massive influx; assign a geographic area to a reception center based on its design capacity.

Set-Up Considerations:

- Special populations will require additional accommodations at the center or special off-site assistance if they are not able to visit a center; special populations include children, pregnant women, the elderly, and those who are immuno-compromised, disabled, homeless, or institutionalized.
- People who bring their pets, farm animals, and property can create a bottleneck if not managed appropriately. A separate pet decontamination area should be established for owners to decontaminate their pets; provide a copy of *Instructions No. 3: Instructions to Public on How to Perform Decontamination of Pets*.
- Potential reception centers are gymnasiums at universities, colleges, or public schools; National Guard armories; health clubs; sports arenas; convention centers; parks; beaches; and parking lots. See Volume II, Section 3.8, for reception center features.

Never separate family members from each other.

To process approximately 1,000 people per hour see Table 15 for minimum staffing requirements. Approximately 135 people are needed to staff one reception center. Staffing requires both technical and non-technical personnel of sufficient numbers to maintain operations for days to weeks. The technical staffing requirements are:

- Radiation Technical Specialists to operate hand-held detection instruments and portal monitors
- Radiation Technical Specialists to evaluate survey results, provide advice to individuals on radiological issues, answer questions, and provide general radiation related advice and consultation
- Clinicians to administer medical services and provide general health advice and consultation (i.e., Nurses, Counselors, etc.).
- Public health staff or others to fulfill general staff positions

Operations

Efficient flow of people through the reception center is necessary to avoid long lines and delays. Operations need to be flexible and scaleable. The term "monitoring" in this context is used generically to mean conducting a radiation scanning survey of the person's clothing, body, personal property, and includes decontamination, if necessary. Volume II, Attachment 6 provides example flow diagrams for the design of public reception centers that handle people only and designs that include handling people with pets.

Step 1: Greeting Station

A greeter will meet people as they arrive at the reception center to explain procedures, answer questions, and provide comfort to those who may be stressed and worried. Greeters who speak the various languages of the community are extremely helpful. Depending on the number of people, several or more greeters may be required to prevent long lines.

Step 2: Medical Triage Station

A clinician posted at the entrance or walking the line of public waiting to be decontaminated can observe people for signs and symptoms of medical conditions that require immediate attention. If identified, the individual should be directed to the medical station for examination, potential treatment, and disposition. The two dispositions are to send the patient to a hospital or to fast track the patient through the monitoring line.

Step 3: Registry Station

Begin the registration process before monitoring and decontamination, if possible. Do not delay monitoring and decontamination for registration. Register victims, responders, health care workers, volunteers, and others who were or may have been contaminated or exposed to radiation. Registration of individuals is important for tracking health concerns post incident. Collecting the following information can assist in the tracking process:

- Name
- Address
- Phone number
- Contact information
- Gender
- Age
- Status; i.e., responder, health care worker, person at the scene, person affected by plume, person who believes they were affected as defined in a public announcements, or volunteer
- Location at time of incident. The distance from the person to the release of radioactive materials is very important information. Attempt to obtain the address, street intersection, visual landmark, etc., to document the location as closely as possible.
- If possible, categorize based on radiological exposure
  - External and internal contamination
  - External contamination only
  - Uncontaminated

Prioritization of individuals is critical if a large population is affected. A contamination triage process should identify and prioritize people according to the following guidelines in order of priority:

- Life-threatening conditions (do not delay medical attention in order to decontaminate)
- Contaminated (confirmed or suspected)
- Less likely contaminated
- Unlikely contaminated (including people who have performed self-decontamination)

The contamination triage is based on responses obtained in the registry process and a quick radiation scan.

Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!

Before proceeding to a Waiting Line, each individual or family should be provided a copy of *Instructions No.1: Public Waiting for Decontamination*.

Step 4: Waiting Lines

A Radiation Technical Specialist or a worker who has received just-in-time training, should walk the line of those waiting to be monitored with a radiation detection instrument (the best choice is a Pancake Geiger-Mueller, microR meter, or gamma (sodium iodide) meter) to determine if anyone waiting in line has contamination levels on their person more than Level 1 are of an immediate concern (see Table 12). These individuals should be removed from the line and more quickly decontaminated. If there are too many individuals showing these contamination levels, the readings could be adjusted to Level 3 (see Table 12). Note that the Radiation Technical Specialist may adjust the above values based on the identity of the radionuclide(s); therefore, verify before using the above contamination levels.

If an individual is suspected of having a high level of contamination (Level 3), send the person and his/her family directly to decontamination. This reduces the chance of cross contamination and gives priority to the most contaminated victims, decreasing their dose as quickly as possible.

Step 5: Radiation Screening Survey Stations

Radiation screening surveys are designed to identify contamination above a specific release level. The public contamination release levels (see Tables 12 and 13) should be developed based on the specific radionuclide (assumed to have been identified prior to the commencement of survey operations at reception centers).

A survey station can consist of a Pancake Geiger-Mueller detector, gamma detector, microR meter, portal monitor, or radiation specific meter, like an alpha or beta scintillator. Hand-held surveys should be performed in accordance with *Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey*. *Form No. 1: Contamination Survey* and *Form No. 2: Public Property Contamination Survey* should be completed and included in the registry for each individual.

A general staff person will help to control the flow of the public through the stations. Radiation Technical Specialists can oversee several general staff performing monitoring who have received just-in-time training. If an individual is contaminated, he/she should proceed to the decontamination area; otherwise, he/she should be released to go home or to an American Red Cross shelter facility.

Step 6: Decontamination Station

Individuals who are contaminated should be sent to the Self Decontamination Station, if applicable. The configuration of the reception center will dictate the setup of decontamination stations. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* as an example of how they should perform self-decontamination, a copy of *Instructions No.3: Instructions to Public on How to Perform Decontamination of Pets*, if applicable. After decontamination, individuals will need to be surveyed for remaining contamination.

Step 7: Checkout Station

After each person has completed the monitoring process, they should proceed to a Checkout Station to complete registry. They should be provided with information and instructions including the following:

- Basic information about radiation and its effects on human health
- Actions that they can take to protect their health
- Public health contact information for questions and additional information

If the individual is going into an American Red Cross shelter located adjacent to the reception center or by controlled transport, they should receive a wrist band or other identifier indicating completion of the monitoring process. The American Red Cross will not allow any persons to enter their shelter without an indication that the person has been monitored and released.

Recommendations for monitoring:

- If there is a large number of people, prioritize hand-held surveys to focus on only the head, face, shoulders, and hands.
- Do not take an individual's identification, money, credit cards, jewelry, or other valuables; give these items to the owner. Provide instructions on how to decontaminate them (*Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home*) and provide a bag for storage until the items can be decontaminated and surveyed later.

Other considerations

- Provide transportation services to assist victims at the scene and to reduce the influx of vehicles at the reception centers.
- Following Universal Precautions will likely provide sufficient protection.
- Counseling services may be needed due to the public's perception or fear of radiation.
- Attempt to reduce and maintain contamination levels at decontamination stations as low as possible.
- Experts predict that the number of worried well could be 10 times more than the number of individuals who were actually exposed or contaminated.
- For portal monitors that alarm at a set standard deviation (sigma) above background, set the monitor to alarm at four standard deviations above background.

Table 12: Victim and Public Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, but only if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Decontaminate to Level 2 lower values, then release for home decontamination in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home.* [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 13: Victim and Public Property Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Valuables should be returned to the owner, including credit cards, identification, money, jewelry, medicines, et. Bag items and notify owner that further evaluation will be required at a later time.

[6] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 15: Staffing Requirements for 1,000 Persons per Hour Reception Center

Minimum Number	Position	Considerations
1	Facility Group Director	
1	Assistant Facility Group Director	
2[(1)]	Greeter	Additional needed for various languages
As needed	Uniformed security officers	Police and National Guard
As needed	Media relations staff	Coordinate with Joint Information Center
5	Crisis counselors	
20	Line attendant	2 per hand-held monitoring station
20	Radiation monitoring technicians	2 per hand-held monitoring station
10	Escort attendant	1 per hand-held monitoring station
10	Line attendant	1 per portal monitor station
20	Radiation monitoring technicians	2 per portal monitor station
10	Escort attendant	1 per portal monitor station
25	Registry staff	
10	Clinicians	Nurses/doctors as needed
1	Emergency Medical Services (EMS)/ambulance	

[(1)]May need more to reduce fatigue

Reference: CDC 2006 (see Volume II for specific citation)

Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination; see Playbook 7 to determine if alpha is present).

Make sure that the instruments have batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a radiation check source to verify the instrument is operating properly.

Screening Survey

If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, hands, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.

If only performing a screening survey, it is acceptable to hold the survey meter probe about 1 to 2 inches away from the body (instead of ½ inch), and move it twice as fast as the normal 1 to 2 inches per second. (If the probe is moved too quickly, its detection capability may be reduced.) If surveying for alpha radiation, hold the survey meter probe ½ inch away from the body and move it at 1 inch per second. Check with state/local radiation control personnel to determine the extent of contamination survey required.

Public that are not familiar with radiological instruments may become alarmed when they hear the "clicks" from the meter. Consider using head phones to listen to the "clicks" or turn the sound off. However, if the sound is turned off, the surveyor must look at the meter reading and watch the probe position at the same time. This will result in the surveyor taking a significantly longer time to survey an individual.

Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

Complete Whole Body Survey

If feasible, perform a complete, whole body contamination survey and record the findings on *Form No 1: Contamination Survey*. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a ½ inch away from the surface to be surveyed, slowly (1 to 2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination)
2. Front of the neck and shoulders
3. Down one arm (pausing at elbow), turn arm over
4. Backside of hands, turn over (pause at palms for about five seconds)
5. Up the other arm (pausing at elbow), turn arm over
6. Shoe tops and inside ankle area
7. Shoe bottoms (pause at sole and heel)

Standard Operating Guide No. 1 (continued)

As with the screening survey, return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

The most common mistakes made during the survey:

Holding the probe too far away from the surface (should be about 1 to 2 inches away for a screening survey or about ½ inch or less for a detailed survey).

Moving the probe too fast (should be about 2 to 4 inches per second for a screening survey or about 1 to 2 inches per second for a detailed survey.)

Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use the probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Recommended procedures for on-scene responders:

1. On-scene responders should wear gloves and a gown or other protective clothing. Each responder should be provided with a personal dosimetry device.
2. Medically unstable patients should be transported to a hospital immediately.
3. A radiological survey, decontamination procedures, or steps taken to contain the contamination may be performed in the ambulance provided these actions do not interfere with more immediate medical requirements of the patient.
4. If the patient is medically stable and conditions at the site permit, limit any further exposure to radiation by moving the patient to an area of low background. The outer clothing of the individual should be removed and the patient should be wrapped in a cloth sheet or blanket to permit handling. The wrapping should be loose to avoid hyperthermia and to allow easy access to the patient by medical personnel.
5. Treat the patient's injuries (i.e., burns, cuts, etc.) sustained in the incident and, if needed, provide symptomatic treatment for the radiation illness (e.g., the use of anti-emetics).
6. If an open wound is involved, cover the wound with a clean dressing.
7. Do not release a medically stable patient to ambulance personnel before a radiological survey has been performed. If contamination is confirmed, a preliminary decontamination should be performed. Record the results of the radiological survey and proceed to decontaminate the patient.
8. Decontaminate the medically stable patient by washing the individual with tepid water to remove any radioactive contamination, beginning with the areas of highest levels of contamination. Proceed gently, mindful that this is a preliminary decontamination and that a more thorough decontamination process will be performed at a medical facility. When finished, repeat the radiation survey of the patient and record the final results. Save all clothing and bedding and all metal objects (e.g., jewelry, coins, belt buckles, etc.). A nasal swab is also recommended to detect inhalation of radioactive contaminants. However, it may be more practicable for medical personnel to perform the nasal swab.
9. Tag each item with the patient's name, location, time, and date. Save each in appropriate containers; mark containers clearly with: "RADIOACTIVE—DO NOT DISCARD."
10. Transport patient to a medical facility for further treatment. The medical facility should be given advanced warning if they are going to receive patients exposed to radiation so that the facility can institute the appropriate medical protocols. Remember, individuals suffering from radiation injury may not be radioactive, but their skin and clothing could be contaminated with radioactive material. Protection of first responders should be focused on the source of the radiation.

(NCRP 2005, Adapted from the 1998 FBI Contingency Plan for Weapons of Mass Destruction FBI, 1998).

Instructions No. 1: Public Waiting for Decontamination

You may have been exposed to radioactive materials ("dust"). The dust from the explosion may have gotten on your clothes or body. To protect your health, you may be asked to go to a place at the incident called a decontamination station at a place called a reception center to clean off. Do not panic; your health is not in immediate danger. Follow these directions to prepare for the reception center:

Step 1: Go to the designated decontamination area or reception center, as directed.
Step 2: Do not touch your face or put anything into your mouth.
Step 3: Enter the decontamination area or reception center and follow the instructions from the staff. You will likely be asked to stand for a screening (survey) of yourself with clothing. Workers will ask you questions about necessary personal information; please provide answers as best as you can.
Step 4: After you are screened, you will be directed to leave if minimal or no radioactive dust is present. If radioactive dust is found, you will be directed to the wash area or you may be sent home with instructions on how to clean yourself. This is called decontamination.
Step 5: If you are directed to enter the wash area, you will be segregated with individuals of the same gender. To the extent possible, families will be kept together through the decontamination process. Prepare to remove your outer clothes behind a privacy curtain. If radioactive dust is on your clothes, removing them will reduce the dust and decrease the chance that you breathe in or ingest the dust. Quick removal of outer clothing will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut the clothing off or prevent the outside from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling the clothing over your head.
Step 6: You will be provided with plastic bags. Place all of your clothing in one bag. You can wash most valuables. Anything that is plastic (including credit cards) or metal, identification, jewelry, and keys are easily washed off. Other types of materials can be wiped off carefully, like money, wallets, and purses. If something cannot be washed then place them in a separate plastic bag from your clothes and seal it. You may be asked to double bag your belongings to minimize the potential for bag breakage. You will be instructed on how to handle these items at a later time when more is known about the hazards of the radioactive dust.
Step 7: Pass through the wash area.
Step 8: When you reach the end of the wash station you will be given clothing to put on and directed to the final staging area. Do not leave without your valuables, even if they are not clean.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Instructions No. 2:
Instructions to Public on How to Perform Decontamination at Home

You may have been exposed to low levels of radioactive materials ("dust"). The dust may have gotten on your hair, skin, clothing, and personal property. Depending on your location, the radioactive dust could be on your vehicle, home, yard, lawn furniture, BBQ grill, or anything outside. The dust may have gotten on your jewelry, wallet or purse, or other personal belongings if you were near the incident. You are not in immediate danger from this radioactive dust; however, you need to go home or to another designated area to remove the dust, which is called decontamination. Because radiation cannot be seen, smelled, felt, or tasted, people at the site of an incident will not immediately know if they have been exposed to radioactive materials. Follow these instructions to limit your contamination.

Get out of the immediate area quickly. Go directly home, inside the nearest safe building, or to an area to which you are directed by law enforcement or health officials. *Do not go to a hospital unless you have a medical condition that requires treatment***.**

If radioactive dust is on your clothes, removing them as quickly as possible will remove up to 90% of the dust, while helping to prevent you from breathing in or ingesting the dust and will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut if off or prevent the outer layer from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling clothing over the head. Removal of clothes should be done in a garage or outside storage area if available, where the ground can be washed off easily. If an outside area is not available, the removal of clothing should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Clothing should be rolled up with the outside "in" to minimize spreading the dust.

If possible, place the clothing in a plastic bag (double bagging is best to reduce the chances of it breaking), and leave it in an out-of-the-way area, such as the corner of a room or garage. Keep people away from it to reduce their exposure to radiation. You may be asked to bring this bag for follow-up tests or for disposal at a later time.

Keep cuts and abrasions covered when handling anything you think has the radioactive dust on it to avoid getting radioactive material in the wound.

Shower and wash all of the exposed parts of your body and hair using lots of soap and lukewarm water to remove the dust. Simple washing will remove most of the radioactive dust. Do not use abrasive cleaners, or scrub too hard. Do not use hair conditioners in your hair because it could trap the radioactive dust onto your hair.

You can also wash your valuables and other personal property. You can wash off valuables and small items at the same time that you wash yourself. If an outside area is not available or if the items are small, the decontamination should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Wash the items with lots of water and soap. A scrub brush can be used to reach small spaces. Only decontaminate items that you can easily move to this location as other larger items can be washed off in place.

Instructions No. 2 (Continued)

For large items, decontamination should take place where the ground can be washed easily, like a sidewalk or driveway. Using a hose, wash off the roof of your home, hard surfaces (driveways, sidewalks,
decks, patios), lawn furniture, grills, toys, and any other surface or item outside. You should NOT attempt to wash your lawn, gardens, or bare soil areas.

Clothes may be washed in your washing machine or at a commercial laundry mat. Any item that is water resistant can easily be washed by hand with water and soap, like jewelry, coins, paper money, credit cards, plastic identification cards, etc. Rinse all dust down the drain with lots of water.

Do not contain the used wash water; instead it should be flushed down the drain or if outside into the stormwater/sewer system. If the wash water pools outside, it should be swept into drainage areas.

If you are going to a reception center to be monitored for the radioactive dust, it is best to change clothes and shower *before* being monitored. Do not bring your valuables or personal property to the reception center.

Listen to the news for additional information and guidance.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Instructions No. 3:
Instructions to Public on How to Perform Decontamination of Pets

Your pet(s) may have been exposed to low amounts of radioactive materials ("dust"). The process of removing radioactive dust, which is called decontamination, from pets is similar to the decontamination process for people. Radioactive dust may be located on your pet's skin and in their fur. Your pet is not in immediate danger but should be decontaminated to minimize spread of the radioactive dust. In order to protect your health and safety as well as your pets, please follow these instructions:

Decontamination should take place where the ground can be washed with a hose. If an outside area is not available, the decontamination should take place in a room where the floor can be easily cleaned, such as the tub or shower areas. Swiffer® pads are good for decontaminating smooth surfaces including the floor.

Keep cuts and abrasions (both yours and your pet's) covered when washing the pet to avoid getting radioactive material in the wound.

If available, wear rubber dishwashing gloves and an apron. Shower and wash all of the exposed parts of your pet using mild dish soap and lots of lukewarm water. Simple washing will remove most of the radioactive dust. Do not use abrasive cleaners or scrub too hard. Do not use hair conditioners because it can trap the radioactive dust onto the hair.

After decontamination of your pet, remove your clothes and wash them separately from other clothes. Wash yourself thoroughly, and do not use conditioner in your hair because it could trap the radioactive dust onto your hair. This will remove any radioactive dust that may have gotten on you.

Form No. 1: Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

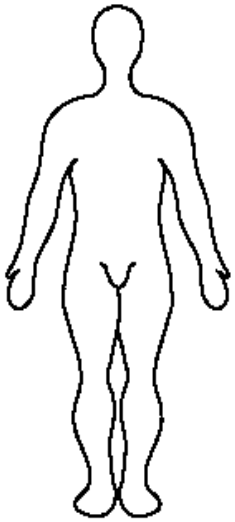
Location at Time of Incident: _____

Medical Radionuclides Received: _____

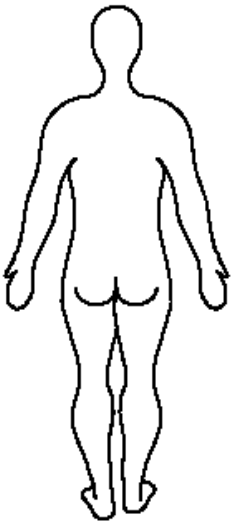
Survey Location: _____

Parent or Guardian (if child):_____

Mark contamination locations and survey reading on the diagrams below.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____ Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency: _____

Person sent to decontamination area: _____Yes _____No Clothing bag number: _____

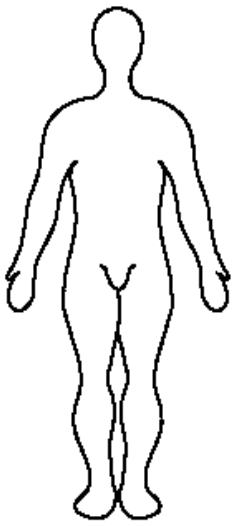
Nasal area reading of 100,000 cpm or 10 mR/hr: _____Yes _____No If Yes, refer to medical facility

Person sent to medical facility: _____Yes _____No

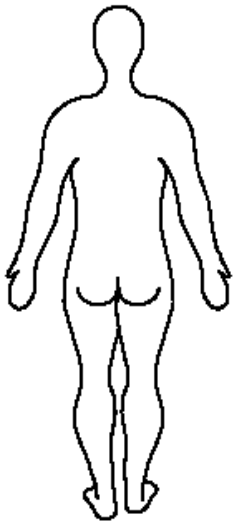
(Adapted from CRCPD 2006; see Volume II for specific citation)

Form No. 1: Contamination Survey (Continued)

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



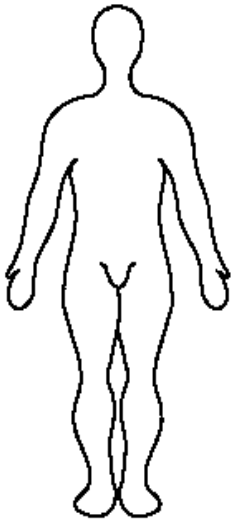
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



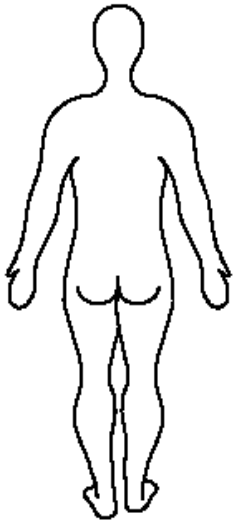
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Form No. 2: Public Property Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

Location at Time of Incident: _____

Survey Location: _____

Description of Property: _____

Draw diagram of property and mark contamination locations and survey reading.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency:_____

Playbook 10: Monitoring Public Property for Contamination

Activity: Conduct contamination surveys of public property.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. Fire Department Hazmat Teams
3. Fire Departments
4. United States Environmental Protection Agency, Emergency Response Section and Radiological Emergency Response Team
5. United States Department of Energy, Radiological Assistance Program

What to Do: See Section 3.9 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

If there is a large quantity of property needing decontamination and monitoring, prioritization may be necessary. At a minimum the following guidance is recommended:

- Do not retain identification, money, credit cards, jewelry, and other valuables if decontamination is unsuccessful. Bag the items for future decontamination and evaluation efforts, and return to their owner.
- Containers for medicines are easily replaced if contaminated. Regardless, never prevent a person from keeping their medication.
- Decontamination of pets can be accomplished by the owner, not responders. Decontamination of pets should be done in a separate area from people. Decontamination techniques for pets are the same as for people (wash thoroughly; don't use a conditioner; do not contain the runoff water). Provide pet owner with a copy of *Instructions No. 3: Instructions to Public on How to Perform Decontamination of Pets.*

Do NOT contain decontamination fluids; release to stormwater/sewer system.

A determination of fixed and removable contamination is recommended to fully protect the property owner, depending on the radionuclide(s). Table 13 summarizes the release levels for belongings and does not consider the use of an item, which may require adjustment to more conservative release levels.

Large items like vehicles, homes, or land present a much more complex survey process. During the early phase of the incident, delaying these items for decontamination and evaluation efforts is likely and messages to the public should state this policy clearly. Depending on the situation, vehicles may be released to the owners prior to decontamination and evaluation to facilitate transportation from the incident to their home, which could expedite the owner's self-decontamination. Advise the owner to take their vehicle through an automatic car wash as soon as possible.

Step 1: Establish Decontamination and Monitoring Station

Monitoring stations should have background radiation levels below one hundredth (1%) of the contamination release levels (see Table 3), if possible. If this cannot be achieved or is not practicable, do not exceed one tenth (10%) of the release level.

A hazmat decontamination station design is adequate for radiological incidents, except if there are large volumes of water, the water should not be contained. The water should be allowed to go into the stormwater or sewer system. If contamination is released to a sewer, make provisions for contamination monitoring at the applicable wastewater treatment plant.

Step 2: Survey for Contamination

Wear appropriate personal protective equipment and survey item for contamination in accordance with the following procedure (see *Standard Operating Guideline No. 1: Procedure for Performing a Radiation Contamination Survey* for additional information):

A. If portal monitors are available, set them up and use them as instructed. However, portal monitors only detect gamma radiation; hand-held surveys with appropriate instrumentation are required to detect alpha or beta radiation. The portal monitors have a vehicle adapter kit, so vehicles can be driven through them to detect external contamination.
B. For hand-held instrument surveys, turn on meter with a Pancake Geiger-Mueller detector or use a microR meter.
C. If applicable, verify that the meter detector switch is set for the Pancake Geiger-Mueller detector.
D. Use a radioactive check source to verify that the Pancake Geiger-Mueller or microR meter is functional.
E. Turn the sound on or use head phones.
F. Hold the Pancake Geiger-Mueller or microR meter less than 1-inch from the responder or equipment and move detector at about 1-inch per second.
G. Survey the most likely contaminated areas first; i.e., for a vehicle: exhaust pipe, air intake area, radiator, wheels, floor mats, handles, etc. If no contamination is found, release the item to the owner. Seek advice from a Radiation Technical Specialist about appropriate survey techniques for objects.
H. Check the meter reading and compare to the Table 13.
I. If release levels are not exceeded, document the results on *Form No. 2: Public Property Contamination Survey* and release the item.
J. If contamination is found at any surveyed areas above release levels, send for decontamination.
K. After the second attempt at decontamination, resurvey the contaminated areas to verify decontamination was successful. If the contamination is below the release levels, release item; otherwise, contact the Radiation Technical Specialist for further instructions. Document the results on *Form No. 2: Public Property Contamination Survey*.

Step 3: Conduct Decontamination

Conduct decontamination per standard hazmat procedures. Usually wet (soap and water) or dry decon procedures are adequate for radiological contamination. After decontamination, resurvey the item for compliance with release levels. If there are large volumes of water used for decontamination, do not collect the runoff water.

Considerations:

- If possible, practice radiation protection principles and locate decontamination stations within the Support Zone/Contamination Reduction Zone at the lowest level of ground contamination and gamma exposure rate possible, preferably near background.
- Attempt to reduce and maintain contamination levels at decontamination stations as low as possible.
- Items that have been decontaminated or evaluated and released should be identified as processed at the scene with a tag and identifying information recorded. This will avoid resurveying an item.
- Large items or items with internal spaces that could trap contamination are particularly time consuming. Consider prioritization of critical items and delay efforts for non-critical items.

- Vehicle decontamination can present major challenges. The public should be instructed to use car washes to decontaminate the exterior of the vehicle. Car wash businesses should be instructed to not run the water recycle mode and allow water to release to the sewer after each car wash.
- Decontamination of vehicle internal contamination is more problematic and may require extensive detailed cleaning techniques and contamination surveys. In addition, contamination mixed with engine oil or gasoline is likely to be classified as a hazardous and radioactive waste, i.e., mixed waste, which requires special handling, packaging, transportation, and disposal protocols. Provide owner a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* to assist them with decontamination procedures.
- For portal monitors that alarm at a set standard deviation (sigma) above background, set the monitor to alarm at four standard deviations above background.

Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 13: Victim and Public Property Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Valuables should be returned to the owner, including credit cards, identification, money, jewelry, medicines, et. Bag items and notify owner that further evaluation will be required at a later time.

6 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination; see Playbook 7 to determine if alpha is present).

Make sure that the instruments have batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a radiation check source to verify the instrument is operating properly.

Screening Survey

If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, hands, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.

If only performing a screening survey, it is acceptable to hold the survey meter probe about 1 to 2 inches away from the body (instead of ½ inch), and move it twice as fast as the normal 1 to 2 inches per second. (If the probe is moved too quickly, its detection capability may be reduced.) If surveying for alpha radiation, hold the survey meter probe ½ inch away from the body and move it at 1 inch per second. Check with state/local radiation control personnel to determine the extent of contamination survey required.

Public that are not familiar with radiological instruments may become alarmed when they hear the "clicks" from the meter. Consider using head phones to listen to the "clicks" or turn the sound off. However, if the sound is turned off, the surveyor must look at the meter reading and watch the probe position at the same time. This will result in the surveyor taking a significantly longer time to survey an individual.

Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

Complete Whole Body Survey

If feasible, perform a complete, whole body contamination survey and record the findings on *Form No 1: Contamination Survey*. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a ½ inch away from the surface to be surveyed, slowly (1 to 2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination)
2. Front of the neck and shoulders
3. Down one arm (pausing at elbow), turn arm over
4. Backside of hands, turn over (pause at palms for about five seconds)
5. Up the other arm (pausing at elbow), turn arm over
6. Shoe tops and inside ankle area
7. Shoe bottoms (pause at sole and heel)

Standard Operating Guide No. 1 (continued)

As with the screening survey, return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

The most common mistakes made during the survey:

Holding the probe too far away from the surface (should be about 1 to 2 inches away for a screening survey or about ½ inch or less for a detailed survey).

Moving the probe too fast (should be about 2 to 4 inches per second for a screening survey or about 1 to 2 inches per second for a detailed survey.)

Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use the probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Recommended procedures for on-scene responders:

1. On-scene responders should wear gloves and a gown or other protective clothing. Each responder should be provided with a personal dosimetry device.
2. Medically unstable patients should be transported to a hospital immediately.
3. A radiological survey, decontamination procedures, or steps taken to contain the contamination may be performed in the ambulance provided these actions do not interfere with more immediate medical requirements of the patient.
4. If the patient is medically stable and conditions at the site permit, limit any further exposure to radiation by moving the patient to an area of low background. The outer clothing of the individual should be removed and the patient should be wrapped in a cloth sheet or blanket to permit handling. The wrapping should be loose to avoid hyperthermia and to allow easy access to the patient by medical personnel.
5. Treat the patient's injuries (i.e., burns, cuts, etc.) sustained in the incident and, if needed, provide symptomatic treatment for the radiation illness (e.g., the use of anti-emetics).
6. If an open wound is involved, cover the wound with a clean dressing.
7. Do not release a medically stable patient to ambulance personnel before a radiological survey has been performed. If contamination is confirmed, a preliminary decontamination should be performed. Record the results of the radiological survey and proceed to decontaminate the patient.
8. Decontaminate the medically stable patient by washing the individual with tepid water to remove any radioactive contamination, beginning with the areas of highest levels of contamination. Proceed gently, mindful that this is a preliminary decontamination and that a more thorough decontamination process will be performed at a medical facility. When finished, repeat the radiation survey of the patient and record the final results. Save all clothing and bedding and all metal objects (e.g., jewelry, coins, belt buckles, etc.). A nasal swab is also recommended to detect inhalation of radioactive contaminants. However, it may be more practicable for medical personnel to perform the nasal swab.
9. Tag each item with the patient's name, location, time, and date. Save each in appropriate containers; mark containers clearly with: "RADIOACTIVE—DO NOT DISCARD."
10. Transport patient to a medical facility for further treatment. The medical facility should be given advanced warning if they are going to receive patients exposed to radiation so that the facility can institute the appropriate medical protocols. Remember, individuals suffering from radiation injury may not be radioactive, but their skin and clothing could be contaminated with radioactive material. Protection of first responders should be focused on the source of the radiation.

(NCRP 2005, Adapted from the 1998 FBI Contingency Plan for Weapons of Mass Destruction FBI, 1998).

Instructions No. 3:
Instructions to Public on How to Perform Decontamination of Pets

Your pet(s) may have been exposed to low amounts of radioactive materials ("dust"). The process of removing radioactive dust, which is called decontamination, from pets, is similar to the decontamination process for people. Radioactive dust may be located on your pet's skin and in their fur. Your pet is not in immediate danger but should be decontaminated to minimize spread of the radioactive dust. In order to protect your health and safety as well as your pets, please follow these instructions:

Decontamination should take place where the ground can be washed with a hose. If an outside area is not available, the decontamination should take place in a room where the floor can be easily cleaned, such as the tub or shower areas. Swiffer® pads are good for decontaminating smooth surfaces including the floor.

Keep cuts and abrasions (both yours and your pet's) covered when washing the pet to avoid getting radioactive material in the wound.

If available, wear rubber dishwashing gloves and an apron. Shower and wash all of the exposed parts of your pet using mild dish soap and lots of lukewarm water. Simple washing will remove most of the radioactive dust. Do not use abrasive cleaners or scrub too hard. Do not use hair conditioners because it can trap the radioactive dust onto the hair.

After decontamination of your pet, remove your clothes and wash them separately from other clothes. Wash yourself thoroughly, and do not use conditioner in your hair because it could trap the radioactive dust onto your hair. This will remove any radioactive dust that may have gotten on you.

Form No. 2: Public Property Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

Location at Time of Incident: _____

Survey Location: _____

Description of Property: _____

Draw diagram of property and mark contamination locations and survey reading.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency:_____

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Playbook 11:
Public Protective Action Guide – Evacuation and Shelter-in-Place

Activity: Determine need for and recommend protective actions for the public, including advice for evacuation and shelter-in-place areas.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Los Angeles County, Department of Public Health, Radiation Management
2. United States Environmental Protection Agency, Emergency Response Section and Radiological Emergency Response Team
3. United States Department of Energy, Radiological Assistance Program and Federal Radiological Monitoring and Assessment Center

What to Do: See Section 3.10 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Protective action guides (PAGs) are implemented to reduce or eliminate exposure and/or contamination to radiation and/or radiological materials. The actions presented in this Playbook are based on the United States Environmental Protection Agency's *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* (EPA 1992) and the *Department of Homeland Security's Planning Guidance for Protection and Recovery Following Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents* (DHS 2008). See Volume II for specific citations.

Protective actions will be based on four criteria during the early and intermediate phase of an emergency. The criteria are:

1. Immediate (i.e., acute) health effects should be avoided
2. Risk of delayed health effects should not exceed a level that is judged to be adequately protective of health in an emergency situation
3. Any reduction of risk to public health achievable at acceptable cost should be implemented
4. Risk to health from a protective action should not exceed the risk from the dose that is avoided

Evaluate radiation measurements collected from impacted areas to determine if any early phase protective action guides (PAGs) are exceeded as summarized in Table 16. Based on the protective action guides (PAGs), make a decision to implement shelter-in-place or initiate evacuations. In the evaluation of data consider the potential exposure pathways as summarized in Table 17. Provide recommendations to Incident Command/Unified Command and assist with development of public announcements that instruct citizens on the selected protective actions.

Considerations:

- Consider the number of population affected by the risk of evacuation versus shelter-in-place.
- Consider critical populations (infirmed, incarcerated, elderly, day care centers, etc.) affected by the risk of evacuation versus shelter-in-place.
- In general, shelter-in-place is safer for people than evacuation.
- Exposure to workers at critical infrastructures that are required to continue operations requires special evaluation and potentially protective actions.
- Prioritize evacuations based on exposure rates and/or contamination levels.

- Shelter-in-place is more protective than evacuation during passage of a radioactive plume. Note that for an explosive radiological dispersal device (RDD), the plume will have settled to the ground within about the first 10 to 20 minutes.
- Plume modeling can provide initial impact assessments but requires ground truthing to modify the modeling predictions, thus implementing actions based on preliminary modeling should proceed with caution and balancing of risk versus gain.
- Individuals in heavy traffic may receive unnecessary exposure if they are in or near contaminated areas. Direct these people to drive to uncontaminated areas or to a building to shelter-in-place. See Playbook 12 more further information.

Table 16: Protective Action Guides

Phase	Potential Effective Dose[1]	Action
Early	< 100 mrem[3]	No sheltering
	≥ 1 rem[3] in first four days	Sheltering
	≥ 1 rem[3] and ≤ 5 rem[3] in first four days	Evacuation, if more protective than sheltering, except for sensitive populations[2]
Intermediate	≥ 500 mrem[3] in second year or any subsequent year	Decontamination and other dose-reduction techniques
	≥ 2 rem[3] in first year	Relocation
	≥ FDA guidance for human food and animal feed	See guidance document
Late	≥ 100 mrem[4] and < 500 mrem[4]	Use ALARA
	< 100 rem[4]	No action

[1] International Council of Radiation Protection (ICRP) definition 1991.

[2] Special groups for which evaluation could cause greater risk to themselves or the public (e.g., persons on medical life support, institutionalized criminals, etc.); evacuation should not be implemented if the projected effective dose is less than 10 rem.

[3] Projected doses are maximally exposed individual and calculation methods consistent with those currently in the Protective Action Guide Manual but should be based on current dose conversion factors.

[4] Projected doses are maximally exposed individual and calculation methods should use dose-assessment computer programs or methodologies accepted by federal agencies using realistic exposure scenarios for the intended actual use of the radioactively contaminated areas.

mrem	millirem
rem	roentgen equivalent man
<	less than
≥	greater than or equal to
FDA	United States Food and Drug Administration
ALARA	as low as reasonably achievable

References: EPA 1992, DHS 2008b (see Volume II for specific citation).

Table 17: Exposure Pathways and Protective Actions

Potential Exposure Pathway	Protective Actions
External radiation from facility or source material	Sheltering Evacuation Control of access to incident
External radiation from overhead plume or immersion in plume	Sheltering Evacuation Control of access to incident
External and internal (inhalation and ingestion) radiation from contamination of skin and clothes	Sheltering Evacuation Control of access to incident Decontamination of people
External and internal (inhalation) radiation from ground deposition	Sheltering Evacuation Relocation Decontamination of land and property
Internal radiation from inhalation of plume	Respiratory protection[1] Sheltering Evacuation Control of access to incident Administration of stable iodine
Internal (inhalation) radiation from contamination resuspension	Evacuation Relocation Control of access to incident Decontamination of land and property
Internal (ingestion) radiation of contaminated food and water	Food and water controls Use of stored animal feeds

[1] Includes covering nose and mouth with a dry or wet handkerchief, bandana, piece of cloth, towel or mask

References: EPA 1992, NCRP 2001, DHS 2008b (see Volume II for specific citation)

Playbook 12: Traffic Control Considerations

Activity: Control traffic in contaminated areas, create responder access corridors, and establish evacuation routes.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

1. Law enforcement agencies
2. California Highway Patrol

What to Do: See Section 3.2.8 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Traffic in contaminated areas can cause an exposure to vehicle occupants. Vehicles traveling through contaminated areas can also result in spread of contamination. Mitigation of this situation requires a coordinated effort to redirect vehicles to alternate routes for safe passage or, if necessary, to shelter-in-place locations to reduce or eliminate exposure to vehicle occupants. Procedural instructions are not provided as every incident and situation is different and law enforcement agencies have plans for traffic control for hazardous materials incidents. The Playbook focuses on considerations that should be taken into account when developing a plan to conduct traffic control after a significant release of radiological material.

Numerous resources are likely required to assist during a significant radiological incident. These resources will come from nearby local agencies which may have easy access to the scene. However, local resources farther away from the scene including State and federal resources may require assistance with access. Creating access corridors for incoming responders can expedite arrival of valuable assets to the scene or other locations as needed. Depending on the resources requested by Incident Command/Unified Command, access corridors that may be established are:

1. Routes on interstate freeways, state highways, and local roadways from outside Los Angeles County to the scene, staging area, or other designated locations.
2. Routes on interstate freeways, state highways, and local roadways from nearby airports to the scene, staging area, or other designated locations.
3. Routes on interstate freeways, state highways, and local roadways from the scene, staging area, or other designated location to hospitals, public reception centers, or emergency operations centers.

If an evacuation of the scene or impacted areas is initiated, evacuation routes will need to be established for safe passage of the public. Similar to establishing access corridors for responders coming into the scene, special considerations are required for the public leaving the scene or impacted areas.

Considerations:

- Vehicle occupants are not protected from gamma radiation in contaminated areas.
- Instructions should be given instructing drivers to close all windows and turn off the air conditioner/heater or keep it on recirculation.
- The longer vehicle occupants are traveling through contaminated areas the higher the occupants' dose and health risk.
- A map of confirmed or projected contaminated areas is helpful to determine affected traffic that should be rerouted. However, early in the response, gross assumptions may need to be made about the level and location of contamination.
- Rerouting traffic to uncontaminated areas may take more effort and time than directing vehicle occupants to take refuge in a building for shelter-in-place. Estimate dose to vehicle occupants for both options and select the most appropriate one with consideration to radiation protection principals.
- The Los Angeles County Traffic Management Center can post directions on electronic message billboards.

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Playbook 13: Hospital-Based Operations and Medical Considerations

Activity: Conduct critical hospital-based operations including triage, medical stabilization, decontamination, and medical management for exposed or contaminated patients.

Resources: The following agencies are the primary, secondary, tertiary, etc., resources that have a reasonable incident response time and should perform the activity.

For medical management:
1. Medical organizations including Emergency Medical Services
2. Los Angeles County, Department of Public Health

For decontamination assistance:
4. Fire Department Hazmat Teams
5. Fire Departments

What to Do: See Section 3.11 in Volume II of the Multi-Agency Radiological Response Plan for more details. One method of how to accomplish the activities in this Playbook is provided below.

Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!

Victims should be triaged in accordance with standard medical and trauma criteria. General objectives in approximate order of importance for the management of contaminated, injured patients are listed below. Ideally, initial decontamination efforts can be integrated with resuscitative efforts; i.e., removing all contaminated clothing during the initial assessment, using universal precautions including a mask, and wrapping the victim in a sheet to contain any residual contamination.

1. First aid and resuscitation
2. Medical stabilization
3. Definitive treatment of serious injuries
4. Prevention/minimization of internal contamination
5. Assessment of external contamination and decontamination
6. Treatment of other injuries and illness.
7. Containment of contamination to the treatment area and prevention of contamination of other personnel
8. Minimization of external radiation to treatment personnel
9. Assessment of internal contamination
10. Treatment of internal contamination (this could be concurrent with many of the above)
11. Assessment of local radiation injuries/radiation burns
12. Careful long-term follow up of patients with significant whole-body irradiation or internal contamination
13. Careful counseling of patient and family members about expected long-term effects and risks

- A person exposed to radiation is not necessarily contaminated.
- Wear appropriate personal protective equipment until directed otherwise.
- Wear a dosimeter if available (not required).
- Notify Los Angeles County, Department of Public Health, Radiation Management at 213-351-7897 during work hours or 213-974-1234 after hours.

After the Immediate category victims, the prioritization of large numbers of Delayed or Minor category victims may be necessary to focus efforts on the most contaminated people. A simple order of priority is as follows:

1. Prioritize victims by proximity to the release location of the radioactive material. Individuals within approximately 1,650 feet (500 meters) of the release or within the EZ should have the highest priority for decontamination and exposure evaluation as they are more likely to be contaminated.
2. If a victim has Level 3 contamination levels (see Table 12) and does not have life- or limb-threatening injuries, decontaminate them immediately. Medical attention should follow decontamination. Reevaluation of contamination should be performed before release.
3. If a victim is not grossly contaminated, provide medical attention and either release them to decontaminate at home or evaluate for contamination. If decontamination is warranted and resources are available, the victim should be decontaminated to contamination levels as low as possible before release. If the victim is released without decontamination, provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home*.
4. If a victim refuses to be monitored or decontaminated, they should be informed that they could have become contaminated. If they want to leave the scene, a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* should be provided and the individual released in accordance with public health policy.

Step 1: Prepare to Receive patients

- Obtain available intelligence including number of victims, type of release (i.e., gas, vapor, liquid, solid), radioactive material or type of emitter (i.e., alpha, beta, gamma, neutron), proximity of victim to release, field decontamination performed, associated injuries/symptoms, and time of arrival.
- Activate your hospital decontamination and mass casualty plan, as appropriate.
- Establish a triage station and set a triage perimeter to ensure that all patients entering the hospital are screened for contamination (excluding victims with life- or limb-threatening injuries).
- Notify your hospital radiation safety experts per your hospital emergency operations plan.
- Notify Los Angeles County, Department of Public Health, Radiation Management at 213-351-7897 during work hours or 213-974-1234 after hours.
- Per your emergency operations plan, call 911 to request a fire department hazardous materials team or the Los Angeles County Fire Department, Health Hazardous Materials Division (Health HazMat). Notify the Medical Alert Center (MAC) and the Los Angeles County Department of Public Health. Outside resources may not initially be available.

Step 2: Establish Decontamination Station

The following criteria should be considered when selecting the decontamination station location:

- Background radiation levels are below one hundredth (1%) of the release levels (see Table 12), if possible. If this cannot be achieved or is not practicable, do not exceed one tenth (10%) of the release levels.
- Contamination on the personnel performing the decontamination of others should not exceed contamination levels found on the ground at the decontamination station.

A hazmat decontamination station design is adequate for radiological incidents, except if there are large volumes of water, the water should not be contained. The water should be allowed to drain into the stormwater or sewer system. If contamination is released to a sewer, make provisions for contamination monitoring at the applicable wastewater treatment plant.

Step 3: Conduct Triage

- If possible, first rapidly separate decontaminated from non-contaminated patients based on visual inspection and history, i.e., patient came from site of incident or from a location not affected by the incident.
- Triage patient based on standard triage protocols.
- Decontamination procedures should not delay medical treatment for patients triaged to the immediate category. However, decontamination can be performed concurrently with treatment. All critically ill or injured patients need to be completely undressed for evaluation; this will also remove 80 to 90% of external contamination. Wrapping the patient in a sheet will also help contain external contaminants. Wiping the patient's skin will help remove external contaminants.
- If resources are available, a rapid screen of the triage line with a hand-held meter can help identify highly contaminated patients for expedited decontamination.

Contamination is not immediately life-threatening, except for highly radioactive shrapnel.

Step 4: Conduct Decontamination

Do NOT delay medical treatment for victims with life- or limb-threatening injuries to conduct decontamination!

Conduct decontamination per standard hazmat procedures. Dry and wet decon systems are adequate for radiological contamination. Wet decon for some victims may not be appropriate depending on their condition, weather, and other factors. If possible, release victims to perform self decontamination at home. Use of cold water or fire hoses for gross decontamination is the least preferred method. A quick decontamination method is to remove outer clothing which should remove 80 to 90% of external contamination.

Removing the outer layer of clothes from a person should remove 80 to 90% of external contamination.

Use tongs or hemostats to remove highly radioactive shrapnel from a victim, if it can be done safely.

Contamination is not immediately life-threatening.

Step 5: Survey for Contamination

After decontamination, survey victim for contamination in accordance with the following procedure (see *Standard Operating Guide No 1: Procedure for Performing a Radiation Contamination Survey* for more detail):

A. If portal monitors are available, set-up and use according to the instructions on the monitor. However, portal monitors only detect gamma radiation; hand-held surveys with appropriate

instrumentation are required to detect alpha or beta radiation. The portal monitors may be used with victims on a gurney, in addition to ambulatory victims.

B. If using a hand-held instrument, turn on meter with a Pancake Geiger-Mueller detector or use a microR meter.
C. If applicable, verify that the meter detector switch is set for the Pancake Geiger-Mueller detector.
D. Use a radioactive check source to verify that the Pancake Geiger-Mueller or microR meter is functional.
E. Turn the sound on or use head phones.
F. Hold the Pancake Geiger-Mueller or microR meter less than 1-inch from the victim and move at about 1-inch per second.
G. Survey the most likely contaminated and most critical areas first: Head/Face, Shoulders, Hands, and Feet.
H. If the frequency of the "clicks" increases (the radiation measurement increases to more than three times the background reading), check the meter reading and compare to Table 12. Try to achieve Level 1 if there are sufficient resources available in a reasonable amount of time; otherwise, try to achieve Level 2. Do not release victims with contamination above Level 3 unless they need immediate medical attention.
I. Document contamination levels on *Form No. 1: Contamination Survey*.
J. If release levels are not exceeded, release the victim.
K. If contamination is found above release levels, send back for more decontamination.
L. After the second decontamination, resurvey the contaminated areas or have them go through a portal monitor to verify decontamination was successful. If the contamination is below the release levels, release victim; otherwise, contact a Radiation Technical Specialist for further instructions.
M. If possible, release levels for victims sent to a hospital should be as low as possible. Notify ambulance crew and hospital staff of potential radiological contamination of victims.
N. Release victim property that meets the levels in Table 13. Identification, credit cards, money, jewelry and other unique valuables can be bagged and returned to the owner if they cannot be decontaminated to release levels. Document contamination levels on *Form No. 2: Public Property Contamination Survey*.

Decontamination Considerations:

- If possible, practice radiation protection principles and locate decontamination stations within the Support Zone/Contamination Reduction Zone at the lowest level of ground contamination and gamma exposure rate possible, preferably near background.
- Attempt to reduce and maintain contamination levels at decontamination stations as low as possible.
- Bag contaminated clothing for future evaluation and potential disposal.
- Contact your hospital or local nuclear medicine specialists if Level 3 contamination is found on a victim's skin after decontamination so the nuclear medicine specialists can determine if further decontamination efforts are appropriate; if you need further assistance see medical treatment resources in the Medical Considerations section.
- A registry of affected victims should be established. The information collected should, at a minimum, include the person's name, address, phone number, Driver's License number if available, location during the incident, and general contamination levels measured by responders or hospital staff.
- If victims are waiting in a line to be decontaminated they should be provided a copy of *Instructions No.1: Public Waiting for Decontamination*.
- If a victim refuses to be monitored or decontaminated, inform them of possible contamination, give them a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* and release in accordance with public health policy.
- For portal monitors that alarm at a set standard deviation (sigma) above background, set the monitor to alarm at four standard deviations above background.

Medical Considerations:

- The medical treatment of exposed and of internally contaminated patients requires specialized knowledge. Multiple treatment resources exist including:
  - Radiation oncologists at your or other local hospitals
  - Nuclear medicine specialists at your or other local hospitals
  - Los Angeles County, Department of Public Health, Radiation Management at 213-351-7897 during work hours or 213-974-1234 after hours
  - Medical Alert Center (MAC) at 323-226-6619 or 323-722-8073
  - Radiation Emergency Assistance Center/Training Site (REAC/TS) at 865-576-1005 (24 hours) or http://orise.orau.gov/reacts/
  - Air Force Radiobiology Research Institute (AFRRI) at 301-295-0530 (24 hours)
  - California Emergency Medical Services Authority (EMSA) at 916-322-4336 (not 24 hours)
  - Office of the United States Surgeon General, Office of Civilian Volunteer, Medical Reserve Corps (MRC); see www.medicalreservecorps.gov
  - United States Department of Human and Health Services, Radiation Event Medical Management (REMM); see www.remm.nlm.gov
- Consider internal contamination in patients who cannot be fully decontaminated and those who have had significant inhalational, oral, or wound exposures.
- Consider assessing nasal swabs and fecal/urinary contamination levels to help estimate level of internal contamination. See Section 3.11 in Volume II of the Multi-Agency Radiological Response Plan.
- Consider decorporation drugs for significant internal contamination. See *Administration of Decorporation Drugs to Treat Internal Radionuclide Contamination, Medical Emergency Response to Radiologic Incidents*, Carol S. Marcus, RSO Magazine 9(5), 2004.
- Patients with significant neurological symptoms attributed solely to radiation exposure have received a potentially fatal dose.
- Surgical procedures for patients with significant exposures should be performed within the first 24 to 36 hours prior to any radiation-induced cytopenia (reduced number of blood cells).
- Risk of significant exposure to health care workers is in general minimal (see Table 5).

Table 12: Victim and Public Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, but only if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Decontaminate to Level 2 lower values, then release for home decontamination in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home.* [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 13: Victim and Public Property Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Valuables should be returned to the owner, including credit cards, identification, money, jewelry, medicines, et. Bag items and notify owner that further evaluation will be required at a later time.

[6] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

Table 5: Dose and Potential Health Effects

Short-Term[1] Whole-Body Dose (rem)	Acute Death[2] from Radiation without Medical Treatment (%)	Acute Death from Radiation with Medical Treatment (%)	Acute Symptoms (nausea and vomiting within 4 hours) (%)	Lifetime Risk Fatal Cancer without Radiation Exposure (%)	Excess Lifetime Risk of Fatal Cancer Due to Short-Term Radiation Exposure[3] (%)
1	0	0	0	24	0.08
10	0	0	0	24	0.8
50	0	0	0	24	4
100	< 5	0	5 – 30	24	8
150	< 5	< 5	40	24	12
200	5	< 5	60	24	16
300	30 – 50	15 – 30	75	24	24[4]
600	95 – 100	50	100	24	> 40[4]
1,000	100	> 90	100	24	> 50[4]

[1] Short-term refers to the radiation exposure during the initial response to the incident. The acute effects listed are likely to be reduced by about one-half if radiation exposure occurs over weeks.

[2] Acute deaths are likely to occur from 30 to 180 days after exposure and few if any after that time. Estimates are for healthy adults. Individuals with other injuries, and children, will be at greater risk.

[3] Most cancers are not likely to occur until several decades after exposure; although leukemia has a shorter latency period of less than five years.

[4] Applies to those individuals that survive Acute Radiation Syndrome.

rem roentgen equivalent man
< less than
> greater than
% percentage

(Adapted from NCRP 2005; see Volume II for specific citation)

Instructions No. 1: Public Waiting for Decontamination

You may have been exposed to radioactive materials ("dust"). The dust from the explosion may have gotten on your clothes or body. To protect your health, you may be asked to go to a place at the incident called a decontamination station at a place called a reception center to clean off. Do not panic; your health is not in immediate danger. Follow these directions to prepare for the reception center:

Step 1: Go to the designated decontamination area or reception center, as directed.
Step 2: Do not touch your face or put anything into your mouth.
Step 3: Enter the decontamination area or reception center and follow the instructions from the staff. You will likely be asked to stand for a screening (survey) of yourself with clothing. Workers will ask you questions about necessary personal information; please provide answers as best as you can.
Step 4: After you are screened, you will be directed to leave if minimal or no radioactive dust is present. If radioactive dust is found, you will be directed to the wash area or you may be sent home with instructions on how to clean yourself. This is called decontamination.
Step 5: If you are directed to enter the wash area, you will be segregated with individuals of the same gender. To the extent possible, families will be kept together through the decontamination process. Prepare to remove your outer clothes behind a privacy curtain. If radioactive dust is on your clothes, removing them will reduce the dust and decrease the chance that you breathe in or ingest the dust. Quick removal of outer clothing will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut the clothing off or prevent the outside from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling the clothing over your head.
Step 6: You will be provided with plastic bags. Place all of your clothing in one bag. You can wash most valuables. Anything that is plastic (including credit cards) or metal, identification, jewelry, and keys are easily washed off. Other types of materials can be wiped off carefully, like money, wallets, and purses. If something cannot be washed then place them in a separate plastic bag from your clothes and seal it. You may be asked to double bag your belongings to minimize the potential for bag breakage. You will be instructed on how to handle these items at a later time when more is known about the hazards of the radioactive dust.
Step 7: Pass through the wash area.
Step 8: When you reach the end of the wash station you will be given clothing to put on and directed to the final staging area. Do not leave without your valuables, even if they are not clean.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Instructions No. 2:
Instructions to Public on How to Perform Decontamination at Home

You may have been exposed to low levels of radioactive materials ("dust"). The dust may have gotten on your hair, skin, clothing, and personal property. Depending on your location, the radioactive dust could be on your vehicle, home, yard, lawn furniture, BBQ grill, or anything outside. The dust may have gotten on your jewelry, wallet or purse, or other personal belongings if you were near the incident. You are not in immediate danger from this radioactive dust; however, you need to go home or to another designated area to remove the dust, which is called decontamination. Because radiation cannot be seen, smelled, felt, or tasted, people at the site of an incident will not immediately know if they have been exposed to radioactive materials. Follow these instructions to limit your contamination.

Get out of the immediate area quickly. Go directly home, inside the nearest safe building, or to an area to which you are directed by law enforcement or health officials. *Do not go to a hospital unless you have a medical condition that requires treatment***.**

If radioactive dust is on your clothes, removing them as quickly as possible will remove up to 90% of the dust, while helping to prevent you from breathing in or ingesting the dust and will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut if off or prevent the outer layer from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling clothing over the head. Removal of clothes should be done in a garage or outside storage area if available, where the ground can be washed off easily. If an outside area is not available, the removal of clothing should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Clothing should be rolled up with the outside "in" to minimize spreading the dust.

If possible, place the clothing in a plastic bag (double bagging is best to reduce the chances of it breaking), and leave it in an out-of-the-way area, such as the corner of a room or garage. Keep people away from it to reduce their exposure to radiation. You may be asked to bring this bag for follow-up tests or for disposal at a later time.

Keep cuts and abrasions covered when handling anything you think has the radioactive dust on it to avoid getting radioactive material in the wound.

Shower and wash all of the exposed parts of your body and hair using lots of soap and lukewarm water to remove the dust. Simple washing will remove most of the radioactive dust. Do not use abrasive cleaners, or scrub too hard. Do not use hair conditioners in your hair because it could trap the radioactive dust onto your hair.

You can also wash your valuables and other personal property. You can wash off valuables and small items at the same time that you wash yourself. If an outside area is not available or if the items are small, the decontamination should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Wash the items with lots of water and soap. A scrub brush can be used to reach small spaces. Only decontaminate items that you can easily move to this location as other larger items can be washed off in place.

Instructions No. 2 (Continued)

For large items, decontamination should take place where the ground can be washed easily, like a sidewalk or driveway. Using a hose, wash off the roof of your home, hard surfaces (driveways, sidewalks, decks, patios), lawn furniture, grills, toys, and any other surface or item outside. You should NOT attempt to wash your lawn, gardens, or bare soil areas.

Clothes may be washed in your washing machine or at a commercial laundry mat. Any item that is water resistant can easily be washed by hand with water and soap, like jewelry, coins, paper money, credit cards, plastic identification cards, etc. Rinse all dust down the drain with lots of water.

Do not contain the used wash water; instead it should be flushed down the drain or if outside into the stormwater/sewer system. If the wash water pools outside, it should be swept into drainage areas.

If you are going to a reception center to be monitored for the radioactive dust, it is best to change clothes and shower *before* being monitored. Do not bring your valuables or personal property to the reception center.

Listen to the news for additional information and guidance.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Form No. 1: Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

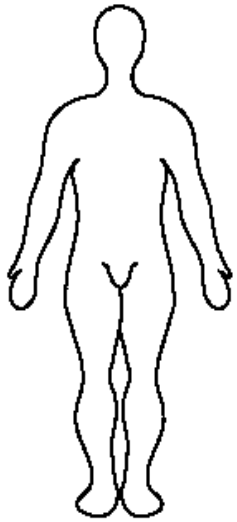
Location at Time of Incident: _____

Medical Radionuclides Received: _____

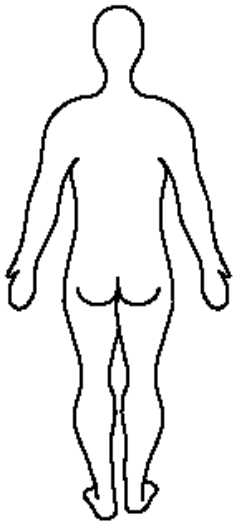
Survey Location: _____

Parent or Guardian (if child):_____

Mark contamination locations and survey reading on the diagrams below.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____ Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency: _____

Person sent to decontamination area: _____Yes _____No Clothing bag number: _____

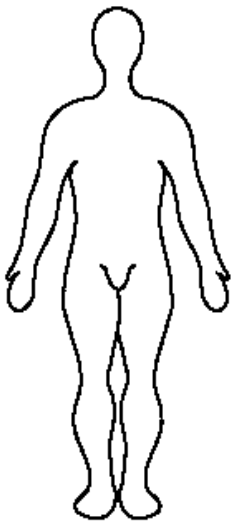
Nasal area reading of 100,000 cpm or 10 mR/hr: _____Yes _____No If Yes, refer to medical facility

Person sent to medical facility: _____Yes _____No

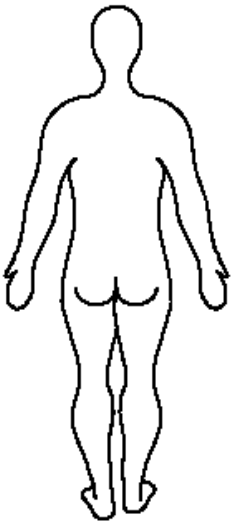
(Adapted from CRCPD 2006; see Volume II for specific citation)

Form No. 1: Contamination Survey (Continued)

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



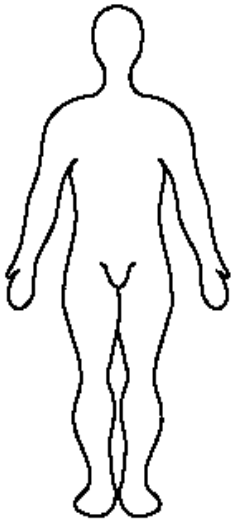
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



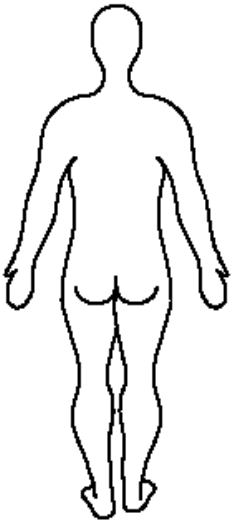
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Form No. 2: Public Property Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

Location at Time of Incident: _____

Survey Location: _____

Description of Property: _____

Draw diagram of property and mark contamination locations and survey reading.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)
Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency:_____

Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination; see Playbook 7 to determine if alpha is present).

Make sure that the instruments have batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a radiation check source to verify the instrument is operating properly.

Screening Survey

If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, hands, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.

If only performing a screening survey, it is acceptable to hold the survey meter probe about 1 to 2 inches away from the body (instead of ½ inch), and move it twice as fast as the normal 1 to 2 inches per second. (If the probe is moved too quickly, its detection capability may be reduced.) If surveying for alpha radiation, hold the survey meter probe ½ inch away from the body and move it at 1 inch per second. Check with state/local radiation control personnel to determine the extent of contamination survey required.

Public that are not familiar with radiological instruments may become alarmed when they hear the "clicks" from the meter. Consider using head phones to listen to the "clicks" or turn the sound off. However, if the sound is turned off, the surveyor must look at the meter reading and watch the probe position at the same time. This will result in the surveyor taking a significantly longer time to survey an individual.

Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

Complete Whole Body Survey

If feasible, perform a complete, whole body contamination survey and record the findings on *Form No 1: Contamination Survey*. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a ½ inch away from the surface to be surveyed, slowly (1 to 2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination)
2. Front of the neck and shoulders
3. Down one arm (pausing at elbow), turn arm over
4. Backside of hands, turn over (pause at palms for about five seconds)
5. Up the other arm (pausing at elbow), turn arm over
6. Shoe tops and inside ankle area
7. Shoe bottoms (pause at sole and heel)

Standard Operating Guide No. 1 (continued)

As with the screening survey, return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

The most common mistakes made during the survey:

Holding the probe too far away from the surface (should be about 1 to 2 inches away for a screening survey or about ½ inch or less for a detailed survey).

Moving the probe too fast (should be about 2 to 4 inches per second for a screening survey or about 1 to 2 inches per second for a detailed survey.)

Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use the probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Recommended procedures for on-scene responders:

1. On-scene responders should wear gloves and a gown or other protective clothing. Each responder should be provided with a personal dosimetry device.
2. Medically unstable patients should be transported to a hospital immediately.
3. A radiological survey, decontamination procedures, or steps taken to contain the contamination may be performed in the ambulance provided these actions do not interfere with more immediate medical requirements of the patient.
4. If the patient is medically stable and conditions at the site permit, limit any further exposure to radiation by moving the patient to an area of low background. The outer clothing of the individual should be removed and the patient should be wrapped in a cloth sheet or blanket to permit handling. The wrapping should be loose to avoid hyperthermia and to allow easy access to the patient by medical personnel.
5. Treat the patient's injuries (i.e., burns, cuts, etc.) sustained in the incident and, if needed, provide symptomatic treatment for the radiation illness (e.g., the use of anti-emetics).
6. If an open wound is involved, cover the wound with a clean dressing.
7. Do not release a medically stable patient to ambulance personnel before a radiological survey has been performed. If contamination is confirmed, a preliminary decontamination should be performed. Record the results of the radiological survey and proceed to decontaminate the patient.
8. Decontaminate the medically stable patient by washing the individual with tepid water to remove any radioactive contamination, beginning with the areas of highest levels of contamination. Proceed gently, mindful that this is a preliminary decontamination and that a more thorough decontamination process will be performed at a medical facility. When finished, repeat the radiation survey of the patient and record the final results. Save all clothing and bedding and all metal objects (e.g., jewelry, coins, belt buckles, etc.). A nasal swab is also recommended to detect inhalation of radioactive contaminants. However, it may be more practicable for medical personnel to perform the nasal swab.
9. Tag each item with the patient's name, location, time, and date. Save each in appropriate containers; mark containers clearly with: "RADIOACTIVE—DO NOT DISCARD."
10. Transport patient to a medical facility for further treatment. The medical facility should be given advanced warning if they are going to receive patients exposed to radiation so that the facility can institute the appropriate medical protocols. Remember, individuals suffering from radiation injury may not be radioactive, but their skin and clothing could be contaminated with radioactive material. Protection of first responders should be focused on the source of the radiation.

(NCRP 2005, Adapted from the 1998 FBI Contingency Plan for Weapons of Mass Destruction FBI, 1998).

Standard Operating Guides

The following Standard Operating Guides are provided in this section for easy duplication:

- Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey
- Standard Operating Guide No. 2: How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter

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Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination; see Playbook 7 to determine if alpha is present).

Make sure that the instruments have batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a radiation check source to verify the instrument is operating properly.

Screening Survey

If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, hands, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.

If only performing a screening survey, it is acceptable to hold the survey meter probe about 1 to 2 inches away from the body (instead of ½ inch), and move it twice as fast as the normal 1 to 2 inches per second. (If the probe is moved too quickly, its detection capability may be reduced.) If surveying for alpha radiation, hold the survey meter probe ½ inch away from the body and move it at 1 inch per second. Check with state/local radiation control personnel to determine the extent of contamination survey required.

Public that are not familiar with radiological instruments may become alarmed when they hear the "clicks" from the meter. Consider using head phones to listen to the "clicks" or turn the sound off. However, if the sound is turned off, the surveyor must look at the meter reading and watch the probe position at the same time. This will result in the surveyor taking a significantly longer time to survey an individual.

Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

Complete Whole Body Survey

If feasible, perform a complete, whole body contamination survey and record the findings on *Form No 1: Contamination Survey*. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a ½ inch away from the surface to be surveyed, slowly (1 to 2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination)
2. Front of the neck and shoulders
3. Down one arm (pausing at elbow), turn arm over
4. Backside of hands, turn over (pause at palms for about five seconds)
5. Up the other arm (pausing at elbow), turn arm over
6. Shoe tops and inside ankle area
7. Shoe bottoms (pause at sole and heel)

Standard Operating Guide No. 1 (continued)

As with the screening survey, return the probe to its holder on the meter when finished. *Do not set the probe down on the ground***.** The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

The most common mistakes made during the survey:

Holding the probe too far away from the surface (should be about 1 to 2 inches away for a screening survey or about ½ inch or less for a detailed survey).

Moving the probe too fast (should be about 2 to 4 inches per second for a screening survey or about 1 to 2 inches per second for a detailed survey.)

Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use the probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Recommended procedures for on-scene responders:

1. On-scene responders should wear gloves and a gown or other protective clothing. Each responder should be provided with a personal dosimetry device.
2. Medically unstable patients should be transported to a hospital immediately.
3. A radiological survey, decontamination procedures, or steps taken to contain the contamination may be performed in the ambulance provided these actions do not interfere with more immediate medical requirements of the patient.
4. If the patient is medically stable and conditions at the site permit, limit any further exposure to radiation by moving the patient to an area of low background. The outer clothing of the individual should be removed and the patient should be wrapped in a cloth sheet or blanket to permit handling. The wrapping should be loose to avoid hyperthermia and to allow easy access to the patient by medical personnel.
5. Treat the patient's injuries (i.e., burns, cuts, etc.) sustained in the incident and, if needed, provide symptomatic treatment for the radiation illness (e.g., the use of anti-emetics).
6. If an open wound is involved, cover the wound with a clean dressing.
7. Do not release a medically stable patient to ambulance personnel before a radiological survey has been performed. If contamination is confirmed, a preliminary decontamination should be performed. Record the results of the radiological survey and proceed to decontaminate the patient.
8. Decontaminate the medically stable patient by washing the individual with tepid water to remove any radioactive contamination, beginning with the areas of highest levels of contamination. Proceed gently, mindful that this is a preliminary decontamination and that a more thorough decontamination process will be performed at a medical facility. When finished, repeat the radiation survey of the patient and record the final results. Save all clothing and bedding and all metal objects (e.g., jewelry, coins, belt buckles, etc.). A nasal swab is also recommended to detect inhalation of radioactive contaminants. However, it may be more practicable for medical personnel to perform the nasal swab.
9. Tag each item with the patient's name, location, time, and date. Save each in appropriate containers; mark containers clearly with: "RADIOACTIVE—DO NOT DISCARD."
10. Transport patient to a medical facility for further treatment. The medical facility should be given advanced warning if they are going to receive patients exposed to radiation so that the facility can institute the appropriate medical protocols. Remember, individuals suffering from radiation injury may not be radioactive, but their skin and clothing could be contaminated with radioactive material. Protection of first responders should be focused on the source of the radiation.

(NCRP 2005, Adapted from the 1998 FBI Contingency Plan for Weapons of Mass Destruction FBI, 1998)

Standard Operating Guide No. 2: How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter

This instruction describes a technique using a Pancake Geiger-Mueller, and if available, a sodium iodide meter, that may be used by first responders to make a quick, initial determination of the type of radiation (alpha, beta, or gamma) present at an incident. Many studies show that the most likely radionuclide(s) to be used in a terrorism incident (like a radiological dispersal device) would be either a gamma emitter or a beta-gamma emitter. However, it is possible that the radionuclide may only emit beta such as strontium-90 or only alpha such as plutonium-239.

This methodology was developed to assist responders in making an initial determination of the type of radiation present. This determination should be used to make decisions until radiation experts arrive with more sophisticated instrumentation to verify the type of radiation and identify the radionuclide(s).

Pancake Geiger-Mueller survey meters will respond to alpha, beta, gamma, and X-rays, but have very limited response to alpha radiation. Sodium iodide survey meters will only respond to gamma or X-rays. Do not be misled into thinking that radioactive materials are not present if no radiation is detected with a sodium iodide survey meter, since it cannot detect alpha or beta radiation.

Determining the Presence of Alpha Radiation Using Only a Pancake Geiger-Mueller Meter

Materials that emit alpha are very harmful when inhaled or ingested. Therefore, it is very important to check for the presence of alpha radiation. Until the presence of alpha radiation is ruled out, responders should use appropriate respiratory protection when conducting operations and while monitoring for radiation.

Procedure

Step 1: Turn on the Pancake Geiger-Mueller meter and check that it is working properly. In an area that has not been contaminated (background area), take and record a reading (typically 30 to 100 cpm).

Step 2: Take readings at approximately 3 inches and about ½ inch (as close as possible without touching) above a smooth, hard surface with the Pancake Geiger-Mueller window (mesh covered side) facing down. If the instrument reading increases by more than a factor of three at ½ inch above the ground as compared to 3-inches above the ground, assume alpha contamination is present.

Step 3: Place a sheet of paper on the smooth, hard surface and take a reading with the window facing down at ½ inch above the paper. The alpha radiation will not penetrate the paper and the window down reading should significantly decrease to near background levels. If the window down measurement taken over the paper does not significantly decrease, the material is probably not an alpha emitter. Note that some radioactive materials that emit alpha, such as americium-241, also emit low energy gamma radiation which will not be stopped by a sheet of paper and thus will be detected by the Pancake Geiger-Mueller.

Step 4: Flip the Pancake Geiger-Mueller probe over so that the window is facing up while maintaining the detector at ½ inch above the ground. The alpha and beta radiation will be stopped by the metal backing of the probe. If the measurement taken in Step 3 at ½ inch above the paper **does not** significantly decrease, the nuclide is likely not a beta emitter. If the measurement taken in Step 3 at ½ inch above the paper **does** significantly decrease, the nuclide is likely a beta emitter.

Note that many radioactive materials emit different amounts of alpha, beta, and/or gamma radiation.

Standard Operating Guide No. 2 (continued)

Determining the Presence of Strontium-90 (or Other Pure Beta Emitters) Using Only a Pancake Geiger-Mueller Survey Meter

Strontium-90 is a pure beta emitter and will not be detected by a sodium iodide instrument or other types of gamma identification survey meters. However, strontium-90 beta radiation can be easily detected and measured with a Pancake Geiger-Mueller. Suspect the presence of strontium-90 if a Pancake Geiger-Mueller meter reads between 1,000 cpm and 10,000 cpm (20 to 200 times background), but there is no corresponding increase in readings using a sodium iodide survey meter (still reads near background).

When strontium-90 is shielded by certain materials, the beta radiation cannot be detected. However, the interaction of the beta radiation with the shielding materials can produce X-rays, which can be detected by the Pancake Geiger-Mueller, sodium iodide, and other types of gamma identification survey meters.

Procedure

Step 5: Take a measurement with the window side of the Pancake Geiger-Mueller probe (mesh covered side) facing down at approximately 6 inches from the ground in an area where the meter reading is between 500 cpm to 1,500 cpm. Then take another measurement with the window side facing up (away from the ground) at the same height.

Step 6: Compare the two measurements.

Step 7: If only strontium-90 (or another pure beta-emitter) is present, the window up reading will be near background (depending on the model of the Pancake Geiger-Mueller probe, background should be in the range of 30 cpm to 100 cpm), and the window facing down reading should be 10 or more times greater than the window facing up reading. This is because the beta radiation is not able to penetrate the back side of the metal Pancake Geiger-Mueller probe.

Step 8: If a gamma or beta-gamma emitter is present (e.g., cesium-137, iridium-192, cobalt-60), the window facing down reading at 6-inches will be approximately twice the window up reading.

Step 9: Take another measurement with the window side of the Pancake Geiger-Mueller probe facing down at approximately 3 feet from the ground in an area where the meter reading is between 500 cpm to 1,500 cpm. Then take another measurement with the window side facing up at the same height. Compare the two measurements. If a gamma emitting nuclide is present, both readings will be approximately the same.

(Adapted from CRCPD 2006: see Volume for specific citation.)

Instructions

The following instructions are provided in this section for easy duplication:

- Instructions No. 1: Public Waiting for Decontamination
- Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home
- Instructions No. 3: Instructions to Public on How to Perform Decontamination of Pets

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Instructions No. 1: Public Waiting for Decontamination

You may have been exposed to radioactive materials ("dust"). The dust from the explosion may have gotten on your clothes or body. To protect your health, you may be asked to go to a place at the incident called a decontamination station at a place called a reception center to clean off. Do not panic; your health is not in immediate danger. Follow these directions to prepare for the reception center:

Step 1: Go to the designated decontamination area or reception center, as directed.
Step 2: Do not touch your face or put anything into your mouth.
Step 3: Enter the decontamination area or reception center and follow the instructions from the staff. You will likely be asked to stand for a screening (survey) of yourself with clothing. Workers will ask you questions about necessary personal information; please provide answers as best as you can.
Step 4: After you are screened, you will be directed to leave if minimal or no radioactive dust is present. If radioactive dust is found, you will be directed to the wash area or you may be sent home with instructions on how to clean yourself. This is called decontamination.
Step 5: If you are directed to enter the wash area, you will be segregated with individuals of the same gender. To the extent possible, families will be kept together through the decontamination process. Prepare to remove your outer clothes behind a privacy curtain. If radioactive dust is on your clothes, removing them will reduce the dust and decrease the chance that you breathe in or ingest the dust. Quick removal of outer clothing will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut the clothing off or prevent the outside from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling the clothing over your head.
Step 6: You will be provided with plastic bags. Place all of your clothing in one bag. You can wash most valuables. Anything that is plastic (including credit cards) or metal, identification, jewelry, and keys are easily washed off. Other types of materials can be wiped off carefully, like money, wallets, and purses. If something cannot be washed then place them in a separate plastic bag from your clothes and seal it. You may be asked to double bag your belongings to minimize the potential for bag breakage. You will be instructed on how to handle these items at a later time when more is known about the hazards of the radioactive dust.
Step 7: Pass through the wash area.
Step 8: When you reach the end of the wash station you will be given clothing to put on and directed to the final staging area. Do not leave without your valuables, even if they are not clean.

(Adapted from CRCPD 2006; see Volume II for specific citation)

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Instructions No. 2:
Instructions to Public on How to Perform Decontamination at Home

You may have been exposed to low levels of radioactive materials ("dust"). The dust may have gotten on your hair, skin, clothing, and personal property. Depending on your location, the radioactive dust could be on your vehicle, home, yard, lawn furniture, BBQ grill, or anything outside. The dust may have gotten on your jewelry, wallet or purse, or other personal belongings if you were near the incident. You are not in immediate danger from this radioactive dust; however, you need to go home or to another designated area to remove the dust, which is called decontamination. Because radiation cannot be seen, smelled, felt, or tasted, people at the site of an incident will not immediately know if they have been exposed to radioactive materials. Follow these instructions to limit your contamination.

Get out of the immediate area quickly. Go directly home, inside the nearest safe building, or to an area to which you are directed by law enforcement or health officials. *Do not go to a hospital unless you have a medical condition that requires treatment***.**

If radioactive dust is on your clothes, removing them as quickly as possible will remove up to 90% of the dust, while helping to prevent you from breathing in or ingesting the dust and will also reduce the length of time that you are exposed to radiation. When removing the clothing be careful of any clothing that has to be pulled over the head. Try to either cut if off or prevent the outer layer from coming in contact with the nose and mouth area. You may also hold your breath while carefully pulling clothing over the head. Removal of clothes should be done in a garage or outside storage area if available, where the ground can be washed off easily. If an outside area is not available, the removal of clothing should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Clothing should be rolled up with the outside "in" to minimize spreading the dust.

If possible, place the clothing in a plastic bag (double bagging is best to reduce the chances of it breaking), and leave it in an out-of-the-way area, such as the corner of a room or garage. Keep people away from it to reduce their exposure to radiation. You may be asked to bring this bag for follow-up tests or for disposal at a later time.

Keep cuts and abrasions covered when handling anything you think has the radioactive dust on it to avoid getting radioactive material in the wound.

Shower and wash all of the exposed parts of your body and hair using lots of soap and lukewarm water to remove the dust. Simple washing will remove most of the radioactive dust. Do not use abrasive cleaners, or scrub too hard. Do not use hair conditioners in your hair because it could trap the radioactive dust onto your hair.

You can also wash your valuables and other personal property. You can wash off valuables and small items at the same time that you wash yourself. If an outside area is not available or if the items are small, the decontamination should take place in a room where the floor can be easily cleaned, such as a tub or shower area. Swiffer® pads are good for decontaminating smooth surfaces including the floor. Wash the items with lots of water and soap. A scrub brush can be used to reach small spaces. Only decontaminate items that you can easily move to this location as other larger items can be washed off in place.

Instructions No. 2 (Continued)

For large items, decontamination should take place where the ground can be washed easily, like a sidewalk or driveway. Using a hose, wash off the roof of your home, hard surfaces (driveways, sidewalks,
decks, patios), lawn furniture, grills, toys, and any other surface or item outside. You should NOT attempt to wash your lawn, gardens, or bare soil areas.

Clothes may be washed in your washing machine or at a commercial laundry mat. Any item that is water resistant can easily be washed by hand with water and soap, like jewelry, coins, paper money, credit cards, plastic identification cards, etc. Rinse all dust down the drain with lots of water.

Do not contain the used wash water; instead it should be flushed down the drain or if outside into the stormwater/sewer system. If the wash water pools outside, it should be swept into drainage areas.

If you are going to a reception center to be monitored for the radioactive dust, it is best to change clothes and shower *before* being monitored. Do not bring your valuables or personal property to the reception center.

Listen to the news for additional information and guidance.

(Adapted from CRCPD 2006; see Volume II for specific citation)

Instructions No. 3:
Instructions to Public on How to Perform Decontamination of Pets

Your pet(s) may have been exposed to low amounts of radioactive materials ("dust"). The process of removing radioactive dust, which is called decontamination, from pets is similar to the decontamination process for people. Radioactive dust may be located on your pet's skin and in their fur. Your pet is not in immediate danger but should be decontaminated to minimize spread of the radioactive dust. In order to protect your health and safety as well as your pets, please follow these instructions:

Decontamination should take place where the ground can be washed with a hose. If an outside area is not available, the decontamination should take place in a room where the floor can be easily cleaned, such as the tub or shower areas. Swiffer® pads are good for decontaminating smooth surfaces including the floor.

Keep cuts and abrasions (both yours and your pet's) covered when washing the pet to avoid getting radioactive material in the wound.

If available, wear rubber dishwashing gloves and an apron. Shower and wash all of the exposed parts of your pet using mild dish soap and lots of lukewarm water. Simple washing will remove most of the radioactive dust. Do not use abrasive cleaners or scrub too hard. Do not use hair conditioners because it can trap the radioactive dust onto the hair.

After decontamination of your pet, remove your clothes and wash them separately from other clothes. Wash yourself thoroughly, and do not use conditioner in your hair because it could trap the radioactive dust onto your hair. This will remove any radioactive dust that may have gotten on you.

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Forms

The following forms are provided in this section for easy duplication:

- Form No. 1: Contamination Survey
- Form No. 2: Public Property Contamination Survey
- Form No. 3: Responder Dose Log

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Form No. 1: Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

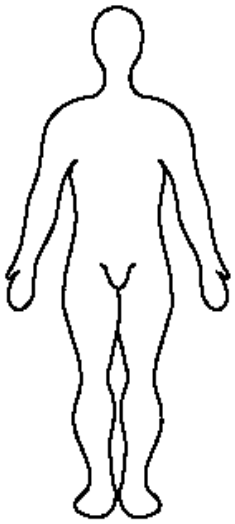
Location at Time of Incident: _____

Medical Radionuclides Received: _____

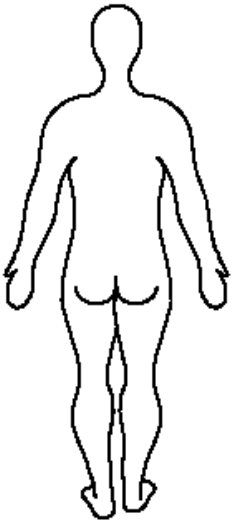
Survey Location: _____

Parent or Guardian (if child):_____

Mark contamination locations and survey reading on the diagrams below.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____ Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency: _____

Person sent to decontamination area: _____Yes _____No Clothing bag number: _____

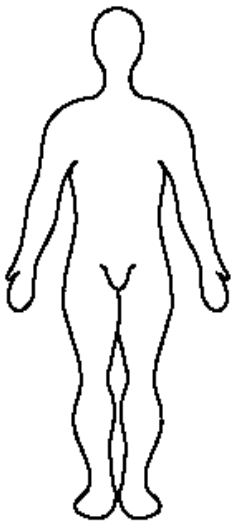
Nasal area reading of 100,000 cpm or 10 mR/hr: _____Yes _____No If Yes, refer to medical facility

Person sent to medical facility: _____Yes _____No

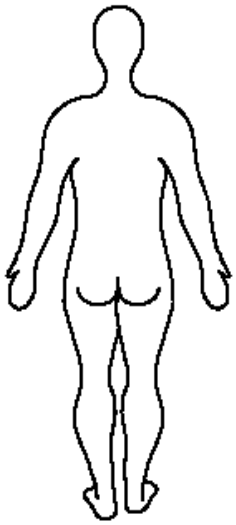
(Adapted from CRCPD 2006; see Volume II for specific citation)

Form No. 1: Contamination Survey (Continued)

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



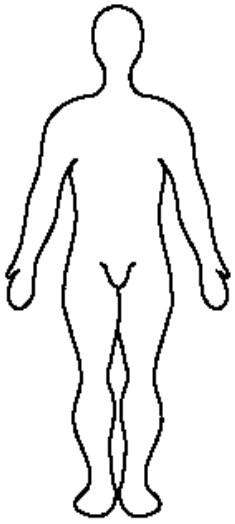
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



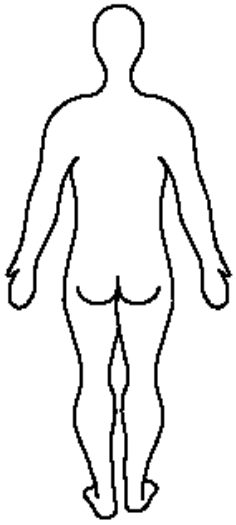
Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Survey results □ before □ after decontamination *Circle if readings are in: cpm mR/hr μR/hr*



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.



Measurements:
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9.

Monitored by (print name):_____ Agency: _____
Instrument Make and Model: _____ Serial Number: _____

Form No. 2: Public Property Contamination Survey

First Name: _____ Middle Initial: _____ Last Name: _____

Date of Birth: _____ Home Phone:_____ Mobile Phone: _____

Address: _____

Date/Time: _____ Drivers License No./State: _____

Location at Time of Incident: _____

Survey Location: _____

Description of Property: _____

Draw diagram of property and mark contamination locations and survey reading.

Survey results □ before □ after decontamination
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Survey results □ before □ after decontamination (see next page)
< _____ _____ ; <10,000 cpm ___ or <0.1 mR/hr ___; <100,000 cpm ___ or <1 mR/hr ___
(fill in value) (fill in units)

Instrument Make and Model: _____Serial Number: _____

Comments: _____

_____

Monitored by (print name):_____ Agency:_____

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Form No. 3: Responder Dose Log

Organization(s) _____ Incident Name _____ Date _____

Name (or ID#)	Dosimeter Type	Dosimeter Serial#	Dose Readings				Safety Officer Initials
			Start Reading *use units*	Time	End Reading *use units*	Time	

_____Units_____
uR = microR = microrem
mR = milliR = millirem
R = rem

Page _____ of _____ Safety Officer Signature _____

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Tables

The following tables are provided in this section for easy duplication:

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Table 1: Summary of Agencies Responsible for Implementing Activity Playbooks

Activity Playbook	Rad Mgmt*	Fire Hazmat	Fire	Law Hazmat	EPA	DOE	FBI	Coroner	Public Health	Law	CHP	Med
1. Exclusion Zone Operations	NL	**1**	**2**	**3**	NL	NL	NL	NL	NL	NL	NL	NL
2. Initial Incident Control Zones	**1**	**2**	NL	**3**	**4**	NL	NL	NL	NL	NL	NL	NL
3. Monitoring Responders and Equipment for Contamination	**1**	**2**	**3**	**6**	**4**	**5**	NL	NL	NL	NL	NL	NL
4. Monitoring Injured Victims for Contamination	**1**	**2**	**3**	NL	**4**	NL	NL	NL	NL	NL	NL	NL
5. Monitoring Uninjured Victims for Contamination	**1**	**2**	**3**	NL	**4**	**5**	NL	NL	NL	NL	NL	NL
6. Advanced Radiation Measurements	**1**	NL	NL	NL	**2**	**3**	NL	NL	NL	NL	NL	NL
7. Alpha Radiation Detection and Considerations	**1**	**2**	NL	**3**	**4**	**5**	NL	NL	NL	NL	NL	NL
8. Crime Scene Investigations	NL	NL	NL	**1**	NL	NL	**2**	**3**	NL	NL	NL	NL
9. Monitoring People for Contamination at Public Reception Centers	**1**	**2**	**3**	NL	**5**	**6**	NL	NL	**4**	NL	NL	NL
10. Monitoring Public Property for Contamination	**1**	**2**	**3**	NL	**4**	**5**	NL	NL	NL	NL	NL	NL
11. Public Protective Action Guides – Evacuation and Shelter-in-Place	**1**	NL	NL	NL	**2**	**3**	NL	NL	NL	NL	NL	NL
12. Traffic Control and Considerations	NL	NL	NL	NL	NL	NL	NL	NL	NL	**1**	**2**	NL
13. Hospital-Based Operations and Medical Considerations	NL	NL	NL	NL	NL	NL	NL	NL	**2**	NL	NL	**1**

*__Rad Mgmt__ Los Angeles County, Department of Public Health, Radiation Management; California Radiologic Health Branch will respond with Radiation Management. Note that Radiation Management has a limited number of staff, and they will be more likely to provide oversight, rather than actually conduct the activity.

Fire Hazmat All fire department hazardous materials teams
Fire All fire departments
Law Hazmat All law enforcement hazardous materials teams
EPA United States Environmental Protection Agency
DOE United States Department of Energy
FBI Federal Bureau of Investigations
Coroner Los Angeles County Coroner's Officer
Public Health Los Angeles County Department of Public Health and/or public health agencies
Law All law enforcement agencies
CHP California Highway Patrol
Med Medical Organizations including Emergency Medical Services
NL Not Listed as a primary, secondary, tertiary, etc. resource to perform activity.

Note: The primary agency to conduct each particular activity is listed with a "1", the secondary with a "2", and so on. If the primary agency is not available to conduct the activity, the secondary agency should be tasked and so on. Two or more agencies may be required to conduct a particular activity given the incident circumstances.

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Table 2: Summary of Activity Playbooks Applicable to Radiological Scenarios

Activity Playbook	RMR	RED	RDD
1. Exclusion Zone Operations	Yes	Yes	Yes
2. Initial Incident Control Zones	Yes	Yes	Yes
3. Monitoring Responders and Equipment for Contamination	Yes	No	Yes
4. Monitoring Injured Victims for Contamination	Yes	No	Yes
5. Monitoring Uninjured Victims for Contamination	Yes	No	Yes
6. Advanced Radiation Measurements	Yes	Partial	Yes
7. Alpha Radiation Detection and Considerations	Yes	No	Yes
8. Crime Scene Investigations	Maybe	Yes	Yes
9. Monitoring People for Contamination at Public Reception Centers	Yes	Partial	Yes
10. Monitoring Public Property for Contamination	Yes	No	Yes
11. Public Protective Action Guides – Evacuation and Shelter-in-Place	Yes	No	Yes
12. Traffic Control and Considerations	Yes	No	Yes
13. Hospital-Based Operations and Medical Considerations	Yes	Yes	Yes

RMR Radioactive Material Release (accidental release of materials by fire, transportation accident, etc.)

RED Radiological Exposure Device (accidental or deliberate act to expose people to contained radioactive material)

RDD Radiological Dispersal Device (deliberate act to spread radioactive materials via explosive, fire, or direct release)

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Table 3: Radiation Incident Zones and Activities

Incident Zone	Radiation Type	Dose Rate / Contamination Level [1]		Activities [2]
Support Zone (SZ)	All	Below Contamination Reduction Zone levels		Staging, Incident Command, etc.
Contamination Reduction Zone (CRZ)	Gamma	1 to 10 mR/hr [3]		Decontamination Activities [6,7]
	Beta	1,000 to 100,000 cpm [4]		
	Alpha	100 to 10,000 cpm [5]		
Exclusion Zone (EZ)	Gamma	10 mR/hr to 10 R/hr [3]		Rescue, Evaluation, Mitigation, and Activities [9]
	Beta	Above 100,000 cpm [4]	Respiratory protection advised/required [8]	
	Alpha	Above 10,000 cpm [5]		
Extreme Caution Area	Gamma	Above 10 R/hr [3] **(200 R/hr Turn Back Limit)** [10]	Level B (SCBA) respiratory protection required	Rescue, Preplanned Evaluation, and Mitigation Activities
	Beta	No Limits		
	Alpha			

1 Incident Zone classification is based on all Radiation Types; i.e., if gamma dose rate is 1 mR/hr, beta contamination level is 500 cpm, and alpha contamination level is 15,000 cpm, the proper Incident Zone classification is "Exclusion Zone" based on the alpha contamination.

2 All activities should be conducted in an area with the lowest levels of exposure and contamination as practicable to accomplish the mission.

3 Gamma radiation measured at approximately 3 feet with ion chamber, energy compensating Geiger-Mueller, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). For PGM, use the backside down, with protective cap on PGM, and mR/hr scale or 3,000 cpm = 1 mR/hr. While values are reasonably good for most gamma emitters, consult a Radiation Technical Specialist if a gamma emitter other than cesium-137 is identified.

4 Beta radiation measured at approximately 1 inch from surface with a Pancake Geiger-Mueller (PGM) detector or a beta-specific detector. **Caution**: PGMs will respond to gamma radiation at approximately 3,000 cpm per 1 mR/hr (for cesium-137). Therefore, when using a PGM to measure beta contamination levels, this gamma radiation response needs to be subtracted from the PGM readout before determining adherence to the beta levels in the table above. For example, if you have measured 1 mR/hr with a gamma detector (as noted in footnote 3 directly above), and using the PGM you measure 4,000 cpm, you need to subtract 3,000 cpm to account for the gamma response before determining the beta contamination level for use with the table above.

5 Alpha radiation measured at approximately ½ inch from a relatively smooth surface (such as a concrete sidewalk) with an alpha-specific detector. If an alpha-specific detector is not available, a PGM may be used as noted in *Standard Operating Guide No. 2, How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter*. **Caution**: Alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

6 Decontamination activities should occur in areas with contamination levels no greater than 10% of the contamination release criteria (refer to Tables 10, 11, 12, or 13) to allow reasonable speed surveys.

7 Residents and other non-essential personnel already within the Contamination Reduction Zone may be allowed to shelter-in-place instead of evacuate, pending logistics for their removal.

8 Respiratory protection should be worn for entry into the exclusion zone and must be worn in areas above 1 R/hr for gamma, 100,000 cpm for beta, and 10,000 cpm for alpha.

9 Residents and other non-essential personnel within the Exclusion Zone need to be evacuated. Shelter-in-place should occur until evacuation is feasible.

10 Consult Incident Commander or Radiation Technical Specialist to exceed limit.

cpm counts per minute
mR/hr milliroentgen per hour
R/hr roentgen per hour
SCBA self-contained breathing apparatus

References: CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

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Table 4: Decision Points

Activities	Exposure Rate (mR/hr)	Cumulative Dose[2] (mrem)
All	Up to 10[1]	Up to 5,000 (5 rem)[1, 3]
Critical infrastructure protection	Up to 10,000 (10 R/hr)[1]	Up to 10,000 (10 rem)[1]
Lifesaving or protection of large populations	Up to 200,000 (200 R/hr)[1] **TURN BACK LIMIT**	Up to 50,000 (50 rem)[1,4]

[1] Gross gamma radiation measured with an ion chamber, or energy compensated Geiger-Mueller probe, or, if necessary, a sodium iodide or Pancake Geiger-Mueller (PGM) with the beta radiation shield closed; i.e., use the backside of the PGM, at approximately one meter (3.3 feet) above the ground.

[2] Effective Dose Equivalent for external dose only. Dose level for eyes is three times the values listed above. Dose limit for any other organ (including skin and extremities) is 10 times the values listed above.

[3] EPA 1992, 29CFR1910.1096(b)(1), and Cal-OSHA (see Volume II for specific citation)

[4] A 50 rem dose will result in an increase in the theoretical cancer mortality risk from the background rate of approximately 24% to approximately 28% (Volume II, Attachment 1, Table 5). Doses above 50 rem are acceptable with approval of the Incident Command/Unified Command, Safety Officer, and a Radiation Technical Specialist in extreme cases. Responders that may receive doses up to this level should be a volunteer, well informed of the risks, and have proper training and detection equipment. For example, a 100 rem dose will result in an increase in the theoretical cancer mortality risk from the background rate of approximately 24% to approximately 32%. See Volume II, Attachment 1, Table 5 for risk values for other doses. This dose should be restricted to a once in a life-time event. However, if a future event requires use of these individuals, they may be used; however, their previous dose must be considered. If the IC/UC allows higher than recommended dose or exposure rate levels, documentation should justify the reasons, and the factors in Volume II, Section 3.2.3, should be considered.

Note: The word "limit" is not used in the context of the Multi-Agency Radiological Response Plan for pre-established health and safety standards. Instead dose, exposure rate, and contamination values are provided as guidance and called "levels" or "decision points." As noted in the above table, doses greater than the occupational limit of 5 rem in a year may be warranted for critical response actions.

mrem millirem
mR/hr milliroentgen per hour
rem roentgen equivalent man
R/hr roentgen per hour

References: CRCPD 2006, NCRP 2005, NCRP 2001, and DHS 2008b (see Volume II for specific citation)

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Table 5: Dose and Potential Health Effects

Short-Term[1] Whole-Body Dose (rem)	Acute Death[2] from Radiation without Medical Treatment (%)	Acute Death from Radiation with Medical Treatment (%)	Acute Symptoms (nausea and vomiting within 4 hours) (%)	Lifetime Risk Fatal Cancer without Radiation Exposure (%)	Excess Lifetime Risk of Fatal Cancer Due to Short-Term Radiation Exposure[3] (%)
1	0	0	0	24	0.08
10	0	0	0	24	0.8
50	0	0	0	24	4
100	< 5	0	5 – 30	24	8
150	< 5	< 5	40	24	12
200	5	< 5	60	24	16
300	30 – 50	15 – 30	75	24	24[4]
600	95 – 100	50	100	24	> 40[4]
1,000	100	> 90	100	24	> 50[4]

[1] Short-term refers to the radiation exposure during the initial response to the incident. The acute effects listed are likely to be reduced by about one-half if radiation exposure occurs over weeks.

[2] Acute deaths are likely to occur from 30 to 180 days after exposure and few if any after that time. Estimates are for healthy adults. Individuals with other injuries, and children, will be at greater risk.

[3] Most cancers are not likely to occur until several decades after exposure; although leukemia has a shorter latency period of less than five years.

[4] Applies to those individuals that survive Acute Radiation Syndrome.

rem roentgen equivalent man
< less than
> greater than
% percentage

(Adapted from NCRP 2005; see Volume II for specific citation)

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Table 6: Responder Alarm Levels

Alarm Level	Exposure Rate[1] (mR/hr)	Cumulative Dose[2] (mrem)
First Alarm	2	10
Second Alarm	10,000 (10 R/hr)	25,000 (25 rem)

[1] Gross gamma radiation measured with an appropriate real time dosimeter at 1 meter (3.3 feet) above the ground. External dose only.

[2] Effective dose equivalent for external dose only.

mR/hr milliroengten per hour
R/hr roengten per hour
mrem millirem
rem roengten equivalent man

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Table 7: Stay Time Table

Radiation Meter Gamma Exposure Rate		Time to Receive This Dose (Times rounded. Table only calculates dose from external sources.)									
		All Emergency Responder Activities Under Emergency Conditions				Protect Property	Lifesaving		Volunteer Only	Potentially Lethal	
		100 mrem	1 rem	2 rem	5 rem	10 rem	25 rem	50 rem	100 rem	300 rem	500 rem
CONTAMINATION REDUCTION ZONE / SUPPORT ZONE	10 µR/hr	1 yr									
	50 µR/hr	12 wk	2 yr								
	100 µR/hr	6 wk	1 yr								
	500 µR/hr	8 dy	12 wk	24 wk	1 yr						
	750 µR/hr	5.5 dy	8 wk	16 wk	40 wk	1.5 yr					
	1 mR/hr	4 dy	6 wk	12 wk	30 wk	1 yr					
	2 mR/hr	50 hr	3 wk	6 wk	15 wk	30 wk	74 wk				
	5 mR/hr	20 hr	8 dy	16 dy	6 wk	12 wk	30 wk	1 yr			
	7.5 mR/hr	13 hr	5.5 dy	11 dy	4 wk	8 wk	20 wk	40 wk	80 wk		
	10 mR/hr	10 hr	4 dy	8 dy	3 wk	6 wk	15 wk	30 wk	1 yr		
EXCLUSION ZONE CAUTION	20 mR/hr	5 hr	2 dy	4 dy	10 dy	3 wk	7 wk	15 wk	30 wk	2 yr	
	30 mR/hr	3.3 hr	33 hr	3 dy	1 wk	2 wk	5 wk	10 wk	20 wk	60 wk	
	40 mR/hr	2.5 hr	1 dy	2 dy	5 dy	11 dy	4 wk	8 wk	15 wk	1 yr	
	50 mR/hr	2 hr	20 hr	40 hr	4 dy	8 dy	3 wk	6 wk	12 wk	35 wk	1 yr
	75 mR/hr	80 min	13 hr	1 dy	3 dy	5.5 dy	2 wk	4 wk	8 wk	24 wk	40 wk
	100 mR/hr	1 hr	10 hr	20 hr	2 dy	4 dy	10 dy	3 wk	6 wk	18 wk	30 wk
	200 mR/hr	30 min	5 hr	10 hr	1 dy	2 dy	5 dy	11 dy	3 wk	9 wk	15 wk
	300 mR/hr	20 min	3 hr	7 hr	16 hr	32 hr	3 dy	1 wk	2 wk	6 wk	10 wk
	400 mR/hr	15 min	2.5 hr	5 hr	12 hr	1 dy	2.5 dy	5.5 dy	11 dy	31 dy	52 dy
	500 mR/hr	12 min	2 hr	4 hr	10 hr	19 hr	2 dy	4 dy	8 dy	25 dy	40 dy
	750 mR/hr	8 min	78 min	2.6 hr	6.5 hr	13 hr	33 hr	3 dy	5.5 dy	16 dy	4 wk
	1 R/hr	6 min	1 hr	2 hr	5 hr	10 hr	25 hr	50 hr	4 dy	12 dy	3 wk
	1.5 R/hr	3 min	40 min	78 min	3.5 hr	6.5 hr	16.5 hr	33 hr	3 dy	8 dy	14 dy
	2 R/hr	3 min	30 min	1 hr	2.5 hr	5 hr	13 hr	25 hr	2 dy	6 dy	11 dy
	3 R/hr	2 min	20 min	40 min	100	200 min	8 hr	16 hr	1.5 dy	4 dy	1 wk
	4 R/hr	90 sec	15 min	30 min	75 min	2.5 hr	6.5 hr	13 hr	1 dy	3 dy	6 dy
	5 R/hr	72 sec	12 min	24 min	1 hr	2 hr	5 hr	10 hr	20 hr	2.5 dy	4 dy
	7.5 R/hr	48 sec	8 min	16 min	40 min	78 min	200 min	6.5 hr	13 hr	40 hr	3 dy
EXTREME DANGER AREA	10 R/hr	36 sec	6 min	12 min	30 min	1 hr	2.5 hr	5 hr	10 hr	30 hr	50 hr
	20 R/hr	18 sec	3 min	6 min	15 min	30 min	75 min	2.5 hr	5 hr	15 hr	1 dy
	30 R/hr	10 sec	2 min	4 min	10 min	20 min	50 min	96 min	3 hr	10 hr	17 hr
	40 R/hr	9 sec	90 sec	3 min	7.5 min	15 min	38 min	75 min	2.5 hr	7.5 hr	12 hr
	50 R/hr	7 sec	72 sec	80 sec	6 min	12 min	30 min	1 hr	2 hr	6 hr	10 hr
	75 R/hr	5 sec	50 sec	100 sec	4 min	8 min	20 min	40 min	80 min	4 hr	6.5 hr
	100 R/hr	4 sec	30 sec	1 min	3 min	6 min	15 min	30 min	1 hr	3 hr	5 hr
	200 R/hr	2 sec	18 sec	30 sec	90 sec	3 min	7 min	15 min	30 min	90 min	2.5 hr
GRAVE DANGER	300 R/hr	1 sec	10 sec	20 sec	1 min	2 min	5 min	10 min	20 min	1 hr	100 min
	400 R/hr	1 sec	9 sec	15 sec	45 sec	90 sec	3.5 min	7.5 min	15 min	45 min	75 min
	500 R/hr	1 sec	7 sec	15 sec	30 sec	72 sec	3 min	6 min	12 min	36 min	1 hr
	750 R/hr	1 sec	5 sec	9 sec	24 sec	48 sec	2 min	4 min	8 min	24 min	40 min
	1,000 R/hr	1 sec	3 sec	7 sec	18 sec	36 sec	90 sec	3 min	6 min	18 min	30 min

1 µR = 0.001 mR = 0.000001 R
1,000 µR = 1 mR = 0.001 R
1,000,000 µR = 1,000 mR = 1 R

µR microroentgen
mR milliroentgen
R roentgen
rem roentgen equivalent man

yr year
wk week
dy day
hr hour
min minute
sec second

Natural Background: about 10 µR/hr = 0.01 mR/hr = 0.00001 R/hr = 0.25 mR/day

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Table 8: Units of Measurement

United States Unit/Symbol	International System Unit/Symbol	Relevance
curie (Ci)	becquerel (Bq)	Amount of radioactivity of a material
rad	gray (Gy)	Amount of absorbed dose to any object
rem	sievert (Sv)	Amount of damage to human tissue or dose equivalent
roentgen (R)	coulomb/kilogram (C/kg)	Amount of ionization of air

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Table 9: Conversion of Units of Measurement

Unit	Conversion
1 curie	3.7×10^{10} disintegrations/second
1 becquerel	1 disintegrations/second
1 rad	0.01 gray (Gy)
1 rem	0.01 sieverts (Sv)
1 roentgen (R)	1 rem (approximate)
1 gray (Gy)	100 rad
1 centigray (cGy)	1 rad
1 sievert (Sv)	100 rem

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Table 10: Responder Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, if returning to duty station or if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	If responder is going directly home, decontaminate to Level 2 lower values, then release for home decontaminate in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home*. If not going directly home decontaminate as noted for Level 1. [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute mR/hr milliroentgen per hour µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

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Table 11: Responder Equipment Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist. Items returning to contaminated areas, including ambulances, may be reused during the incident with these contamination levels.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not reuse or release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Upon demobilization, high priority equipment, like an ambulance, should be given quicker attention for decontamination efforts to release at the lowest contamination level possible.

6 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute mR/hr milliroentgen per hour µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

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Table 12: Victim and Public Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to 1,000 cpm beta and 100 cpm alpha, but only if doing so does not preclude decontamination of others with higher contamination levels. Provide a copy of *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home* before release for self-decontamination.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Decontaminate to Level 2 lower values, then release for home decontamination in accordance with *Instructions No. 2: Instructions to Public on How to Perform Decontamination at Home*. [4,5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Decontaminate without delay to achieve Level 2 values.[5] If respiratory protection was not used, responder needs to be evaluated to determine if internal contamination bioassay is needed.
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

[1] Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

[2] Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

[3] Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

[4] Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

[5] Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

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Table 13: Victim and Public Property Contamination Release Levels

Radiation Type	Existing Contamination Level	Maximum Background Levels	Decontamination Instructions / Release Levels
Level 1 (Third Priority)			
Beta [1]	100 to 10,000 cpm	10 % of Release Level	Decontaminate to lowest level practicable using routine field decontamination methods (wiping and washing) and release without restriction if less than 1,000 cpm beta and 100 cpm alpha.
Gamma [2]	(Gamma instruments not usable at these levels)		
Alpha [3]	10 to 1,000 cpm		
Level 2 (Second Priority)			
Beta [1] or	10,000 to 100,000 cpm or	10 % of Release Level	Control large items, bag smaller items, and retain until evaluated by a Radiation Technical Specialist.[5]
Gamma [2]	50 [(4)] to 100 µR/hr (i.e., 0.01 to 0.1 mR/hr)		
Alpha [3]	1,000 to 10,000 cpm		
Level 3 (First Priority)			
Beta [1] or	Greater than 100,000 cpm (Use gamma above 200,000 cpm) or	10 % of Release Level	Do not release. Contact a Radiation Technical Specialist for determination of disposition.[6]
Gamma [2]	Greater than 100 µR/hr (i.e., Greater than 0.1 mR/hr)		
Alpha [3]	Greater than 10,000 cpm		

Note: Except as noted in the table, either beta or gamma measurements can be used as release criteria. In addition alpha criteria must be met if alpha radionuclides are present.

1 Measured with a Pancake Geiger-Mueller (PGM) probe at approximately 1-inch from the surface. **Caution**: Do not use PGM above 200,000 cpm. Due to instrument dead-time loss above this value, PGM will significantly under-respond to radiation levels (e.g., a 500,000 cpm reading is actually 1,500,000 cpm).

2 Gamma radiation measured with ion chamber, energy compensated Geiger-Mueller detector, or if necessary, sodium iodide or Pancake Geiger-Mueller (PGM). If PGM is used for gamma, face backside of probe towards contamination and if feasible cover front side of probe to shield beta; then read mR/hr or calculate mR/hr using relationship 1 mR/hr = 3,000 cpm (for Cs-137 only). The table mR/hr values are based on a distance of 5-6 inches from the surface to the centerline of the detector. The mR/hr values can be increased by a factor of 5 (e.g., 500 µR/hr = 100,000 cpm) using a 1-inch surface-to-centerline distance. Consult a Radiation Technical Specialist if gamma emitter other than Cs-137 is present or if contamination is in a very small area (e.g., less than the PGM probe area).

3 Measured with an alpha specific detector at approximately ½ inch from a relatively smooth surface. **Caution**: alpha radiation is very difficult to measure accurately. Presence of moisture, oil, dust, or dirt may shield all alpha. Seek Radiation Technical Specialist assistance if alpha contamination is detected.

4 Normal gamma background is 5-10 µR/hr; therefore, 50 µR/hr is the lowest practicable gamma level for determining contamination presence while allowing reasonable speed scans. If local background level exceeds 5 µR/hr, the lowest practicable gamma level for determining contamination presence will increase (remember that background needs to be approximately 10% or less than the contamination release level to allow reasonable speed surveying).

5 Valuables should be returned to the owner, including credit cards, identification, money, jewelry, medicines, et. Bag items and notify owner that further evaluation will be required at a later time.

6 Contamination levels above 10,000 cpm (or even above 100,000 cpm) may be acceptable for release upon consultation with the Radiation Technical Specialist.

cpm counts per minute
mR/hr milliroentgen per hour
µR/hr microroentgen per hour

Reference CRCPD 2006, NCRP 2005, and NCRP 2001 (see Volume II for specific citation)

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Table 14: Radionuclides of Concern

Radionuclide	Half-Life	Primary Radiation[1] Type
Americium-241 (Am-241)	430 years	Alpha, Gamma
Am-241/Beryllium	430 years	Alpha, Gamma, Neutron
Cesium-137 (Cs-137)	30 years	Beta, Gamma
Cobalt-60 (Co-60)	5.3 years	Beta, Gamma
Iridium-192 (Ir-192)	74 days	Beta, Gamma
Plutonium-238 (Pu-238)	86 years	Alpha, Gamma
Plutonium-239 (Pu-239)	24,400 years	Alpha, Beta, Gamma
Pu-239/Beryllium	24,400 years	Alpha, Beta, Gamma, Neutron
Radium-226 (Ra-226)	1,600 years	Alpha, Beta, Gamma
Ra-226/Beryllium	1,600 years	Alpha, Beta, Gamma, Neutron
Strontium-90 (Sr-90)	29.1 years	Beta, Bremsstrahlung (low energy x-rays)
Uranium-235 (U-235)	700,000,000 years	Alpha, Beta, Gamma
Uranium-238 (U-238)	4,500,000,000 years	Alpha, Beta, Gamma

[1] Includes primary radiation emitted from daughter products

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Table 15: Staffing Requirements for 1,000 Persons per Hour Reception Center

Minimum Number	Position	Considerations
1	Facility Group Director	
1	Assistant Facility Group Director	
2[(1)]	Greeter	Additional needed for various languages
As needed	Uniformed security officers	Police and National Guard
As needed	Media relations staff	Coordinate with Joint Information Center
5	Crisis counselors	
20	Line attendant	2 per hand-held monitoring station
20	Radiation monitoring technicians	2 per hand-held monitoring station
10	Escort attendant	1 per hand-held monitoring station
10	Line attendant	1 per portal monitor station
20	Radiation monitoring technicians	2 per portal monitor station
10	Escort attendant	1 per portal monitor station
25	Registry staff	
10	Clinicians	Nurses/doctors as needed
1	Emergency Medical Services (EMS)/ambulance	

[(1)]May need more to reduce fatigue

Reference: CDC 2006 (see Volume II for specific citation)

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Table 16: Protective Action Guides

Phase	Potential Effective Dose[1]	Action
Early	Less than 100 mrem[3]	No sheltering
	Equal to or greater than 1 rem[3] in first four days	Sheltering
	Equal to or greater than 1 rem[3] and equal to or less than 5 rem[3] in first four days	Evacuation, if more protective than sheltering, except for sensitive populations[2]
Intermediate	Equal to or greater than 500 mrem[3] in second year or any subsequent year	Decontamination and other dose-reduction techniques
	Equal to or greater than 2 rem[3] in first year	Relocation
	Equal to or greater than FDA guidance for human food and animal feed	See guidance document
Late	Equal to or greater than 100 mrem[4] and less than 500 mrem[4]	Use ALARA
	Less than 100 rem[4]	No action

[1] International Council of Radiation Protection (ICRP) definition 1991.

[2] Special groups for which evaluation could cause greater risk to themselves or the public (e.g., persons on medical life support, institutionalized criminals, etc.); evacuation should not be implemented if the projected effective dose is less than 10 rem.

[3] Projected doses are maximally exposed individual and calculation methods consistent with those currently in the Protective Action Guide Manual but should be based on current dose conversion factors.

[4] Projected doses are maximally exposed individual and calculation methods should use dose-assessment computer programs or methodologies accepted by federal agencies using realistic exposure scenarios for the intended actual use of the radioactively contaminated areas.

mrem	millirem
rem	roentgen equivalent man
<	less than
≥	greater than or equal to
FDA	United States Food and Drug Administration
ALARA	as low as reasonably achievable

References: EPA 1992, DHS 2008b (see Volume II for specific citation).

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Table 17: Exposure Pathways and Protective Actions

Potential Exposure Pathway	Protective Actions
External radiation from facility or source material	Sheltering Evacuation Control of access to incident
External radiation from overhead plume or immersion in plume	Sheltering Evacuation Control of access to incident
External and internal (inhalation and ingestion) radiation from contamination of skin and clothes	Sheltering Evacuation Control of access to incident Decontamination of people
External and internal (inhalation) radiation from ground deposition	Sheltering Evacuation Relocation Decontamination of land and property
Internal radiation from inhalation of plume	Respiratory protection[1] Sheltering Evacuation Control of access to incident Administration of stable iodine
Internal (inhalation) radiation from contamination resuspension	Evacuation Relocation Control of access to incident Decontamination of land and property
Internal (ingestion) radiation of contaminated food and water	Food and water controls Use of stored animal feeds

[1] Includes covering nose and mouth with a dry or wet handkerchief, bandana, piece of cloth, towel or mask

Reference: EPA 1992, NCRP 2001, DHS 2008b (see Volume II for specific citation)