RELATED TERMS

- Dirty Bomb
- Incident Site Management
- Radioactive Material

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PRIMARY DISCIPLINES

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- Fire
- Hazardous Materials

Radiological Dispersal Device Incident Response Planning: Incident Identification

PURPOSE

Describes pre-planning initiatives to enhance emergency response personnel's capacity to identify a radiological dispersal device (RDD) incident.

SUMMARY

Emergency responders may not realize that radioactive material has been released at an incident scene during the early stages of emergency response operations. To address this challenge, emergency planners should consider developing RDD-specific plans and standard operating procedures that enhance responders' ability to identify the radiological component of an RDD event. Responders should be trained to assume that radioactive material has been dispersed at an incident site after any explosion of unknown origin until proven otherwise. Emergency response organizations should ensure that personnel likely to respond to an RDD event possess appropriate radiation detection equipment. Jurisdictions might find it especially helpful to provide all first response fire vehicles with radiation detection instruments. Emergency responders also should be trained periodically to use radiation detection instruments as well as to recognize radiation exposure symptoms.

This Best Practice provides emergency planners with information on the recognition of radiation exposure symptoms and radiation detection equipment. For more information on training, please refer to the *Lessons Learned Information Sharing* Best Practice document: "Radiological Dispersal Device Incident Response Planning: Training and Exercises."

DESCRIPTION

Radioactive materials are colorless, odorless, tasteless, and cannot be detected by the human senses. The radiological component of an RDD might not be identified at the onset of emergency response operations. For instance, responders first onsite of a dirty bomb event may not immediately realize that the explosion dispersed radioactive materials. Responders may be alerted to the radiological dimension of an incident through several ways, including:

- **Random Radiation Measurement**: Emergency responders may discover that a device dispersed radioactive materials only after a passive or inadvertent radiation measurement, such as one by an automatic radiation detection instrument on an emergency vehicle. In November 1983, a hospital electrician sold a teletheraphy unit containing about 6,000 1-millimeter pellets of cobalt-60 (over 400 curies) to a scrap yard in Ciudad Juarez, Mexico. Yard

For more information on types of RDDs, please refer to the *Lessons Learned Information Sharing* Best Practice document: "Radiological Dispersal Device Incident Response Planning: Overview."

workers did not know that the source contained radioactive material, and they incorporated it into several products sold in the United States and Mexico. The Los Alamos National Laboratory in New Mexico detected the contamination in January 1984 after a truck carrying contaminated rebars triggered automatic radiation sensors at the Laboratory.

- **Radiation-Induced Symptoms Begin Manifesting in First Responders and/or the Population**: Emergency response personnel may discover that radioactive material is onsite only after first responders and/or victims begin manifesting radiation-induced symptoms. However, responders should be aware that radiation-induced symptoms will manifest only if onsite radiation is very high. In December 2001, three woodworkers found an orphaned radiothermal generator (RTG) containing two strontium-90 sources outside the village of Liya in the Tsalenjikha District, Republic of Georgia. Each source is about the size of a person's hand, contains approximately 40,000 curies of radioactivity, and emits heat. The men removed the RTG's shielding and took the cylinders to their campsite to use as heat sources. The woodworkers developed radiation sickness within hours and went to a local hospital. They were transferred to a hospital in Tblisi as soon as radiation-induced symptoms were recognized.

Emergency response organizations can ensure that responders are able to identify the radiological component of an RDD event at the start of emergency response operations by:

- Providing emergency responders with radiation detection equipment. Emergency response organizations need to consider local requirements, potential threats, and available resources when selecting radiation detection equipment for local emergency responders.
- Training emergency responders to use radiation detection equipment and to recognize radiation exposure symptoms.

Recognition of Radiation Exposure Symptoms

Experts generally concur that the radiation dose delivered by an RDD will be limited and will cause minimal radiation exposure symptoms. A dirty bomb explosion, for example, would probably disperse the radioactive material at detonation, which would immediately reduce the intensity of the exposure. In most cases, victims may not show any radiation exposure symptoms after a dirty bomb explosion. Conversely, extended exposure to radioactive material hidden in a public library, subway, or church could cause radiation exposure symptoms in some victims.

Emergency planners can include a list of acute radiation exposure symptoms, such as nausea, vomiting, and skin burns, in their RDD plans. This list can help emergency personnel quickly recognize radiation exposure symptoms and thus become aware that an RDD attack may have occurred. Emergency planners also can stress the following concepts in their RDD plans:

- Exposure to several agents can cause symptoms similar to acute radiation exposure.
- Many people may start manifesting psychosomatic symptoms that mimic acute radiation exposure if they believe that a radiological release event took place. For

The Virginia Department of Health, Emergency Preparedness and Response Programs' "Radiological Event Reference Guide for Emergency Responders and Healthcare Providers" includes a section called "Recognizing Radiation-Related Illnesses" with information on acute radiation exposure symptoms. This guide is intended for emergency response personnel who will likely provide onsite emergency medical care to victims following a radiological release event, such as an RDD attack.

more information on identification and management of victims with psychosomatic symptoms, please also refer to the *Lessons Learned Information Sharing* Best Practice document: "Radiological Dispersal Device Incident Response Planning: Psychological Management."

- Radiation exposure symptoms may take days to manifest following an RDD event. Experts anticipate that in many cases victims will not develop any symptoms. Therefore, symptoms of radiation exposure are likely to be recognized initially by first receivers as victims report to healthcare facilities. Only in a very limited number of cases may first responders encounter victims manifesting radiation-induced symptoms at an RDD incident site. In those cases, first responders should assume that onsite radioactivity is very high until proven otherwise.

RDD plans should emphasize that emergency responders should perform onsite radiation measurements when victims and responders start manifesting radiation exposure symptoms. Performing radiation measurements will be essential to verifying that an RDD event occurred.

Emergency planners also should include guidelines for regularly training emergency responders to recognize acute radiation exposure symptoms in their RDD plans. Training can help responders become familiar with these symptoms and enable them to quickly implement appropriate protective actions from the onset of emergency response. For more information on training programs, please refer to the *Lessons Learned Information Sharing* Best Practice documents: "Radiological Dispersal Device Incident Response Planning: Exercises and Training" and "Radiological Dispersal Device Incident Response Planning: Incident Site Medical Management."

The Armed Forces Radiobiology Research Institute's Medical Management of Radiological Casualties includes information on whole body radiation absorption, the type of symptoms, the timing of symptom onset, the duration of symptoms, and other relevant information.

- **~0.7 Gy (70 rad)**: Some victims may experience nausea and a mild headache beginning 6 hours after exposure and lasting 12 hours; performance capacity is relatively unaffected.
- **0.7-1.25 Gy (70-125 rad)**: Transient mild nausea and vomiting is expected in 5-30% of exposed personnel with onset at 3-5 hours after exposure and duration of up to 24 hours; performance capability may be slightly degraded.
- **1.25-3 Gy (125-300 rad)**: 20-75% of exposed persons will experience transient mild to moderate nausea and vomiting; 25-60% of exposed persons will experience mild to moderate fatigability and weakness; performance capacity will be materially degraded starting from 4 to 6 hours post-exposure; 5-10% of persons exposed to doses as high as 3 Gy (300 rad) are likely to die from their radiation injuries.
- **3-5.3 Gy (300-530 rad)**: 50-90% of exposed persons will experience transient moderate nausea and vomiting; 80-100% of exposed persons will experience mild to moderate fatigability; performance capacity will be materially degraded; 10-50% of exposed individuals will likely die in the absence of aggressive medical treatment.
- **5.3-7.5 Gy (530-750 rad)**: Virtually all exposed persons will experience moderate to severe nausea and vomiting, dizziness and disorientation, and severe fatigue and weakness during the first day post-exposure; 100% mortality occurs within 2-3 weeks in the absence of aggressive medical treatment; mortality likely at the upper end of the dose range even with aggressive therapy.
- **7.5-10 Gy (750-1000 rad)**: Exposed persons will experience the rapid onset of severe nausea, vomiting, anorexia, fatigue, weakness, dizziness, and disorientation; 100% mortality likely within 2-2.5 weeks even with aggressive therapy.
- **>10 Gy (1000 rad)**: Exposed persons will experience the rapid onset of severe nausea, vomiting, anorexia, fatigue, weakness, dizziness, and disorientation; 100% mortality likely within days of exposure even with aggressive therapy.

Radiation Detection Equipment

Effective emergency response to an RDD event requires access to and correct use of radiation detection equipment. A monitor instrument could be one of the most important pieces of equipment for emergency responders following an RDD event. These tools allow responders to perform their duties effectively while keeping themselves safe.

Types of Radiation Detection Instruments

Emergency response organizations can employ four categories of detection instruments during an RDD emergency response:

- **Alarming personal radiation dosimeters** are used by emergency responders working in the radiation control zones. The National Council on Radiation Protection and Measurements (NCRP), *Management of Radiological Terrorism Events Involving Radioactive Material* (NCRP Report No. 138), maintains that all emergency responders who could respond to an RDD event should be issued personal radiation dosimeters as part of their standard protective equipment. Personal radiation dosimeters can be used to monitor emergency responders' radiation exposure while performing time-sensitive, critical missions.
- **Passive dosimeters** are used routinely to monitor responders' radiation exposure or total dose. Passive dosimeters generally do not display the dose level and require processing to determine a responder's total dose. As a result, passive dosimeters could not be used to monitor doses at the incident site to ensure responders' compliance with current guidelines. However, these instruments could be helpful to measure a responder's total radiation dose after an incident.
- **Survey instruments** are used to detect the presence of a radiation field and surface contamination as well as to screen people for contamination at the scene. Both sensitive and high-range meters may be necessary following an RDD event. Sensitive meters are routinely used to monitor people for contamination, and high-range instruments may be needed to survey the incident site. Many academic and medical centers, biomedical research facilities, and nuclear medicine departments employ survey instruments. Planners should consider identifying organizations within their jurisdictions that could provide survey instruments after an RDD attack.
- **Radionuclide identifiers** are used to determine the type of radioactive material released. The timely identification of the radioactive material can help emergency responders implement appropriate protective measures for victims, members of the public, and emergency responders. Radionuclide identifiers generally require specialized technical expertise to operate. Emergency planners should consider identifying organizations that could deploy this capability rapidly after an RDD event. Many organizations, including the state radiation control organizations, nuclear medicine laboratories, and university radiation safety programs could supply this type of equipment during RDD emergency response.

Emergency planners should assess local resources, requirements, and probable RDD threats when selecting radiation detection instruments for emergency responders in a jurisdiction. Planners in jurisdictions where the RDD threat is considered low could establish mechanisms to request specialized equipment from other jurisdictions or organizations. Many jurisdictions also may have old civil defense radiation detection equipment. These instruments usually can be refurbished and employed effectively during RDD emergency response operations. This could help jurisdictions where the probability of an RDD attack is low prepare for and respond to such an event without investing considerable resources in new, costly equipment.

Radiation Monitoring Instruments for First Emergency Vehicles and Responders

Emergency response organizations should equip responders who are likely to be first onsite of an RDD event with basic radiation monitoring instruments even in jurisdictions where the RDD threat may be low. The first emergency vehicles responding to a suspected RDD event also should be equipped with radiation monitoring instruments. These instruments should operate automatically and provide unambiguous alarms. NCRP Commentary No. 19 provides valuable information for radiation detection equipment planning. This commentary describes personal dosimeters' characteristics and radiation monitoring instruments for emergency responders first onsite.

The Houston Fire Department routinely trains firefighters to turn on their radiological monitoring equipment while en route to an incident scene. This procedure can help ensure that firefighters do not inadvertently enter a hot zone.

Equipment Requirements for Personal Radiation Dosimeters

Emergency responders who are likely to respond to an RDD event should have personal radiation dosimeters with several fundamental characteristics. These dosimeters should:

- Alert emergency response personnel automatically to the presence of radiation at an incident site.
- Have large displays and readily visible indicator lights or audible alarms. This will allow responders to use their dosimeters efficiently even at an incident site where there is fire, smoke, or loud noises.
- Have set alert and alarm levels in compliance with local guidelines. NCRP Commentary No. 19, *Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism,* states that these alert and alarm levels should be set by "the local authority to ensure compliance with local guidelines, thereby reducing the need for the wearer to read and interpret a value in the field."
- Be inexpensive to purchase and simple to maintain.
- Be rugged for field use. These instruments should not be affected by changes in environmental conditions such as temperature, humidity, dust, rain, or electromagnetic fields.
- Be simple to use, small in size, lightweight, and easily integrated into a responder's normal equipment load.
- Require limited training to operate.
- Work continuously without needing any emergency responder's intervention.

Baltimore City, Maryland: Selecting Alarming Personal Dosimeters

In 2002, the city of Baltimore started purchasing personal dosimeters for the city's firefighters and police officers. The dosimeters could not be switched off and also required non-standard batteries that needed a special tool to be changed. As a result, the batteries drained in 1 month and could not be replaced as quickly as they were depleted. Many emergency responders lacked operational personal dosimeters for extended periods of time. Subsequently, the city of Baltimore has started exchanging these alarming personal dosimeters for a different model that can switch off to conserve battery life and takes standard, easy-to-change batteries.

Detection of False Positives

RDD plans should ensure that emergency responders are aware that some materials are naturally radioactive. Large shipments of these products could activate personal radiation dosimeters or radiation detection equipment on emergency response vehicles. This information can help emergency responders quickly identify false positives. Products that

are naturally radioactive include large shipments of bananas, kitty litter, ceramic tiles, camera lenses, potassium nitrate fertilizer, granite, and marble. Moreover, many legitimate radioactive sources used in medical or industrial applications as well as people who have been injected with radioactive isotopes for medical treatments may trigger radiation detection equipment. Emergency responders should be able to quickly ascertain if a legitimate commercial radioactive source or naturally occurring radioactive material triggered the alarm.

Instrument Sensitivity

Emergency planners should consider local requirements when establishing alert levels for radiation detection instruments. These instruments need to be sensitive enough to automatically alert emergency responders when the exposure rate reaches a predefined level. This level should be sufficiently high to minimize false positives.

Deployment of Radiation Detection Instruments

RDD plans should include guidelines detailing the deployment of radiation detection equipment in a jurisdiction. Deployment of this equipment is essential to help emergency responders detect the radiological component of an RDD event.

RDD plans should address such issues as the deployment of radiation detection instruments at strategic locations and/or in emergency vehicles. This will help emergency responders realize that an RDD attack occurred at the onset of emergency response operations. Plans also could include a list of recurring public events that might become targets of RDD attacks. A list of likely targets can help emergency response organizations prepare for the deployment of appropriate radiation detection instruments.

Radiation Detection Equipment at Strategic Locations

Emergency response organizations may consider establishing a network of fixed detectors at strategic locations or on the roofs of large buildings. Such a surveillance system could detect an RDD attack minutes after dispersal takes place by sending monitoring data to a central command post. Strategic locations could include harbors, stadiums, sites of historical value, and government facilities. Emergency managers might use the monitoring data to produce a real-time plume map.

Multi-Layered Defense

The New York City Police Department at times deploys radiation portal monitors at fixed strategic locations in and around the city. These locations include places near or on bridges and along main transportation routes.

Radiation Detection Equipment in Emergency Vehicles

Emergency response organizations could create a mobile detection network system by placing radiation instruments in fire engines or patrol police cars. The instruments could automatically monitor sections of a city during the normal course of operations.

Preventive Measures: The New York City Fire Department

The New York City Fire Department (FDNY) periodically issues an official order prompting field units to maintain their radiological detectors in the “on” position at all times. These units move within their designated response areas in New York on a 24-hour basis. All the FDNY units throughout the city also could be notified to take readings after an RDD event for plume-tracking purposes. The New York City Police Department (NYPD) also issued pager-type radiological detectors to all police sergeants on patrol duty. These measures allow the FDNY and NYPD to maintain a network of mobile sensors that can detect radioactive materials used in a dirty bomb before the attack takes place or immediately after.

High-Profile Events

Emergency planners could establish a list of high-profile events in a jurisdiction that could be likely targets of RDD attacks. This list can help emergency response organizations plan for the efficient use of radiation detection instruments available in a jurisdiction. High-profile events may include large public gatherings, such as sporting events, political conventions, or county fairs. Emergency planners should assess local threats and vulnerabilities when planning for radiological monitoring during high-profile events.

Preventive Measures: The Department of Energy

The Department of Energy (DOE) routinely draws upon technical experts from the Los Alamos, Sandia, and Lawrence Livermore national laboratories to deploy search teams during high-risk events. These teams can assist local and state officials in monitoring large public events, such as the Super Bowl and the State of the Union address. The DOE teams can employ a variety of clandestine methods, including radiation sensors carried in backpacks or mounted on vehicles and helicopters. During monitoring operations, the teams can send measurement data via a secure Internet line to scientists at the national laboratories for analysis. This capability can be crucial to help teams rapidly and efficiently identify potential threats. Team members also can train up to 16 local responders to conduct basic search missions in less than an hour.

Background Radiation Survey

Emergency planners should consider mapping the background radiation levels in multiple areas of their jurisdictions. These maps could record radiation hotspots at medical and industrial facilities where radioactive materials are used routinely. Maps can also list buildings constructed with materials that naturally emit radiation and areas with high radon content in the soil. This can help emergency responders distinguish between false alarms and real radiological threats. Mapping the background radiation levels could help jurisdictions achieve the following:

- **Identify an RDD threat prior to an event**: Emergency planners could establish guidelines to conduct periodic background radiation surveys in a jurisdiction. This could help emergency response organizations discover locations with new sources of radiation in a jurisdiction. Law enforcement officials then could be directed to investigate these specific locations and to verify if a threat exists before an attack takes place.
- **Map the path of the plume**: Emergency response organizations may use background radiation maps to chart the path of a radioactive plume following an RDD event. Responders also may use available data to identify likely hotspots and areas that require implementation of particular emergency procedures.
- **Assist with cleanup**: Jurisdictions could use background radiation survey data to assess contamination levels and to establish decontamination limits for different areas after an RDD event. Indeed, buildings and other areas could be decontaminated up to the pre-incident radiation levels rather than attempting to remove any trace of radiation.

Background Radiation Mapping Methods

A variety of methods could be used to map background radiation levels in a jurisdiction. These methods may include directing emergency response personnel to record radiation levels at regular intervals and/or during routine activities. For instance, FDNY directs its personnel to use their alarming personal dosimeters to perform the following activities:

- Record radiation levels in front of their stations at five scheduled times each day during the first full week of May; and

- Report any elevated background radiation readings— defined as above 0.05 mR/hr and below 1 mR/hr— during routine activities.

Emergency planners may include in their plans guidelines for performing these surveys at regular intervals. Jurisdictions should consider conducting surveys of background radiation levels when conditions change in a jurisdiction. For instance, new medical facilities or construction projects that use large quantities of granite could change a city's radiation background levels significantly.

Resources

Several resources are available to help emergency planners identify radiation detection equipment appropriate for their specific needs. These resources include but are not limited to:

- US Army Center for Health Promotion and Preventive Medicine's *Medical NBC Battlebook* describes radiological detectors, such as ionizing chambers and Geiger-Mueller counters, as well as commonly used dosimeters, such as chemical and thermoluminescent dosimeters.
- The Department of Energy, Office of Worker Protection Policy and Programs' *Radiation Detection Instrumentation at the Department of Energy* describes radiation monitoring and personal dosimetry capabilities used by the DOE.
- The Department of Homeland Security's Domestic Preparedness Equipment Technical Assistance Program (DPETAP). DPETAP assists responders in the selection, operation, and maintenance of their radiological, chemical, and biological detection and response equipment. DPETAP Mobile Technical Assistance Teams provide onsite technical assistance and training at no cost to jurisdictions. The teams support emergency responders in the operation and maintenance of their domestic preparedness detection equipment.

  Jurisdictions are advised to train emergency responders to efficiently use radiation detection equipment. For more information on training programs available for emergency responders, please also refer to the *Lessons Learned Information Sharing* Best Practice: "Radiological Dispersal Device Incident Response Planning: Exercises and Training."
- The Department of Labor, Occupational Safety & Health Administration's (OSHA) *Radiation Detection Instruments* shows types of radiation detection instruments and their applications.
- The Environmental Protection Agency's *Water and Wastewater Security Product Guide: Radiation Detection Equipment* includes information on monitoring personnel, packages, or water assets.
- The Institute of Electrical and Electronics Engineers, Inc. and the Department of Homeland Security, Science & Technology Directorate's *Radiation Detection Standards Program* includes standards such as:
  - N42.32-2003, American National Standard Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security
  - N42.33-2003, American National Standard for Portable Radiation Detection Instrumentation for Homeland Security
  - N42.34-2003, American National Standard Performance Criteria for Hand-held Instruments for the Detection and Identification of Radionuclides
  - N42.35-2003, American National Standard for Evaluation and Performance of Radiation Detection Portal Monitors for Use in Homeland Security

- The Memorial Institute for the Prevention of Terrorism's Responder Knowledge Base. This comprehensive database provides emergency responders, purchasers, and planners with a trusted, integrated, electronic source of products, standards, certifications, grants, and other equipment-related information.

Testing and Calibration

Emergency planners should consider including guidelines for testing radiation detection instruments in their RDD standard operating procedures prior to field deployment. This is also essential for jurisdictions that do not employ their radiation detection instruments regularly. Testing can include ensuring that the batteries do not require replacement.

FDNY directs all officers with alarming personal dosimeters to change the batteries every 3 months on specific days.

NCRP Report No. 138 advises jurisdictions to include a maintenance and calibration program in their emergency planning program. A maintenance and calibration program could guarantee proper operation of all the radiation detection equipment as well as periodic recalibration of the equipment.

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- Details radiation health and safety standards, including sections on exposure limits in restricted areas, exposure to airborne radioactive materials, *precautionary procedures and personal monitoring*, evacuation warning signs, and other related topics.

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