Decontamination, Disposal, and Documentation

INTRODUCTION

This module discusses ways in which equipment and personnel can become contaminated with radioactive material and describes methods for exiting the hot zone following a radiological transportation accident. Some of the PPE and equipment used in decontamination needs to be disposed of properly to prevent further spread of radioactive contamination. Once contaminated material is bagged, it needs to be clearly identified, documented, and disposed of properly.

PURPOSE

The purpose of this module is to inform you of methods used to decontaminate personnel and equipment. This information will help you prevent further spread of radiological contamination and minimize the amount of radioactive waste generated when performing response activities at the scene of a transportation incident involving radioactive material.

MODULE OBJECTIVES

Upon completion of this module, you will be able to:

1. Identify how personnel, personal protective equipment, apparatus, and tools become contaminated with radioactive material.
2. State the purpose of radioactive material decontamination.
3. Identify the four recommended decontamination stations or processing steps.
4. Identify your responsibilities for radioactive material disposal and event documentation.

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RADIOACTIVE CONTAMINATION

Radioactive contamination is undesired radioactive material deposited on the surfaces of or inside structures, areas, objects, or people. Radioactive material can be solid, liquid, or gaseous. If radioactive material is released from a package, personnel, personal protective equipment (PPE), apparatus, and tools can become contaminated if they contact this material. When individuals (accident victims or response personnel), PPE, or equipment become contaminated, the contamination can easily be spread by cross-contamination or secondary contamination to other persons, equipment, or surfaces. People can become contaminated internally, externally, or both. Care should be taken to avoid cross-contamination. The following practices will help to avoid spreading contamination.

- Establish control zones
- Change gloves after handling accident victims and contaminated equipment
- Avoid unnecessary activity in the contaminated area
- Sleeve or wrap equipment prior to entry into the area
- Adhere to the policy of no eating, drinking, smoking, or chewing in the hot zone
- Avoid touching unprotected skin areas

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RADIOACTIVE DECONTAMINATION

Radioactive decontamination involves removing radioactive material (contamination) from locations where it is not wanted. Factors that should be considered when choosing a decontamination process include the following:

- Identification of the material
- Physical state of the material
- Health condition of the patient or responder contaminated
- Potential health effects on the patient or responder
- Available PPE and equipment to the responder
- Number of personnel that need decontaminated

Decontamination can fall into one of the following categories:

Gross Decontamination

Is the phase of the decontamination process during which the amount of surface contaminants is significantly reduced. As discussed in the Patient Handling module, this is often accomplished by removing a person's outer clothing.

Emergency Decontamination

Is the physical process of immediately reducing contamination of individuals in potentially life-threatening situations with or without the formal establishment of a decontamination corridor. It would be very unlikely in a radiological transportation event that radioactive contamination levels would be high enough to be considered life-threatening and therefore warrant emergency decontamination. Emergency decontamination may be warranted for other life-threatening conditions (e.g., medical distress, exposed to highly toxic chemicals, etc).

Traditional emergency decontamination can be as simple as removal of the outer layer clothing followed by a washing down with water from a fire hose or safety shower. However, if radiological contamination is the only hazard present, then the conventional gross decontamination method of removing the outer layer of clothing followed by technical decontamination should be sufficient.

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The additional step of washing down victims or responders with water may complicate the response. Water does nothing to neutralize the hazardous nature of radioactive material, and the contaminated runoff could spread the contamination beyond the immediate hazard zone. In addition, the ability to detect contamination on a person, their clothing, or equipment is more difficult when the item is wet because the water acts as a shield.

Regardless of the method chosen, essentially only gross decontamination is provided, so the victim or responder can still be exposed to contaminants and may pose a threat of secondary contamination.

Technical Decontamination

Is the planned and systematic process of reducing contamination to a level that is as low as reasonably achievable (ALARA). For radiological events this typically involves removing contaminants from the person or item to be decontaminated as will be discussed later in this module.

Mass Decontamination

Is the physical process of reducing or removing surface contaminants from large numbers of victims in potentially life-threatening situations in the fastest time possible.

The methods and considerations discussed under emergency decontamination would also apply to a mass decontamination event. As noted in the U.S. Army Edgewood Chemical Biological Center Special Report ECBC-SP-024, *Guidelines for Mass Casualty Decontamination During a HAZMAT/Weapon of Mass Destruction Incident*, removing clothes is the single most critical step in mass decontamination and may remove 80-90% of physical contamination. Removal of the clothing is recommended prior to the secondary step of a high-volume, low pressure water shower. This is because clothing might actually inhibit decontamination by trapping the contamination inside sleeves, neck openings, shoes, or pant legs.

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For radioactive contamination, using gentle friction, such as rubbing with hands, cloth, or sponges is recommended to aid in removal of the material from the body while washing during the low pressure shower. Rubbing should start with the head and proceed down the body to the feet.

The use of large volumes of water, as would be the case in a mass decontamination effort, will result in the dilution of the hazardous material. Though as discussed previously, water cannot change the fact a material is radioactive. Efforts should be made to isolate both the clothing and the runoff generated during decontamination. This will help minimize the potential spread of contamination. Realize that radiation levels could also become elevated in areas where these materials are being concentrated.

Decontamination is performed in order to:

- Decrease radiation exposure by removing the radioactive material
- Prevent further spread of radioactive material
- Prevent or decrease the risk of internal contamination

DECONTAMINATION PLAN

The release of a hazardous material at an accident scene can complicate the mitigating actions needed by responders. At accidents involving hazardous material, responders should always be aware of the possibility of contamination. If a hazardous material has been released from its container, package, or transport, responders have the responsibility to plan for and manage the possibility of contaminated persons and equipment at the incident scene.

The management and planning for controlling contamination and handling contaminated persons and equipment involves the establishment of a decontamination plan. The decontamination plan should include:

- A sketch of the decontamination corridor layout
- Establishment and identification of the control zone boundaries as recommended in the Emergency Response Guidebook

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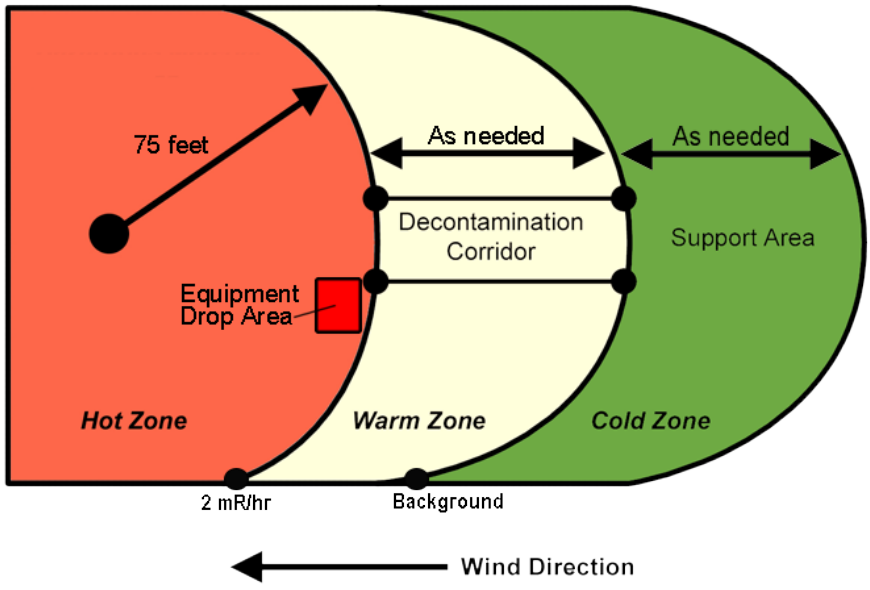
- An explanation of the decontamination method to be used
- The number of persons needed to perform the decontamination operation
- The level of personal protective equipment needed to perform decontamination of victims, responders, or equipment
- Containment controls to be used to control runoff
- Selected disposal method of waste created during decontamination operations
- Post incident medical considerations, including briefing on incident chemical hazards and, as need, follow-up health care evaluations

DECONTAMINATION CORRIDOR SETUP

If field decontamination is necessary, it is important to establish a decontamination station/area. As with other hazardous material incidents, the decontamination corridor is usually established inside the warm zone running between the hot zone and cold zone. The Incident Commander and Safety Officer will determine where the decontamination corridor should be established and will consider the following:

- Wind direction relative to incident scene
- Natural background levels
- Hot, warm, and cold zone boundaries
- Areas for best access into and out of incident scene



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The decontamination corridor usually establishes four stations or processing steps. They are:

- **Equipment Drop Area** (inside hot zone) - This is where tools, equipment, etc., should be set down to wait for radiological survey. A small piece of plastic or poly can be placed on the ground to define the drop area. The plastic or poly will also serve to protect the ground from secondary contamination from equipment.
- **Decontamination Dressdown Corridor** - This is where protective clothing will be removed and placed into appropriate containers (e.g. plastic lined containers). The use of pre-marked tarps or designation of dressdown position will assist in controlling the spread of contamination.
- **Radiological Survey Station** - This is the area where, after removing protective clothing, personnel are surveyed for radiological contamination. Radiological surveys need to be performed by qualified individuals. Personnel who are contaminated must go to the decontamination station. Personnel who survey "clean" will be allowed to exit into the cold zone. If you suspect that personnel exiting the hot zone may not be contaminated, you may want to consider surveying them prior to removal of their protective clothing. If personnel survey clean while wearing their protective clothing, the clothing will not need to be disposed of as radioactive waste. Personnel should be surveyed again after removal of their protective clothing.
- **Decontamination Station** - This is where personnel decontamination is performed. After decontamination, personnel will be resurveyed for a second time to determine the effectiveness of the decontamination effort.

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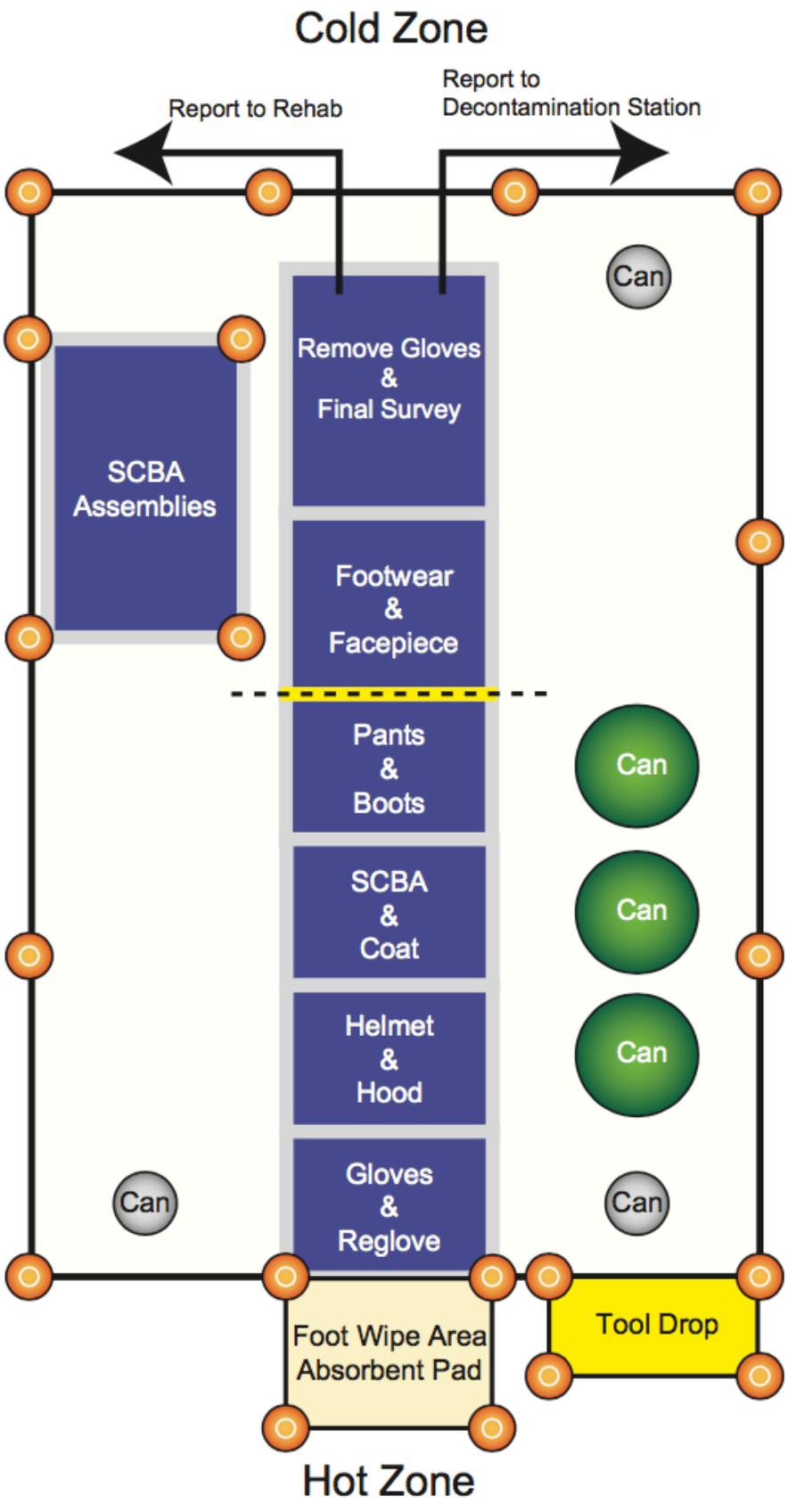

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EQUIPMENT DROP AREA

Any tools taken into the hot zone must be staged prior to entering the decontamination dressdown corridor. A tool drop area located inside the hot zone and near the entrance to the corridor is where tools, equipment, etc., should be placed until a radiological survey can be performed. A small piece of plastic or poly can be placed on the ground to define the drop area. The plastic or poly will also serve to protect the ground from secondary contamination.

DECONTAMINATION DRESSDOWN CORRIDOR

Use of traditional wet decon procedures may not be necessary if radioactive material is the only hazard present. While use of traditional wet decon processes (wash and rinse) are effective for radioactive material, their use may complicate skin decontamination and generate large quantities of wastewater. Consideration should be given to decontamination methods that will minimize the skin contamination problems and reduce the amount of waste generated. There are simpler methods available for decon that are less time consuming, require fewer resources, and generate less waste.

If SCBAs were worn by responders entering the hot zone, air supply limitations may be a concern. If an approved air purifying respirator cartridge is available, the decontamination worker can insert a cartridge in place of the air supply demand valve from the SCBA facepiece. This will eliminate concerns about responders running out of air during the decontamination process. If negative pressure respirators were worn by responders entering the hot zone, air supply limitations will not be a concern. At this point, responders can implement the decontamination dressdown process.

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Removing all protective clothing (gross decon) can dramatically reduce the contaminants on the emergency responder. With the assistance of decontamination corridor workers, the decontamination dressdown process begins when the responder enters the pre-marked decontamination corridor and begins the dressdown process.

Decontamination workers will begin the dressdown process with the removal of the responder's fire fighting gloves and continues through removal of the communication device, dosimetry, helmet, hood, SCBA harness/backplate, coat, pants, boots, SCBA facepiece, and finally the medical exam gloves. As with the traditional decontamination process, a primary concern for the decontamination team is to avoid or reduce cross contamination as much as possible.

After performing each step in the decontamination dressdown process, the removed PPE should be placed in an appropriate container or bag inside the decontamination corridor. This clothing should be contained and controlled until surveyed. Minimizing the accumulation of contaminated or radioactive material (removed clothing, packages, etc.) in the area will help keep area radiation dose rates low. After responders have completed the decontamination dressdown process, they should report to the radiological survey station.

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Special considerations should be given for decontamination of Law Enforcement Officers. Their sensitive items (weapons, taser, vests, etc.) will require chain of custody prior to or during the decontamination process. Securing the sensitive items in their vehicle or bagged during the dressdown process is required. The Radiation Authority will work with law enforcement officials to ensure sensitive items are surveyed, decontaminated and/or dispositioned as needed.

RADIOLOGICAL SURVEY STATION

It is important that properly qualified personnel conduct surveys for radiological contamination. The contamination survey will confirm the dressdown process was effective and contamination is not present on the responder's skin or station uniform. If a radiological survey shows areas of localized contamination on the responder's clothing or skin, the location of the contamination should be noted on a personnel radiological survey form and the responder should be sent to the Decontamination Station for decon.

DECONTAMINATION STATION

The Decontamination Station is the area where decontamination workers remove skin or clothing contamination that may have been identified in the Radiological Survey Station. Performing a thorough contamination survey on individuals and equipment exiting the hot zone helps minimize the spread of contamination. It is important to identify contamination before someone is allowed to leave the area as "clean." Personnel can become contaminated internally, externally, or both. Internal contamination occurs when radioactive material is ingested or inhaled or otherwise taken into the body. External contamination occurs when

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radioactive material gets on you or your clothing. The dry or decontamination dressdown process should remove the majority, if not all radiological contamination from the responder. However, the responder's station uniform or skin could be contaminated requiring decontamination. For localized contamination of the skin, pre-packaged pre-moistened wipes may be used instead of water to minimize the amount of waste generated. For localized contamination on clothing, a tape press may be used to remove the contamination. This method is similar to how lint would be removed from clothing. Any water or material used in the decontamination process needs to be contained and considered radioactive waste.

Decontamination of the skin can also be accomplished by using conventional cleansing techniques on contaminated body surfaces (i.e., gentle washing and flushing that does not abrade the skin surface). When washing and flushing skin surfaces, mild soap and lukewarm water are recommended. Lukewarm water is preferred because cold water can cause skin pores to close, fixing the contamination into the skin. Hot water can cause skin pores to open, allowing the contamination to go deeper into the skin. Techniques beyond gross/dry decontamination should only be performed by properly trained personnel and under the direction of the Radiation Authority.

All waste generated during decontamination operations will need to be bagged, clearly identified as "radioactive," and properly dispositioned for decay or disposal. TEPP has several job aids and model procedures that can be used to assist with decontamination and incident documentation. These include:

- Hazardous Materials Incident Response
- Radioactive Material or Multiple Hazardous Materials Decontamination
- Radioactive Material Disposable Personal Protective Clothing Ensemble Entry Dress Up and Dressdown
- Decontamination Dressdown of an Armed Law Enforcement Officer

All resources can be found on the Department of Energy's website: em.doe.gov/otem.

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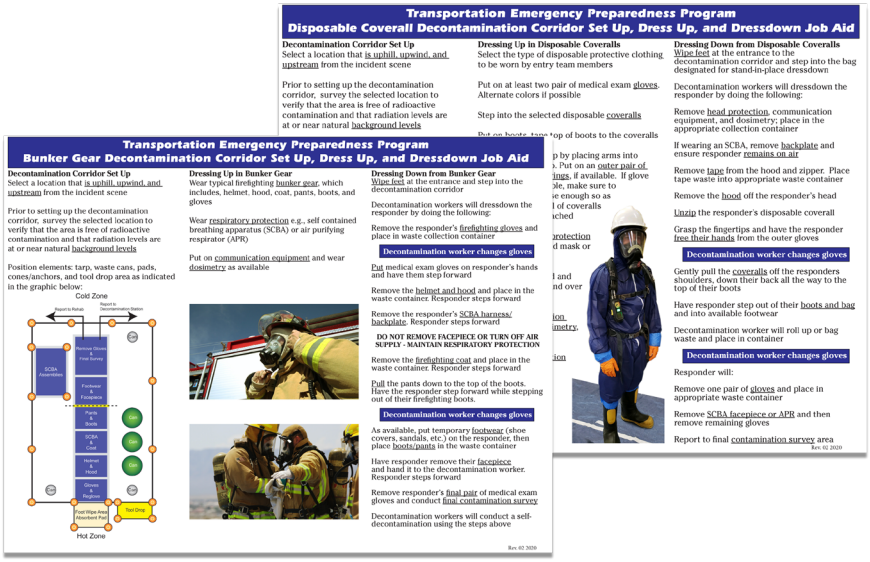
The graphic below is of a job aid that TEPP developed to illustrate the methods detailed in the TEPP Model Decon Procedure. The job aid illustrates how a first responder dressed in bunker gear and SCBA can process through the decontamination corridor. The reverse side shows how a first responder dressed in disposable coveralls and SCBA/APR can process through the decontamination corridor.



Transportation Emergency Preparedness Program
Bunker Gear Decontamination Corridor Set Up, Dress Up, and Dressdown Job Aid

Decontamination Corridor Set Up
Select a location that is uphill, upwind, and upstream from the incident scene

Prior to setting up the decontamination corridor, survey the selected location to verify that the area is free of radioactive contamination and that radiation levels are at or near natural background levels

Position elements: tarp, waste cans, pads, cones/anchors, and tool drop area as indicated in the graphic below;

Cold Zone

Hot Zone

Dressing Up in Bunker Gear
Wear typical firefighting bunker gear, which includes, helmet, hood, coat, pants, boots, and gloves

Wear respiratory protection e.g., self contained breathing apparatus (SCBA) or air purifying respirator (APR)

Put on communication equipment and wear dosimetry as available

Dressing Down from Bunker Gear
Wipe feet at the entrance and step into the decontamination corridor

Decontamination workers will dressdown the responder by doing the following:

Remove the responder's firefighting gloves and place in waste collection container

Decontamination worker changes gloves

Put medical exam gloves on responder's hands and have them step forward

Remove the helmet and hood and place in the waste container. Responder steps forward

Remove the responder's SCBA harness/ backplate. Responder steps forward

DO NOT REMOVE FACEPIECE OR TURN OFF AIR SUPPLY - MAINTAIN RESPIRATORY PROTECTION

Remove the firefighting coat and place in the waste container. Responder steps forward

Pull the pants down to the top of the boots. Have the responder step forward while stepping out of their firefighting boots.

Decontamination worker changes gloves

As available, put temporary footwear (shoe covers, sandals, etc.) on the responder, then place boots/pants in the waste container

Have responder remove their facepiece and hand it to the decontamination worker. Responder steps forward

Remove responder's final pair of medical exam gloves and conduct final contamination survey

Decontamination workers will conduct a self-decontamination using the steps above

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Transportation Emergency Preparedness Program
Disposable Coverall Decontamination Corridor Set Up, Dress Up, and Dressdown Job Aid

Decontamination Corridor Set Up
Select a location that is uphill, upwind, and upstream from the incident scene

Prior to setting up the decontamination corridor, survey the selected location to verify that the area is free of radioactive contamination and that radiation levels are at or near natural background levels

Dressing Up in Disposable Coveralls
Select the type of disposable protective clothing to be worn by entry team members

Put on at least two pair of medical exam gloves. Alternate colors if possible

Step into the selected disposable coveralls

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. Put on an outer pair of ings, if available. If glove ble, make sure to e enough so as l of coveralls ached

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Dressing Down from Disposable Coveralls
Wipe feet at the entrance to the decontamination corridor and step into the bag designated for stand-in-place dressdown

Decontamination workers will dressdown the responder by doing the following:

Remove head protection, communication equipment, and dosimetry; place in the appropriate collection container

If wearing an SCBA, remove backplate and ensure responder remains on air

Remove tape from the hood and zipper. Place tape waste into appropriate waste container

Remove the hood off the responder's head

Unzip the responder's disposable coverall

Grasp the fingertips and have the responder free their hands from the outer gloves

Decontamination worker changes gloves

Gently pull the coveralls off the responders shoulders, down their back all the way to the top of their boots

Have responder step out of their boots and bag and into available footwear

Decontamination worker will roll up or bag waste and place in container

Decontamination worker changes gloves

Responder will:

Remove one pair of gloves and place in appropriate waste container

Remove SCBA facepiece or APR and then remove remaining gloves

Report to final contamination survey area

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EQUIPMENT DECONTAMINATION

Equipment decontamination involves removing radiological contamination from equipment. Not all equipment can be decontaminated (e.g., straps, porous material, equipment with inaccessible areas). Some pre planning before taking material into the hot zone can help prevent equipment from becoming contaminated. For example, equipment can be placed in a clear poly bag before being taken into the contaminated area. Upon exit from the area, the contaminated bag can be removed and disposed of.

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If equipment needs to be decontaminated, consider the following methods:

- Critical hand-held equipment - Trained personnel can attempt to decontaminate equipment by wiping it down with a damp, absorbent cloth
- Critical heavy equipment - Trained personnel can attempt decontamination using a non-abrasive wash solution

All solid and liquid waste generated during decontamination will need to be controlled, properly packaged, and stored for eventual disposal in accordance with applicable regulations.

As discussed above, the U.S. Army Guidelines are one resource for responders to use when selecting a radiological decontamination method. Others resources include the U.S. Department of Health and Human Services Radiation Event Medical Management web site (https://remm.hhs.gov), the Centers for Disease Control, and various publications from the National Council on Radiation Protection and Measurements, just to name a few.

Realize that there usually is no one perfect solution to decontamination that will account for every possible variable. The important thing to remember is to choose a decontamination method most appropriate for the highest hazard and risk to victims and responders present at the scene.

DRESSDOWN CORRIDOR OPERATIONS AND WASTE DISPOSAL

Waste disposal can be a problem at any hazardous material scene. For a radiological incident, processes should be put in place as soon as possible to ensure all radioactive waste is contained.

- Have plastic-lined waste containers at the entry/exit of the decontamination corridor for disposing of potentially contaminated material. These containers are often the same as for other hazardous material contaminated wastes.

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- Seal the tops of full plastic bags and place them in a holding area inside the hot zone. Ensure that containers are clearly identified as "radioactive" and are properly stored for disposal later.
- Ensure that the area is monitored periodically because, as waste material accumulates, increased radiation dose rates are possible.
- Let properly trained personnel (state Radiation Authority, hazardous material response team, and contractors) survey waste material for contamination. Contaminated waste will need to be disposed of in accordance with applicable regulations.

Other Considerations

Prior to making decisions about disposing of any material as waste, or taking the time to decontaminate material and equipment, take a moment to consider all options.

Once the emergency phase has been completed, consider decontamination vs. disposal when making decisions about protective clothing that will be worn during additional entries. For example, use of inexpensive disposable coveralls instead of turnout gear may be preferred. Under most conditions, disposable coveralls will provide adequate protection against radioactive material contamination.

Many radioactive materials have very short half-lives. Commonly shipped medical and research isotopes have half-lives of hours or days. Short-lived material can be sealed in a container to await decay of the material to a stable or non-radioactive state.

When using large quantities of water for decontamination, remember that the water has to be handled as radioactive material. Contaminated water can be difficult to deal with and expensive to process.

Also, avoid generating unnecessary waste. Use only the material needed to complete a safe and effective response.

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DISPOSAL AND DOCUMENTATION RESPONSIBILITIES

Once the emergency response phase of the incident is over, the focus will switch to cleanup and disposal of radioactive waste. The carrier is responsible for costs associated with scene cleanup and the disposal of radioactive material/waste. Carriers of radioactive material are required to provide financial protection to the public in the unlikely event of an incident involving radioactive material. The required amount of liability coverage for carriers of radioactive material varies according to the mode of transport (road, rail, waterway, or air) and the type and quantity of radioactive material being shipped. If the damages from a transportation-related accident (radiological) exceed the amount of the carrier's private insurance coverage, umbrella coverage is provided under the Price-Anderson Act.

Event documentation and reporting is an important step in recovering costs associated with a transportation incident involving hazardous material. Time, resources, and property damage must be recorded for payment. Documentation will be the legal evidence necessary in the future. Your documentation must include: who, what, when, where, how, and why.

Check Your Understanding

1. Radioactive material can take the form of a _____, _____, or _____.

2. List two reasons for performing radiological decontamination.
   _____
   _____

3. Identify the four recommended decontamination stations or processing steps.
   _____
   _____
   _____
   _____

4. Personnel _____ is usually accomplished using mild soap and lukewarm water.

5. Which of the following statements is true regarding equipment decontamination?
   a. Contaminated equipment should be hosed off immediately
   b. Contaminated equipment should not be taken into the hot zone
   c. Equipment that is contaminated should be disposed of as radioactive waste
   d. Not all equipment can be decontaminated

6. For decontamination operations, a _____ _____ is usually established inside the warm zone, running between the hot zone and cold zone.

7. The _____ is responsible for costs associated with scene cleanup and the disposal of radioactive material/waste.

8. Event _____ and reporting is an important step in recovering costs associated with a transportation incident involving hazardous material.

ANSWERS

1. solid
   liquid
   gas
2. See page 5
3. See page 7
4. decontamination
5. d
6. decontamination
   corridor
7. carrier
8. documentation