The Medical Examiner/Coroner's Guide For Contaminated Deceased Body Management

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Preface

In the past few years, a number of publications and other resources have appeared concerning the management of mass fatality incidents. Some are geared toward the general management of incidents while others cover more specific topics such as decontamination procedures. Still others cover selected agents including chemical, biological, or radiological ones. Few publications have been written specifically for medical examiners and coroners.

The Medical Examiner and Coroner's Guide for Contaminated Deceased Body Management is written specifically for the medical examiner or coroner who will be in charge of investigations of fatalities that result from terrorism or other events that result in contaminated remains. In some such cases, agents may be used that will require mitigation of environmental hazards and decontamination of human bodies. To that end, this *Guide* provides information and suggestions that may be useful in understanding the principles involved in decontamination procedures, recognizing that it may not be the medical examiner or coroner staff who actually conducts decontamination procedures.

The suggestions in this guide may differ slightly from those in other publications. However, those who have contributed to this guide believe that the recommendations are practical, workable, have a scientific basis, and do not differ much in substance when compared with other relevant publications.

 Reference to specific commercial products is for informational purposes only and does not constitute endorsement of the product or company which produces the product.

The recommendations contained in this Guide are not mandated nor are they required by federal, state, or local law. Rather, the recommendations are intended to assist medical examiners and coroners for the purposes of planning and providing a set of reasonable practice guidelines for incident response.

Acknowledgements

The authors of this Guide wish to thank the authors, contributors, and organizations who have produced the following publications and materials:

- *Guidelines for Mass fatality Management During Terrorist Incidents Involving Chemical Agents*. Produced by the U.S. Army Soldier and Biological Chemical Command (SBCCOM). November, 2001. Available in 2006 at: http://www.mipt.org/pdf/guidemassfatalitymgmt.pdf
- *Medical Examiner/Coroner Guide for Mass Fatality Management of Chemically Contaminated Remains.* Prepared by the Department of Justice, Office of Justice Programs, Office of State and Local Domestic Preparedness, and the Department of Defense, US Army Soldier and Biological Chemical Command, Improved Response Program. Available in 2006 at: http://www.kyha.com/documents/CoronerGuide.pdf
- *Model Procedure for Medical Examiner/Coroner on the Handling of a Body/Human Remains that are Potentially Radiologically Contaminated.* Prepared by the Transportation Emergency Preparedness Program. Available in 2006 at http://web.em.doe.gov/otem/Medical_Examiner_Coroner.pdf
- Department of Defense (DOD) Armed Forces Epidemiological Board (AFEB) Memorandum. *Disposition of Contaminated Remains-2003-06*. 14 January 2003.
- Department of Defense. *Joint Procedures for Decontamination and Disposition of Human Remains in Operation Desert Storm*. April 25, 1991.
- Fowler D, Nolte KB. Biologic and Chemical terrorism: Surveillance and Response. In, *Handbook of Forensic Pathology (Chapter 35).* College of American Pathologists, Northfield, Illinois. 2003.
- CAPSTONE DOCUMENT: *Mass Fatality Management for Incidents Involving Weapons of Mass Destruction*. Second Draft. July 2003. U.S. Army Soldier and Biological Chemical Command (SBCCOM) and Department of Justice, Office of Justice Programs, Office for Domestic Preparedness.

This *Guide* is heavily based on the references cited above and, within this Guide, these helpful resources are not repetitively referenced. Additional references are cited in standard reference format.

We also wish to thank those at the Centers for Disease Control and Prevention who provided suggestions for this guide at various points during its preparation:
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Introduction

In the event of a terrorist attack or unintentional event with fatalities involving biological, chemical or radiological (BCR) agents, decontamination procedures may be required that can be complex and require the expertise of fully trained and qualified responders such as hazardous materials (HazMat) technicians. The medical examiner/coroner (ME/C) will certainly be involved in the investigation and certification of such deaths because deaths resulting from intentional acts may be considered as homicides and those involving unintentional injury also fall under the ME/C's jurisdiction. Because of a lack of or inadequately trained ME/C personnel, the ME/C and his/her staff may not be directly involved in decontamination or other pre-morgue procedures. However, the ME/C should at least be familiar with decontamination procedures because they may impact on evidence collection and/or the temporal sequence of death investigation conducted by the ME/C.

This Guide was developed to provide information for ME/Cs and is based on a review of established procedures, scientific literature, and current thinking about fatality incidents in which decontamination procedures may be required. It is virtually impossible for pre-planning or guidelines to address all possible scenarios and contingencies. This Guide, however, provides a core set of suggestions that may need to be modified or supplemented as dictated by the specific circumstances of a given incident.

An attempt has been made to identify core topics that need to be considered when decontamination procedures are needed. These include:

- Definitions
- Potential Agents
- Incident Command
- Personal Protective Equipment
- Communication
- Initial Scene Assessment
- The Hot Zone, Warm Zone, Dismount Area, and Cold Zone
- Numbering Systems
- Basics of Decontamination Procedures
- The Decontamination Site
- General Processing Procedures
- Transport Between Zones
- Body Storage
- The Morgue-Autopsy Area
- Post-Examination Processing and Storage
- Removal and Disposition of Hazardous Materials
- Radioactivity Issues
- Other Considerations
- Demonstrative Photographs

In this Guide, discussion of topics is arranged in the general order shown above.

Definitions

- *Agent.* The chemical, biological, or radiological entity(ies) used in a terrorist attack or involved in an untoward unintentional event causing death.
- *Decontamination.* The process of removing or chemically degrading an agent on the body surface to a level that poses little or no risk to others in proximity to that surface (1).
- *Hot Zone*. The area contaminated by the agent (2) and/or immediately surrounding such an area and extending far enough to prevent the agent from being released to personnel outside the zone. This zone is also referred to as exclusion zone, red zone, or restricted zone (US DOT, 2000 North American Emergency Response Guidebook). Access is limited and controlled.
- *Warm Zone*. The area surrounding the Hot Zone which may include areas used for decontamination, in which hazards are expected to be controlled and/or mitigated. Access is limited and controlled.
- *Cold Zone*. Any area outside of the Hot and Warm Zones in which bodily or other processing is carried out but hazards have been controlled or abated, eliminating or significantly reducing risks to workers. Access to the Cold Zone is also controlled and limited to authorized personnel.

The ME/C will, at a minimum, need to communicate with those working in the Hot Zone and Warm Zone to ensure that evidence and information of importance to the ME/C is preserved and documented. It may be helpful for at least two ME/C personnel to be HazMat-trained in the donning of various types of personal protective equipment (see below) in case entry into the Hot or Warm Zone is required, although HazMat training can be time-consuming . Medical examiners and coroners will, almost certainly, be involved in the Cold Zone where postmortem examinations are likely to be performed.

Potential Agents

The Centers for Disease Control and Prevention has developed a list of critical chemical and biologic agents that may be used by terrorists (3).

<u>Chemical agents</u>

- **Nerve agents:** Tabun, Sarin, Somon, GF, and VX
- **Blood agents:** Hydrogen cyanide and cyanogens chloride
- **Blister agents:** Lewisite, nitrogen and sulfur mustards, and phosgene oxime
- **Heavy metals:** Arsenic, lead, mercury
- **Volatile toxins:** Benzene, chloroform, trihalomethanes
- **Pulmonary agents**: Phosgene, chlorine, vinyl chloride
- **Incapacitating agents**: BZ (3-quinuclidinyl benzilate), pesticides, dioxins, furans, PCBs
- **Explosives**: Ammonium nitrate combined with fuel oil
- **Flammable gases and liquids**: Gasoline, propane
- **Poisonous industrial gases, liquids, solids**: Cyanides, nitriles
- **Corrosive industrial acids and bases**: Nitric acid, sulfuric acid

Biologic Agents:

- **Category A (High-level risk**): Smallpox, anthrax, plague, botulism, tularemia, Filoviruses such as Ebola and Marburg causing hemorrhagic fevers, and Arenaviruses such as Lassa and Junin causing hemorrhagic fevers
- **Category B:** Q Fever, brucellosis, glanders, alphaviruses causing encephalitis, ricin toxin, epsilon toxin from *Clostridim perfringes*, *Staphylococcus* enterotoxin B, *Salmonella* species, *Shigella dysenteria*, *E Coli* O157:H7, *Vibrio cholerae*, and *Cryptosporidium parvum*
- **Category C:** NipahVirus, Hantavruses, Tickborne hemorrhagic fever and encephalitis viruses, Yellow Fever virus, multidrug-resistant TB.

Although chemical agents are more likely than biological agents to require decontamination procedures, some biologic agents also may require such procedures. Biologic agents that involve spores (such as anthrax), external lesions (such as smallpox), or infected secretions are some examples. Radiologic agents may also be used in terrorist attacks. The most important in terms of decontamination is the so-called "dirty bomb" in which radioactive residue may exist on bodily surfaces and clothing and may be amenable to removal using decontamination procedures.

Incident Command

Most likely, the incident will be managed using the Incident Command System (ICS) with a structured hierarchy of leaders who report to a single Incident Commander (2). This structure, and the specific personnel in each responsible leadership position, need to be clearly defined before response is initiated. In advance of any event, the ME/C should contact local emergency response agencies to determine who would probably serve as the Incident Commander in the case of an incident, to identify persons who would need to be contacted during response, and to determine how the ME/C will fit into the ICS response. It will probably be the Incident Commander who, in conjunction with needed consultants, will determine the level of protective gear and other precautions required, and who will enter and have access to the Hot Zone and other zones.

Personal Protective Equipment

Initially, until the need for lesser protection is established, it must be assumed that the highest caliber of personal protective gear needs to be worn in the Hot Zone. This should include:

- A full body suit that is resistant to chemicals and biological agents.
- Self-contained breathing units, then, as indicated by identification of specific suspect agents and degree of exposure in the Warm and Cold Zones, cartridge respirators with HEPA and/or charcoal filtration or lesser forms of respiratory protection as indicated (based on circumstances and the agent involved). Such phasing would be determined by the Incident Commander in consultation with appropriate experts.

In any case, even with low risk, the minimum protective equipment should include

- A full body suit that can be removed at the site
- Gloves, appropriate respirators (masks), and face shields or eye cover as dictated by the suspected agent. A full face mask will protect against inhalation of radioactive dust.

After decontamination is accomplished (see below), routine personal protective equipment should suffice for most agents (assuming that decontamination has been effective).

Level A PPE utilizes a self-contained breathing apparatus, a fully encapsulating chemical resistant suit, and inner chemical/biological resistant hand covers and boots or shoes.

Level B PPE utilizes a single or 2-piece chemical suit that need not be fully encapsulating, and also employs a self contained breathing apparatus. This gear is similar to standard fire-fighting gear.

It is doubtful that many medical examiner or coroner personnel will be trained in the use of Level A or B equipment, although offices with larger staffs may be able to accomplish this via specific in-house training or training through working with other groups such as HazMat or weapons of mass destruction (WMD) preparation.

Level C PPE utilizes a full-face air-purifying canister-equipped respirator, full body chemical-resistant suit, inner and outer chemical resistant gloves, and resistant boots/shoes. Level C includes not only the full-face air-purifying canister-equipped respirators but also powered air-purifying respirators (PAPRs). The PAPRs operate and deliver filtered air under positive pressure and the non-powered air purifying respirators (NAPRs) depend on the efforts of the wearer and operate under negative pressure. The filters used are variable and the correct filters are needed to filter particulate matter, chemicals, organic vapors, or gases.

Level D PPE utilizes simple overgarments, preferably water-resistant, to provide a physical barrier to cover the skin and clothing.

It is imperative that personnel entering contaminated areas be fully trained in the proper use of personal protective equipment, and such personnel will usually consist of fully qualified HazMat technicians. Additionally, it may be helpful for at least two people from the ME/C's office to be trained in the donning and use of Level A and B PPE (all ME/Cs should be familiar with Level C which is the standard for airborne pathogens) to enable ME/C personnel to enter the Hot or Warm Zone, as needed for their purposes. As an alternative, HazMat personnel, through mutual agreement with the ME/C, may perform necessary duties on-scene at the direction of the ME/C. Whomever performs these duties, the persons would alternate, as needed to allow for needed rest and equipment changes. In most cases where ME/C personnel would be needed, Level B or Level C PPE will suffice. Level C will be adequate in most cases where decontamination or autopsy procedures are performed.

Level A and B PPE can be hot to wear and sight can be restricted. This is even more true for some Level C equipment such as PAPRs which can also impose problems with communication because of inability to hear or communicate with electronic devices such as radios. The air supply may last less than an hour. For these reasons, aside from any ME/C personnel, multiple teams of workers trained in the use of PPE need to be available (and a "suited up" backup team needs to be ready) to replace workers whose air supply is exhausted, or who are prone to being overcome by heat, or who may need emergency care due to injury or unforeseen complications (2). A "buddy system" of workers should be used.

Level C respirator cartridges last about three hours before replacement is needed. Of the various Levels of PPE, Level C is the least expensive to purchase and easiest to maintain, learn how to use, and don (2).

Communication

All operational sites should include direct communication lines that are not subject to unwanted monitoring and the failures typical of radio and cell phone systems (4). Use of the latter two systems is acceptable but should not be relied upon without direct communication lines also in place. This may require the running of telephone or other hard wire or cable types.

Initial Scene Assessment

Its is recommended that the initial assessment team at the scene include a:

- Trained HazMat Technician
- Medical Examiner/Coroner or investigator
- Law Enforcement evidence technician

The FBI has HazMat technicians who may respond to the scene, but they may not be immediately available. Usually, the fire department which serves the scene area— along with its associated HazMat team— will have (or can obtain) the necessary equipment, technology, and personnel to assess the scene for chemical and radiological hazards. Such equipment usually consists of:

- Geiger counter or similar field devices capable of detecting gamma and beta radiation at levels as low as 1 millirem/hour. 1mrem/hr detection sensitivity is adequate for personal safety assessment, but more sensitive equipment may be needed to detect contamination above normal background of .01/mrem/hr.
- Chemical detection units that can sample air
- Chemical detection units into which chemical detection tickets (which can be touched to potentially contaminated surfaces) can be placed for chemical analysis – much like the detection units used at airports for detection of explosive residues.

HazMat team members may not be familiar with the needs and usual practices of the ME/C. Discussion of HazMat and ME/C needs and roles should occur through advance planning prior to any event. Reiteration of these needs and roles should occur at the

incident site before scene processing so that HazMat operations do not interfere with the needs of the medical examiner or coroner, and to ensure that HazMat personnel may be able to collect evidence on behalf of the ME/C, if needed, especially if ME/C personnel lack appropriate PPE and Hazmat training.

It is unlikely that a biological toxin or agent will first be detected at a scene where there are multiple deceased. Events involving biologicals will probably be detected based on the sequence and timing of events, common "syndromes," tests performed on victims who become ill and have time to seek medical care, and autopsy findings. There is currently no "quick and dirty" way to quickly screen for a broad scope of biological agents or toxins at the scene, although such methods are being developed.

Sensitivity/Specificity. Modern equipment is sensitive enough to detect most predictable chemical and radiological hazards. The methods, sensitivity, and specificity for detection of biological agents at scenes have not been established.

Critical levels. There are established and published criteria for various chemicals and other agents and the parts per million or millirems that impose risks over an 8-hour exposure. This information should be used when assessing whether special decontamination procedures will be needed and whether processed bodies have been rendered "safe." The characteristics and risks of biological agents have been recently published in a Guide Book for Medical Examiners and Coroners (5), and additional information is available on the SBCCOM website at http://www.mipt.org/Source.asp?id=95

Evidence. In the event that a BCR agent is used, there will probably be enough evidence at the scene, in historical and circumstantial information, on clothing, and on or within the body (biologic organisms or toxins) that decontamination procedures will not significantly interfere with the collection of evidence needed by the ME/C to determine the cause, manner, and circumstances of death. However, if there is a need for the medical examiner/coroner to collect evidence at the scene (such as swabs of residue on the skin), such evidence should be placed in glass containers—especially if a chemical agent is suspected—because some chemical agents can interact with plastic. If glass containers are used, they should be packaged in a secondary container (such as a metal tube) that will prevent breakage of the glass and allow for decontamination of the container. Evidence labels and all tags used for bodies, bags, and personal effects must be of a type that will not deteriorate or become illegible when subject to soap, water, bleach, or other chemicals. Embossed metal tags (or bracelets for bodies) may be required.

> *Key Point: Work with the HazMat team to secure needed equipment and personnel to detect the type of hazard(s) that may exist at the scene, to determine whether decontamination procedures will be needed and, if needed, which type of procedures will be required.*

In the Hot Zone

Some general procedures for the Hot Zone area include the following:

- If ME/C personnel cannot enter the Hot Zone, HazMat personnel could prepare videotape of the scene area so death investigators can review it at another site.
- The area needs to be documented and photographed (or imaged) and mapped with GPS or other system before manipulation or movement so relative positions of bodies, parts and objects can be re-created
- Waterproof and chemical-resistant numbering tags or bracelets need to be placed on bodies, parts, and containers
- Loose items need to be collected and tagged so they are not lost during transport
- Loose clothing and other non-human items can be collected in labeled, sealed containers such as paint cans which are not easily broken, are easily cleaned, and which will contain and preserve "volatile" substances.
- An open wire mesh body litter can be used to bring bodies and other parts or items to an accessible point(s) at the edge of the Hot Zone so they may be prepared for transport to the Dismount or Decontamination area (see below)

In the Hot Zone, the use of durable equipment should be minimized in favor of disposable alternatives. Information should be collected in a manner that avoids the use of paper documents at the work site and does not require person to person contact. Equipment and supplies in the Hot Zone should include:

- Appropriate personal protective equipment, donned in a clean and secure area with controlled access
- Tags to label bodies, other items, and containers
- Communication devices to relay documentary information without the use of paper documents at the incident site
- GPS instruments to record the location of bodies and other items
- Digital cameras that, preferably, can transmit images to a nearby operations center
- Transport vehicles to transfer bodies and workers, if needed, to the edge of the Hot Zone or beyond

The Dismount Area

The Dismount Area is where bodies (and clothing) are taken when removed from the Hot Zone or Hot Zone Margin for temporary holding or storage until decontamination procedures can occur (6). The Dismount area should be:

- Located upwind from the incident site and close to decontamination area
- Out of common view (e.g., behind temporary barriers)
- Accessible via land transport vehicle, if possible
- Equipped with lifts to assist with body movement
- Cool, if possible, but not necessarily refrigerated unless lengthy delays are expected prior to decontamination. Refrigeration may be required, however, and may also provide a place to store bodies out of public view.
- Covered (tent-like roof)
- Protected against scavengers, vermin, and insects

Hot Zone Margin and Dismount Area
A decision will need to be made whether the Hot Zone Margin and Dismount Area (see above) will be at one location or in different locations. The decision will be made on the basis of the suspected agent and to some extent, geography and the setting.

At the Hot Zone Margin or Dismount Area, the following need to be available:

- Body bags (one for each body), humans remains pouches (if bodies are fragmented), and sealable containers such as paint cans for clothing and other smaller items
- Tags to label bodies, other items, and containers
- Transport vehicles to transfer bodies (and workers as needed) and items to the Dismount Area or decontamination area.

Clothing should be removed, containerized, and labeled at the site serving as the Dismount Area. Jewelry and watches securely fixed to the body may be left in place. Bodies should be placed in labeled body bags. Body bags should not contain vinyl which is subject to degradation by certain chemical agents.

Wallets and other identifying paperwork in the clothing should remain with the clothing for processing at the decontamination site. It may be useful to process apparently identifiable bodies as one group and those that cannot be readily identified as another.

Numbering System

A useful and simple numbering system is to label items with the initials of the recovery person followed by a number, with each new body or part being numbered sequentially (RLH-1, RLH-2, etc). **The numbers on the tags on bodies, body bags, and the clothing clearly associated with that body or body part should all be the same**. This system avoids having to coordinate numbers with other personnel, so long as it is assured that no two recovery personnel have the same initials. In a large scale event with many recovery personnel, other numbering systems may be needed. If clothing is to be kept and not discarded after initial processing, it should be decontaminated before being transferred from the decontamination area.

Basics of Decontamination (Derived from SBCCOM publications)

Decontamination consists of rinsing, washing, or immersing the body (or clothing or other items) to remove adherent substances and provide some bactericidal action. Basically, decontamination either removes, neutralizes, or degrades the offending agent. In almost all instances, a 1% to 2% bleach (hypochlorite) solution is more than adequate to remove, hydrolyze, or neutralize the offending agent.

Decontamination of clothing and other items should be considered after forensic investigation requirements have been met. If decontamination of such items poses additional risks to personnel, it may be best to seal items in containers—after adequate

documentation and forensic analysis—for disposal. In many instances, simple removal of the clothing (after photography) will eliminate most or all contaminants.

Decontamination may be accomplished by:

- Removal of clothing
- Manually washing and rinsing (probably best)
- Spraying with a soft spray that minimizes spatter and aerosolization
- Submersing the body or items in a tank, pit, or trench (the "soak" method)

Spraying alone does not guarantee decontamination, especially if remains are heavily soiled with greasy, organic, or proteinaceous materials such as blood clots. Mechanical cleaning such as brushing with soap solution is essential prior to applying bleach or other decontamination agents. The time required for the soak method to be effective may be prohibitively long, and manual scrubbing would still be needed. Thus, the best method is probably one which includes manual washing and scrubbing with detergents followed by cleaning with bleach/hypochlorite.

Household bleach solutions usually contain 5% hypochlorite. This strength of bleach may pose respiratory risks and poses other risks for living persons. For most decontamination procedures involving dead bodies, 5% household bleach diluted 1 part bleach to 3 parts water will be adequate in providing a final concentration of 1-2%. .

The decontamination solution should be allowed to remain in contact with the body or object for a minimum of 5 minutes and preferably 15 minutes. The body or object should then be rinsed thoroughly with water.

.After a decontaminated body is placed in a container such as a body bag, the outside of the container should be decontaminated by washing or spraying. Duct tape may be used to seal the zipper area, if needed to prevent leakage.

If bodies need to be physically scrubbed, soft sponges or brushes should be used. Nylon products should be avoided because bleach solution will damage them.

If bodies are to be submersed, a tank or constructed pit (lined with a bleach-resistant material) large enough to fully submerse a body will be needed. Other items that may be required are:

- Ropes (non-nylon) to assist with raising and lowering of the body into the tank or pit
- A platform or basket on which to place the body while it is being submersed. This platform or basket needs to be of neutral or negative buoyancy so submersion of the body is facilitated
- Weights to assist in submersion of the body and to keep the body submersed
- If bodies are soft or decomposed, a small-gauge mesh container into which the body may be placed for submersion to avoid disarticulation, dismemberment, or sloughing and loss of soft tissue

- Chlorine monitor to ensure that spray, tank or pit fluid maintains a chlorine level equivalent to a 1-2% bleach solution.

In most instances, clothing will have been previously removed from bodies at the Hot Zone Margin or Dismount Area (after necessary documentation, tagging, and photographing). The clothing will then need to be decontaminated separately from the body, unless a decision is made to destroy clothing without decontamination. Separate decontamination procedures for clothing accomplishes several things:

- The unclothed body will be easier to decontaminate
- Initial manipulation of the clothing (which will probably have the highest extent of contamination because it covered the body) is done nearer to the Hot Zone which is already contaminated
- The packaged clothing will be easier to process and decontaminate under controlled circumstances
- The clothing and bodies may be sent to separate facilities for processing and documentation
- Personal effects may be more readily examined for identification purposes

Mild detergent/soap should be used to clean remains prior to decontamination- especially when chemical agents are involved-- because the soap may help dissolve or remove oily residues.

Basically, decontamination involves washing of bodies, clothing, and the exterior of their containers with bleach solution—nominally 1 to 2%—although lower concentrations will probably be as effective against most agents. A major component of decontamination is the washing and removal of agent-containing residue, independent of the actions of the bleach. The body is rinsed with water after the bleach solution has been in contact with the body for at least 5 minutes, and preferably 15 minutes.

Commercial household bleach usually contains about 5.25% hypochlorite. A 0.5% hypochlorite solution is the concentration of bleach often used for cleaning floors and equipment, although higher concentrations are acceptable. If <u>living</u> persons need to be decontaminated, initial cleaning should be done with soap and water. If bleach solution is then used on a living person, its concentration should not exceed 0.5% hypochlorite, and lower concentrations can be effective.

The physical movement of bodies through the decontamination area may be accomplished in a variety of ways, including the use of back boards, mesh litters, plywood on saw horses, commercial roller systems like those used to move boxes, or any practical method that allows serial movement of the body and exposure of all body surfaces. In some locations, it may be possible to use a longitudinal, water-filled culvert or ditch though which the body may pass while the water/soap/bleach solution is progressively diluted with water along the way to accomplish the rinse. However, maintaining proper concentrations may be difficult.

It is imperative that decontamination procedures be performed by those with appropriate training and protective equipment. Usually, this will involve HazMat technicians trained in decontamination procedures.

The Decontamination Site

The decontamination site is where decontamination procedures are carried out. The site selected for decontamination should, if possible, have the following characteristics:

- A safe distance from the Dismount Area, and upwind from it, if possible
- Far enough from the incident site that the Dismount Area may be placed between the Hot Zone margin and decontamination site
- Ready access to fresh water supply or water transport vehicles
- Reasonably accessible via ground transport
- Large enough and flat enough to accommodate large tents or tent-like roofs
- Have a sloped area of 1:12 minimum slope to allow for water runoff
- Have ground cover or artificial cover or turf that can serve as a sump to absorb water and control its runoff, and to avoid soiling of bodies with dirt and other ground debris
- Enable the placement of ditches, drains, ponds or pools to control and direct water runoff
- Be close to electrical or fuel supplies (if generated power needs to be provided)

Minimum equipment and supplies at the decontamination site include:

- Bleach and fresh water (water from natural sources such as streams, rivers, and lakes may be used)
- Soft sponges and brushes made of non-nylon materials
- Pumps, hoses, and other devices capable of pumping bleach solution at the rate of normal water pressure (20 to 90 psi), and pumps capable of collecting runoff at a rate greater than or equal to water inflow rate
- Drums to mix solutions and hold collected runoff (if tank trucks are not available on site to collect runoff as it occurs)
- Spray units to spray bodies with bleach solution if submersion is not required
- Tanks or pits large enough to submerse a body or clothing in bleach solution
- Personal protective equipment as dictated by the suspected agent(s)
- Clean body bags (2 for each body)
- Clean, sealable containers to hold clothing
- Tags for marking bodies and clothing with identification numbers
- Decontamination showers (soap and water for personnel after removal of protective equipment) and areas for workers
- Receptacles for discarded body bags, protective wear, and other items that can be transported and incinerated or otherwise disposed of as hazardous waste
- Chlorine monitor to ensure adequate bleach/chlorine concentration
- Clean and climate-controlled operations center with restroom facilities, showers, and changing area. This are should be separated from areas where disinfectants

are sprayed and should be well-ventilated to ensure that unprotected personnel are not exposed to respiratory or other hazards.
- Chemical detection unit (or Geiger Counter) to verify that decontamination was effective
- A station at which transport vehicle cargo areas may be decontaminated

The decontamination area may be structured as three separate zones including red, yellow, and green. Contaminated bodies are in the red zone. Photographs can be taken here as bodies are received. The clothing can then be removed and additional photographs can then be taken before the body is moved. Having one photographer and one contaminated camera may be advisable. The body is then moved to the yellow zone where decontamination is performed using solutions and techniques that are suitable for the agent involved. After decontamination, chemical activity monitors or Geiger counters, depending on the incident, can be used to test the effectiveness of decontamination as bodies are prepared for transport to the green zone. If additional decontamination is needed, this is conducted in the yellow zone. Once a body arrives in the green zone, in can then be double bagged or otherwise sealed for transport to the morgue facility.

The use of tanks and soaking may pose problems. There are possible splash risks and cross contamination. Further, maintaining the needed concentration of hypochlorite may be difficult.

Following decontamination, bodies and clothing are rinsed with water and should be double-bagged. The exterior of each bag should be decontaminated on all surfaces.

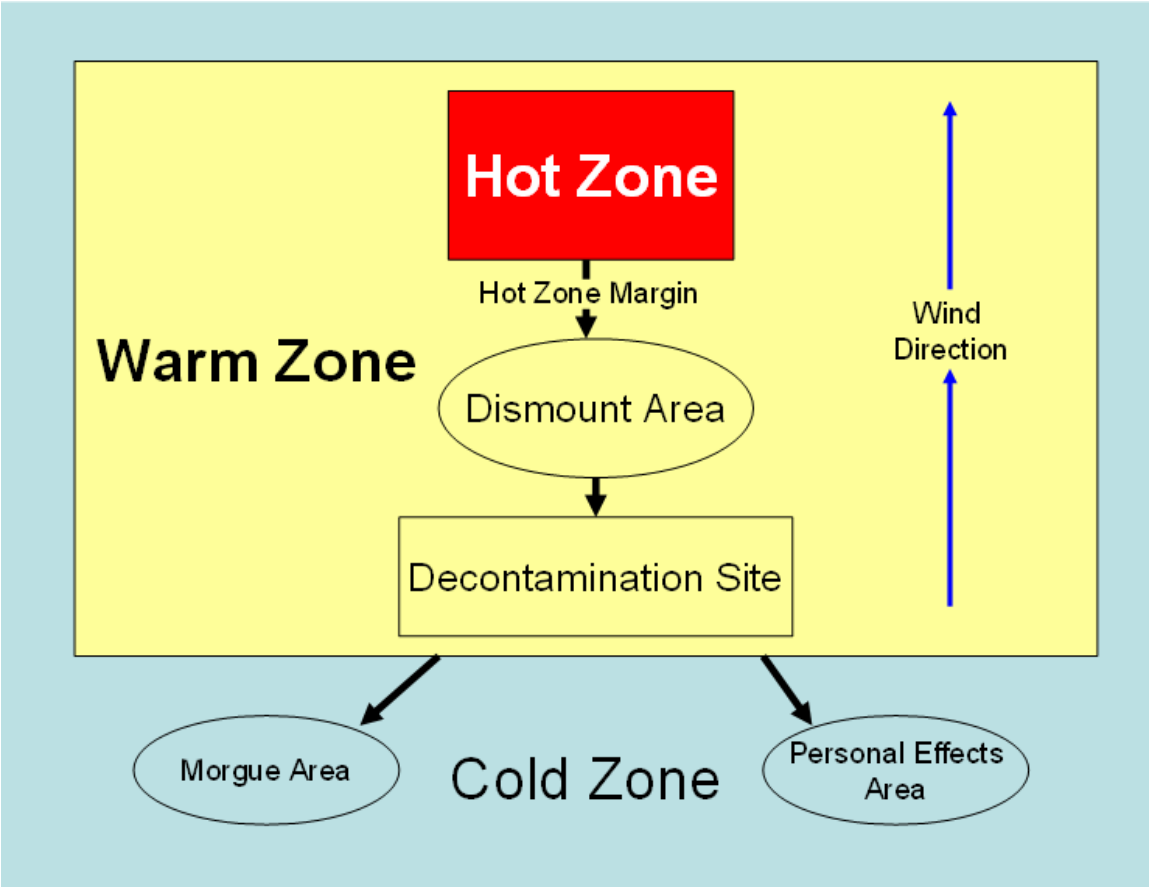
The PPE worn by workers in the decontamination area also need to be decontaminated. Special showers, solutions, and brushes are needed for the workers as they exit the decontamination area, where they can shower in their garb (perhaps with assistance from others in contaminated PPE), and then remove their PPE once decontaminated.

Summary of General Processing Flow

When decontamination is required, various processing areas need to be defined and strategically located. In addition to the Hot Zone, the following areas need to be established:
- Hot Zone Margin
- Warm Zone
    - Dismount Area (where bodies are taken from the incident site in preparation for decontamination)
    - Decontamination Site (where bodies and clothing are actually decontaminated)
- Cold Zone Areas to include morgue and personal effects areas
- Morgue area (where bodies are taken for examination after decontamination)
- Personal Effects/Clothing Area (where clothing is taken for processing after decontamination. This may or may not be the same area as the morgue.)

Waste handling, including effluent from washing stations, and waste incineration or waste packaging for removal to off-site incineration also need to be considered when planning site operations and layout.

Schematically, the workflow may be depicted as:



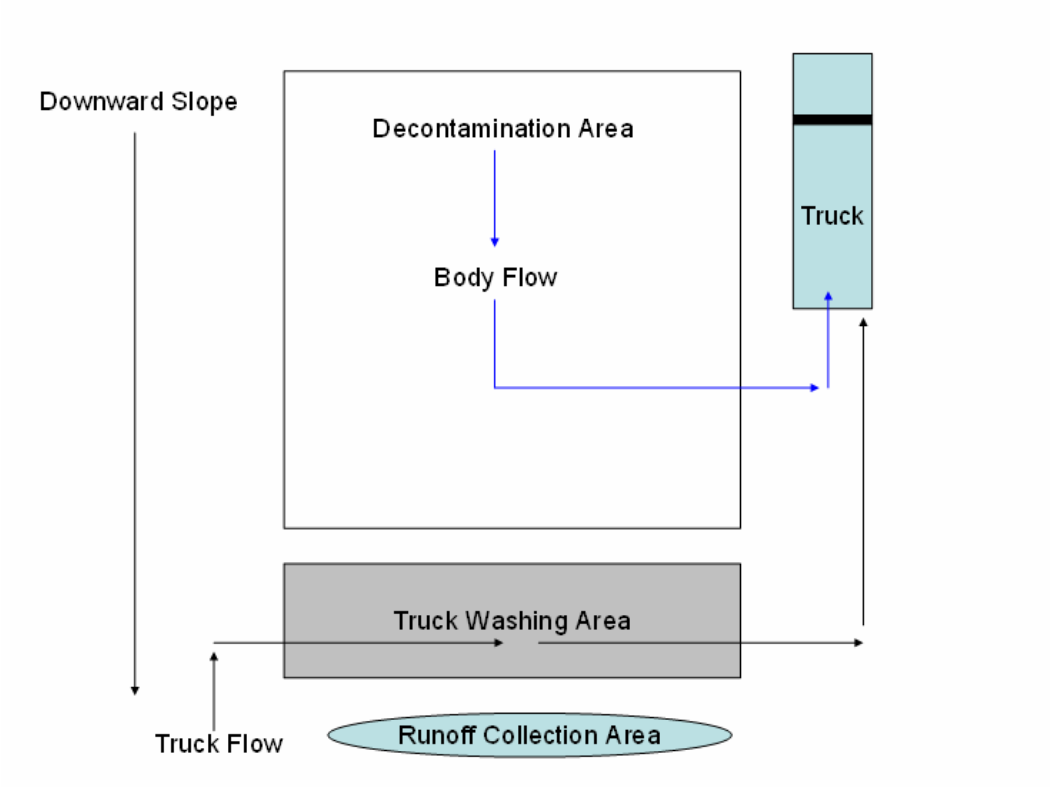
The distance between, and the specific locations of these areas depends on many factors including, but not limited to:

- Terrain
- Available facilities, supplies, fuel, power, and water
- Access
- Wind direction (Dismount area should be upwind from the incident site, and the decontamination area should be upwind from the dismount area). Remember that wind direction can change and that procedures may need to be temporarily halted or relocated.

Transport to Dismount/Decontamination Areas

Bodies and other containerized items should be transported using land vehicles, when possible. The route between the Hot Zone and Dismount Area should be made inaccessible to all except those driving transport vehicles and any workers who must supply support services to the vehicles or drivers. To facilitate decontamination of transport vehicles, open, flat-bed trucks with low side walls and rear gate should be used. The truck bed cargo area should be decontaminated after each delivery of bodies, at a point between the decontamination area and the area where water runoff is collected (see diagram, below).
The following schematic shows a workable spatial relationship between the:

- decontamination area
- area where the body storage truck may be placed
- truck decontamination area
- runoff collection area

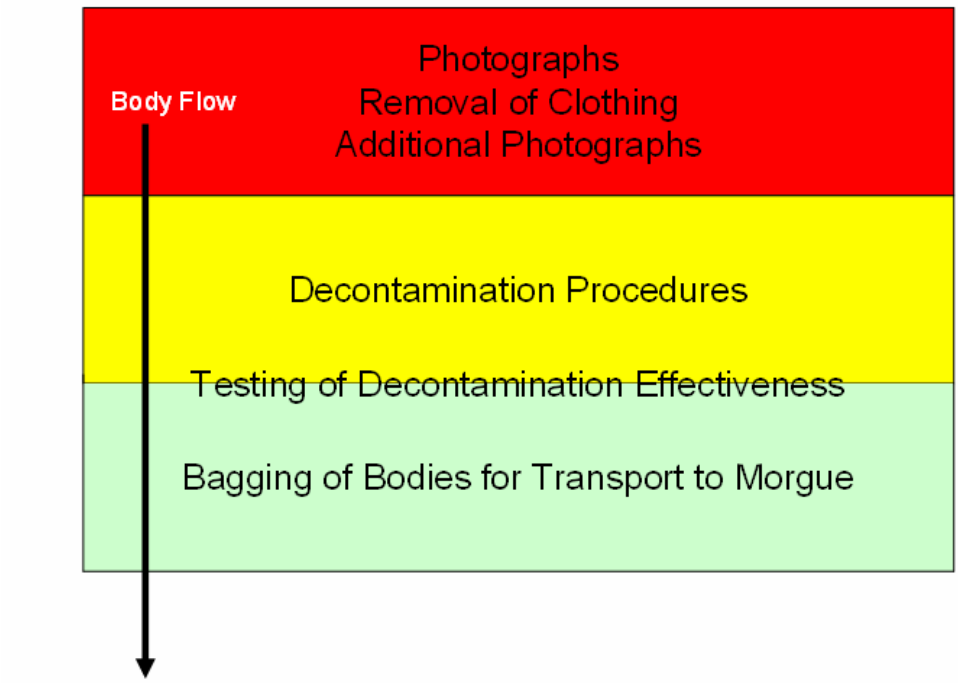


Drivers should wear disposable protective suites and appropriate PPE, as dictated by the circumstances, and remain in their vehicles at all times except when preparing to leave duty and undergo decontamination. Those loading bodies onto transport vehicles at the incident site (or unloading bodies at the dismount area) should not leave their work sites until they are transported to the decontamination area at the end of their work shift or at other times, as needed, for gear changes or personal needs.

If air transport is required between the incident site and dismount/decontamination area, the type of aircraft will depend on available landing areas and their proximity . If helicopters are used, bodies may be transported on a suspended platform (or basket), but the helicopter should remain high enough above the platform (and ground) to minimize or eliminate wind (and spreading of the agent) from the rotors. Also, a body or item transported by air from the Hot Zone should be containerized and the outer container decontaminated before transport.

Railroad transport may be used if nearby. The location of the dismount area and decontamination site should be near the tracks if rail transport is utilized. Railroad has the advantage that refrigerated cars may be readily available and serve both purposes of transport and storage. Work areas may even be established in railroad cars.

The decontamination area itself can be conceptualized and schematically depicted as follows:



From the Decontamination Area to the Morgue and Personal Effects Areas

Procedures for the transport of decontaminated and containerized bodies and clothing are the same. If the morgue and personal effects processing location will be at the same facility, these items may be transported together in the same vehicle. If the bodies will be transported to one location and the personal effects and clothing to another, parallel systems can be established with one vehicle for clothing and personal effects and another for bodies.

At the decontamination site, a refrigerated truck may be used to store decontaminated, containerized bodies (and clothing). This truck can remain on site until the morgue area has been readied to receive and process bodies. At that time, the truck may be relocated to the morgue area property (or nearby area) where the truck can remain as an "in" cooler to store bodies as they subsequently arrive at the morgue area. A second refrigerated truck can be placed near the morgue area to store bodies after they have been processed at the morgue and undergone examination. A third refrigerated truck can be placed at the decontamination area to replace the original, if needed. Such a decision will be based on the anticipated number of bodies and their recovery and processing rate. If the number of bodies is small, or the recovery rate is expected to be slow, bodies may be transported from the decontamination area to the morgue area individually or a few at a time in smaller vehicles suitable for such purposes. Each time a vehicle returns from the morgue area to the decontamination site, the cargo area should be decontaminated before new bodies are placed in the cargo area.

Storage of Bodies Pre- and Post-Examination

Even if a permanent autopsy facility is available with adequate storage for bodies, it may be helpful to use refrigerated trucks to store bodies prior to bodily examination and after bodily examination (separate trucks). This will minimize risk of contamination of the permanent facility and will also provide a place to store bodies that will continue to arrive due to routine case load. The interior and exterior of the trucks may be monitored to assess the effectiveness of decontamination procedures and to identify unsuspected contamination hazards.

The Morgue-Autopsy Area

Whether or not the morgue area is a temporary or permanent facility, at the morgue area, a station should exist at which the following can be accomplished for each body prior to its being taken into the autopsy area for examination:

- Placement on a gurney or autopsy cart
- Washing of exterior container with bleach solution
- Removal and discard of the container into a biowaste receptacle for subsequent incineration or other required disposition
- Washing or rinsing of body with water (or dilute bleach solution if the external aspect of the body appears to have been re-soiled during transport)
- Tagging of the body with identification number (if not already tagged)
- Discharge of the runoff into a sanitary sewer (this should be safe if decontamination procedures were effective, plus, non-solid biowaste at autopsy is discharged into the same sanitary sewer system)
- Immediate transport of the body into the autopsy/examination area for examination without further storage in the morgue facility.

In some instances, it may be desirable to divide remains into two groups—those that will need specific examination at the morgue and those that will not— and store them separately to facilitate operations. In other instances, it may be feasible to conduct all needed aspects of bodily examination at or near the decontamination area. Doing so will minimize the need for separate morgue operations. Whether this can be accomplished will depend on the scope and nature of the incident.

Other than cyanide, the risk of off-gassing to autopsy and morgue personnel is low or negligible if decontamination procedures have been properly carried out. For most respiratory and other chemical agents, what is left in the deceased body will not endanger morgue personnel.

In general, autopsies should be done on all cases if the case load and agent-specific biosafety constraints do not preclude doing so. With some diseases such as viral hemorrhagic fevers, autopsy may need to be limited to index cases or cases in which the findings or possible cause of death seems atypical in comparison to other cases in the incident. Minimal examination should consist of thorough external examination with written and photographic documentation, and the collection and processing of appropriate specimens and evidence.

Post-Examination Processing

After examination, the body should be placed in a body bag. The sealed bag should then be placed in a second bag, the outer surface of which should be cleaned with 0.5% bleach solution (The 1:10 solution normally used for routine disinfection). The double-containerized bodies may then be taken directly to, and stored in the refrigerated truck placed on site for body storage prior to release, or treated as below.

If air transport will be required, the double-bagged body should be placed in a Ziglar case and Ziglar Casket and the lids affixed using a continuous bead of silicon sealant and screws. If cremation is required, the double-bagged body may be placed in a sealed zinc coffin and a surrounding wood casket; both will burn at cremation temperatures.

In general, with infectious bioterrorism agents, embalming should not be performed. It poses unnecessary risk to workers and can retard the decomposition process, which may facilitate the elimination of infectious agents of concern. Further, embalming can cause agents that were formerly on the inside of the body to resurface on the exterior of the body or associated surfaces. Some embalming chemicals may adversely react with bleach, posing hazards to workers.

It may not be feasible for each body to be tested to ensure effective decontamination before it is released. It may be more practical to monitor levels of chemicals or radiation in the general area where bodies are stored prior to release, and immediately outside the storage area(s). Measuring of biologic agents, of course, is not feasible at present.

The medical examiner/coroner should do what he/she can to return remains for disposition at the family's direction. However, if decontamination has not brought hazards to a safe level, it may be necessary to retain the body or, under some circumstances, request voluntary cremation or impose mandatory cremation after appropriate involvement of public health and safety officials. Virtually all chemical or biological agents are effectively mitigated at cremation temperatures above 1000 degrees F. Cremation, however, does not affect radioactive material and to protect the crematorium and area, radioactive remains should not be cremated. Bodies contaminated with highly infectious agents (e.g., smallpox, hemorrhagic fever viruses) or spore producing bacillus anthracis should be cremated. Bodies infected with other types of infectious bioterrorism agents can be directly buried.

In general, the basic procedure at most stages of processing are:

- Preliminary examination
- Decontamination
- Detailed examination
- Packaging or containerizing
- Decontamination of package or container exterior surfaces

Implanted Devices

Bodies will need to be screened at some point to identify and remove implanted devices such as pacemakers. Whether screening is done with metal detectors or x-rays will depend on available equipment. Whether devices are removed at the scene, elsewhere, or at all will depend on the circumstances of the incident, available morgue facilities, federal regulations regarding the management of implanted devices, and the intended method of disposition. For example, some devices such as battery-powered pacemakers can explode if cremated. Removed devices need to be decontaminated and packaged in containers that have their exteriors decontaminated. Such items should be forwarded to the funeral director so that return to the appropriate party (such as the physician who implanted the device, the device manufacturer, or family member) may occur as required.

Removal and Disposition of Hazardous Materials

The main items that will need to be disposed of include:

- Used body bags
- Collected runoff at decontamination area
- Used personal protective equipment
- Used cleaning utensils

It should be feasible to place used body bags and used protective equipment and cleaning materials in approved receptacles that can be transported by authorized and licensed hazardous waste management companies. Incineration in approved incinerators is a reasonable method of disposal, although the plastic elements of body bags may produce toxic by-products into the air that will need to be controlled and appropriately managed.

Incineration is reported to be capable of aerosolizing anthrax spores and, where anthrax spores are involved, an approved afterburner may be required to avoid aerosolization.

Runoff from the decontamination area needs to be collected by authorized and licensed hazardous waste management agencies and disposed of using methods and locations that are compliant with state law, Environmental Protection Agency (EPA) regulations, CDC's Agency for Toxic Substances and Disease Registry (ATSDR) recommendations, and department of transportation regulations regarding the vehicles used for transport.

According to the EPA, in general, Good Samaritan statutes protect responders from liability if runoff of contaminated material occurs uncontrolled while rescue of living victims is occurring. Once imminent threats to human health and life are addressed, responders need to take all reasonable effort to contain contamination and avoid or mitigate environmental consequences. After imminent threats are mitigated, gross misconduct or negligence does create a liability for responders from both governmental and private sector viewpoints. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) addresses these issues. A Federal On-Scene Coordinator (FOSC) can determine which environmental regulations are applicable, relevant, or appropriate. Local and state officials should utilize a FOSC as needed, available through EPA (7).

Further discussion of specific methods and sites for disposal are beyond the scope of this Guide.

Radioactivity Issues

Immediate deaths from a nuclear weapon will probably result from blast injury. However, fallout can cause acute radiation syndrome after many hours or days. Radioactive fallout decays very rapidly—to about 10% of original levels in 8 hours and 1% after 2 days.

"Dirty bombs" contain radioactive material combined with explosives that would contaminate surfaces but should be amenable to washing and decontamination. People who die quickly following an explosion with radioactive material would not be expected to harbor significant radiation internally. Dirty bombs may also produce radioactive shrapnel in the body and can pose hazards. Shrapnel needs to be identified and removed using instruments other than the hands.

Radiation levels should be measured on the ground because detection by air can miss hot spots. Bodies and clothing should be washed using the usual procedures and the containers should be marked as radioactive. After decontamination, bodies and clothing should be checked with a meter to ensure that decontamination was successful. More than one treatment may be required.

Radioactivity warning tags should be applied to remains or items that are radioactive. A radioactivity report may need to be attached to, and accompany the remains.

At the time of this writing, the Centers for Disease Control and Prevention and the New York City Medical Examiner were developing more specific guidelines for the handling of decedents contaminated with radioactive materials. In brief, key elements are:

- Purchasing, maintaining, and calibrating radiation survey equipment is probably not feasible for most medical examiner or coroners offices. Advance arrangements need to be made with a local nuclear facility, hospital nuclear medicine department, or state radiation control director to develop plans for equipment and survey response to an incident involving radioactivity.
- When dosimeters are used to check exposure, they should be read when starting exposure, worn in an area that is not covered or concealed by clothing, and be read at the end of the work assignment. It may be helpful to put a single contact person in charge for monitoring dosimeter usage, reading, and documentation of exposure. Protective wear should be removed and left at the area.
- When the scene is first evaluated, radiation should be surveyed and plotted on a map of the area so workers know where the hotter areas are. When not directly engaged in work, workers should migrate to the area with the lowest radiation. It might be possible to use a video camera and have the radiation levels be verbally recorded as the scene is processed. The tape could then be used outside the hot area to construct the scene map so workers know where the hot areas are.
- More likely, a radiologic dispersal device (RDD or "dirty bomb") would be involved and would require decontamination of external aspects of the body
- Radioactive shrapnel from a dirty bomb probably poses the greatest risk. Bodies need to be surveyed for radioactivity and x-rayed so that any identified shrapnel can be removed (with forceps, not the hands) even if an autopsy is not performed and before release of the body. A radioactivity meter may be needed to locate small fragments which may not show up on x-ray.
- In the rare event that persons inhale or ingest radioactive materials (as may occur with a nuclear bomb) and develop radiation sickness, there is little risk of dangerous levels of radioactivity with casual exposure to the external aspects of the body, but the interior of the body may pose hazards from handling organs and tissues, albeit it probably low risk in most cases if shrapnel has been removed. Thus, autopsy is not recommended unless absolutely necessary. This is a question of risk versus benefit.
- Stay times near radioactive remains must be calculated by determining radioactivity dose rates in mrem/hour and using 200 mrem per worker as a practical exposure limit, although 5 rem is the legal limit. Use the highest radiation count in the work area (derived from the map) to make such calculations, and set the limit as low as possible without hampering the work effort.
- Actual exposure should be measured with dosimeters worn by staff
- A Geiger Mueller pancake probe can be used to conduct initial surveys of the radioactivity of decedents, and counts in excess of 300 per minute above background should result in labeling as radioactive

- Bodies causing a pancake probe reading of more than 100 mrem/hour should be stored in a refrigerated area at least 10 meters removed from workers until plans can be made to handle such bodies
- If radioactive shrapnel is present it should be removed with forceps to minimize exposure to the hands
- BioSeal or Zieglar cases will prevent release of radioactive material into the environment.

Further details and practical guidelines are anticipated when this publication is finalized.

Other Considerations

New Methods. Newer methods of decontamination, such as the use of microwaving or x-raying, are being investigated. However, there is insufficient information and technology readily available to address such methods in this publication.

Temporary interment. If, for some reason, bodies cannot be transported from the incident site in a timely manner and there is no suitable place to store bodies, the bodies may be bagged and temporarily interred on site until transport can be accomplished.

Special agents. Cholera, TB, plague, smallpox, yellow fever, viral hemorrhagic fevers, and diphtheria may bring into play special quarantine or detention procedures mandated by public health authorities. If such bodies are brought into the United States from elsewhere, the Code of Federal regulations requires either: embalming and placement in a sealed casket; cremation; or a permit issued by the Centers for Disease Control and Prevention.

Cremation recommended in smallpox cases. Because smallpox virus can survive in buried bodies in lesions, cremation is recommended in such cases.

Recommendation for no autopsy. In cases viral hemorrhagic fevers it has been recommended that an autopsy not be performed unless needed to establish the diagnosis in an index case, and that experts at the CDC should be consulted before an autopsy is performed. Although there is not uniform agreement regarding cases of anthrax or smallpox, vaccination of workers would allow autopsies of smallpox cases to be performed, when needed, and appropriate PPE should abate major risks when autopsies are performed in cases of anthrax.

Recommendation for NO embalming. Although embalming does provide some advantages-- allowing bodies to be kept without refrigeration up to three weeks, for example-- in general, embalming is not required. Embalming should not be performed on remains that contain residual hypochlorite due to the potential for generation of dangerous gases when mixed with embalming fluid.

Anthrax spores. Anthrax requires oxygen to sporulate. Spores do not form inside of a closed corpse. The major risk occurs if body fluids are exposed to air. Thus, proper disinfection is required of working surfaces when autopsy is performed. Autopsy tools used in an anthrax case should be autoclaved or incinerated.

Body bags and containment material. BioSeal ™ containment material is reportedly effective for containment of all known hazardous substances, vapors, fluids, gases, and powders. It may be used as needed to enclose bodies or other items such as clothing. Type II and Type IIA body bags are made of special material to contain hazardous substances and prevent leakage. These types of bags should be used, when indicated.

Marking of containers and coffins. Once examination is complete and bodies are identified and containerized, the exterior of the container or coffin should be marked indelibly to indicate case number, decedent name, social security number, and date of birth.

Policy of not reopening. Once bodies are finally containerized for final disposition, the containers should not be reopened to view the body or further prepare the body for burial or funeral service purposes. When possible, facial photographs of the deceased should be provided to funeral directors to affirm to the next of kin that the correct body has been provided. When this is not possible, other distinct identifying information should be provided.

Coffin preparation. During final casketing, formaldehyde, sawdust, and/or tow may be placed around the body bag inside of the impermeable casket if possible interactions with hypochlorite have been eliminated.

Other disinfectants. Other potentially useful disinfectants exists but can be dangerous and pose respiratory risks. They should be used only in controlled settings with adequate ventilation and protective equipment.

Organ Donation. Being the victim of a chemical or radiologic event does not necessarily preclude the availability of organs or tissues for transplantation purposes. If someone survives a chemical poisoning for a period of time the agent may no longer be present. Biologic agents may well preclude the use of organs or tissues for such purposes. Decisions will need to be made depending on the type of agent and in consultation with appropriate experts. Most likely, the time required for decontamination and processing, however, will preclude the procurement of tissue within allowable time frames.

Animal remains. Contaminated remains of small animals may be containerized in metal containers or drums. Processing of such remains will need to be coordinated after consultation with the FBI, Health Department, and veterinary consultants.

Informing families. Family members should be provided with prompt information that includes description of what remains and effects the family will likely receive and how long it may take. Advance explanation for anticipated delays should also be provided.

Fragmented Remains. Except for a dirty bomb, a situation with fragmented remains or body parts that will require decontamination seems unlikely. In certain circumstances, however, it may be necessary to decontaminate fragmented remains. In these situations, care should be taken to avoid the use of chemicals that would jeopardize the quality of DNA samples. The laboratory personnel assigned to process the DNA should be consulted before any chemicals are applied to fragmented remains. Chemicals applied to the remains for purposes other than decontamination, such as insect repellants, should also be avoided unless approval for their use is granted by the DNA laboratory personnel.

Interment. It may be necessary to inter bodies temporarily to preserve them if an incident has occurred in a location that makes safe storage or transport of bodies difficult. In other instances, such as those with very large numbers of fatalities or fragmented remains, it may be necessary to have a mass interment (or cremation) that is essentially permanent. Such decisions will need to be made by the incident commander in conjunction with appropriate authorities and must take into account public health, political, and cultural considerations.

Demonstrative Photographs

The Red Zone. The clothed body is photographed before the clothing is removed. (The hoods are all labeled with a number. This is done not only to keep track of individual equipment but also so people outside of the line can identify individual workers.)

Body being immersed into decontamination solution. This particular decontamination tub has jet sprayers to assist in decontamination. With this system, a special filtration system is required to gather tissues such as skin and hair that comes off the body while it is in the tub.

Shower for the contaminated workers as they exit the decontamination zone. They shower with scrub brushes in the blue tent. The shower can be done with a “buddy”. The green pool is used for a final rinse of the feet. The worker then exits the pool and removes the PPE. It may be necessary to have individuals with Geiger counters or chemical monitors at this point to test worker before s/he removes his/her PPE.

Testing “tissue” for contaminants as it exits the yellow zone and enters the green zone.

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For a more exhaustive list of research articles and summaries, see:

- Department of Defense (DOD) Armed Forces Epidemiological Board (AFEB) Memorandum. *Disposition of Contaminated Remains-2003-06*. 14 January 2003.

Useful Web Sites:

CDC information on biological, chemical, and radiologic agents
http://www.bt.cdc.gov/

DMORT. For information on DMORT and its procedures.
www.dmort.org

DOJ OVC. For information on family assistance
www.ojp.usdoj.gov/ovc

SBCCOM .
http://www.mipt.org/Source.asp?id=95

Other decontamination resources
http://www.wmdfirstresponders.com/Decontamination.htm

Joint Publication 4-06, Mortuary Affairs in Joint Operation, June 5 2006
http://www.fas.org/irp/doddir/dod/jp4_06.pdf#search=%22JP%204-06%22

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