Decontamination for Weapons of Mass Destruction

INTRODUCTION:

Biological, chemical and radioactive contamination present a multitude of problems. Decontamination must occur to minimize effects of agents on living organisms and to prevent spreading contamination through transport of victims and equipment.

There are many options for the number of steps or procedures required for the contamination reduction process. How stringent the process will be depends on the hazard, condition of people or equipment requiring decontamination and resources available.

This module addresses:

- Safety,
- Contamination reduction,
- Criteria for decontamination area selection,
- Criteria for procedure selection,
- Decontamination of victims requiring emergency medical attention,
- Decontamination of large numbers of people and
- Equipment decontamination.

Contamination Reduction—General Safety

Removing contaminates puts people at risk. To reduce the risk, workers must have the appropriate level of personal protective equipment (PPE).

Washing inherently entails water spray and splashing, which should be limited as much as possible to prevent uncontrolled contamination spread.

Ideally, what is removed and what is used for removal will be captured and confined. Before people or equipment leave the contamination reduction corridor, it is essential to confirm there is no contamination left that could be transported out of the hot and warm zones.

Decontamination workers must be trained in the proper techniques for assisting responders in the removal of potentially contaminated equipment. Both the responder and the decontamination crew must be protected from the hazards.

Utensils used for cutting or gaining access to personnel should be blunt to prevent inadvertently cutting someone or accidentally penetrating protective clothing. Emergency medical scissors or penny cutters work well.

Decontamination Area Selection

Selecting an appropriate decontamination area is essential for emergency operations involving nuclear, biological or chemical (NBC) agents. Applying the criteria described below facilitates decontamination operations setup, maximizing effectiveness and minimizing likelihood of moving the operation due to a tactical situation change.

Nuclear, biological and chemical agents are hazardous materials. Decontamination procedures are based on standard procedures used by Hazardous Materials Emergency Response Teams across the country. The decontamination area is where the contamination is systematically removed. A one-way corridor for contamination reduction begins at the edge of the contaminated area, or hot zone. Contamination is progressively removed from the person or item as it moves along the corridor,

the warm zone. Completely decontaminated people or items are then moved into the area totally free of contamination, the cold zone.

ENVIRONMENTAL FACTORS:

In addition agent hazards, environmental hazards must be addressed. The decontamination process may take time and people in PPE will be threatened by heat stress. On hot days, the area chosen for the decontamination procedures should be away from direct sunlight, or barriers should be erected to create shade.

Most decontamination procedures will include getting people wet and removing clothing. Hypothermia is a very real danger in cold environments. Minimizing exposure to cold must be a consideration when determining decontamination area location.

Environmental criteria also influence decontamination area location. Survey the site prior to selection. Features present in one area may offer advantages. Curbing and sump systems can facilitate collection of water runoff. If clothing removal and a shower with soap and water are the contamination removal procedures of choice, a nearby facility such as schools, sports facilities locker rooms, public baths, etc., may provide the necessary area for decontamination.

CONTAMINATION REDUCTION PROCEDURES CRITERIA:

Selecting which decontamination procedures to use will be contingent upon whom or what will be decontaminated, what the contaminant is and how much contact there was with it, whether the person being decontaminated is ambulatory or is experiencing a medical emergency, and the resources available to perform the decontamination procedures.

It is highly likely more than one type of decontamination layout will be needed for events involving WMD. There are differences between contamination removal procedures for protected responders and unprotected civilians, both gross and deliberate decontamination, as well as between those who can participate in their own decontamination and those who cannot. There are also differences between decontamination techniques for people and those for equipment.

Recommended Contamination Reduction Procedures

MINIMAL CONTACT WITH AGENT:

This type of decontamination is intended for responders wearing PPE who have unquestionably had minimal or no exposure to contamination. Even then, the type of potential contamination—highly lethal, or atmospheres containing mists or liquid vapors—may negate use of this setup.

The applicable scenarios behind this contamination reduction type are:

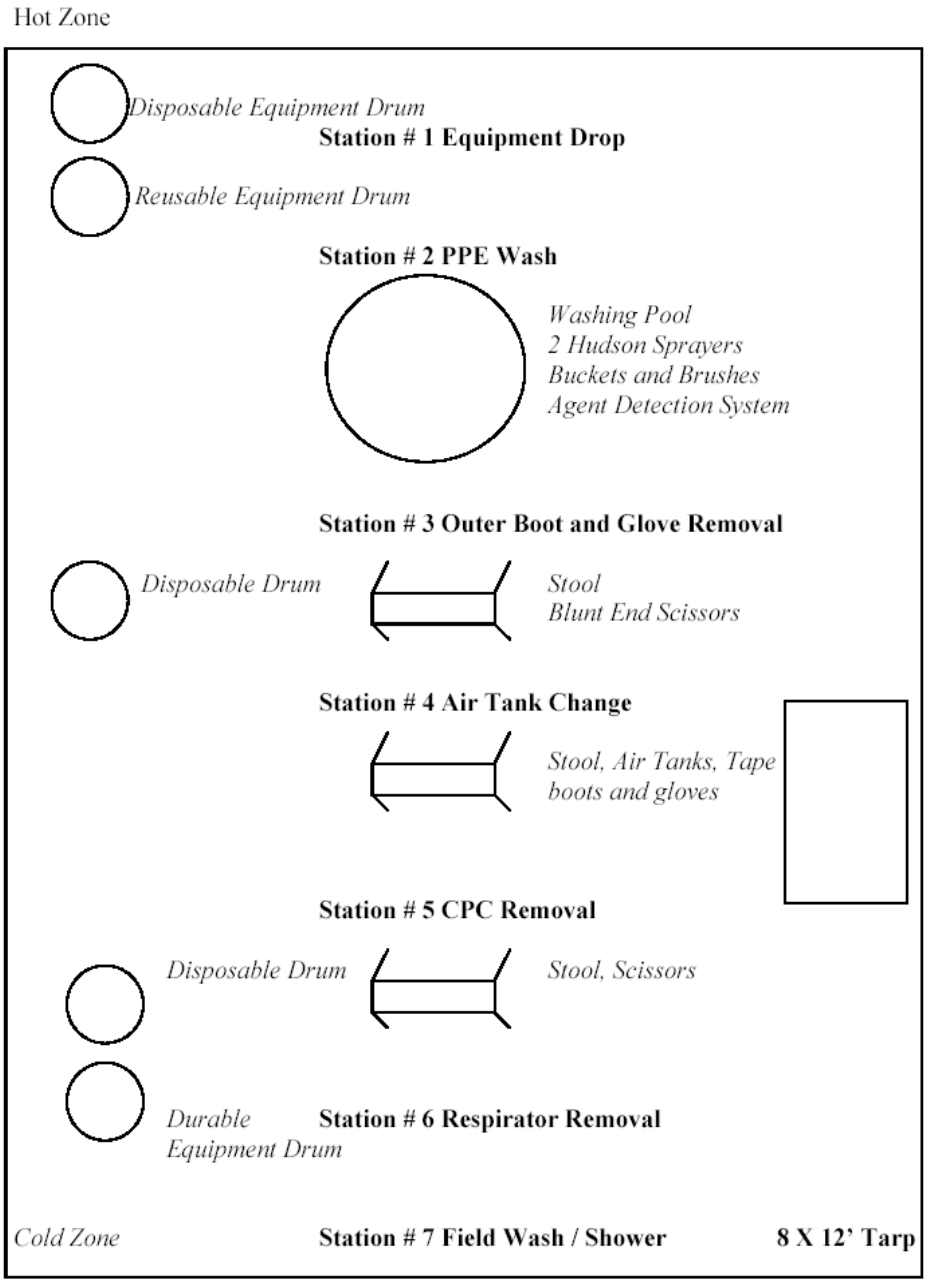
- Personnel wearing PPE have performed reconnaissance without entering any areas of contamination,
- Contamination is of extremely low order or
- Personnel have been in a low hazard area with little chance of exposure.

In many instances, this will be a contamination reduction procedure for the purpose of changing air supply bottles for personnel re-entering the hot zone, or for rotating personnel.

Normally, Hazardous Materials Response Teams will be the agencies with appropriate equipment and personnel trained to perform decontamination functions. Other emergency responders, however, may assist in setting up the decontamination area layout. For situations with limited personnel, other agencies, such as fire departments, may be able to provide personnel trained in the use of appropriate PPE for the role of decontamination workers.

A tarpaulin large enough to accommodate the decontamination area should be used to clearly mark where each procedure step is to occur and where t necessary equipment is to be placed. This facilitates setup of contamination reduction area by personnel who recognize equipment and understand the intended function, such as fire service or law enforcement personnel, but who will not be performing those tasks.

Figure 1. Minimal Contact Decontamination Area Layout



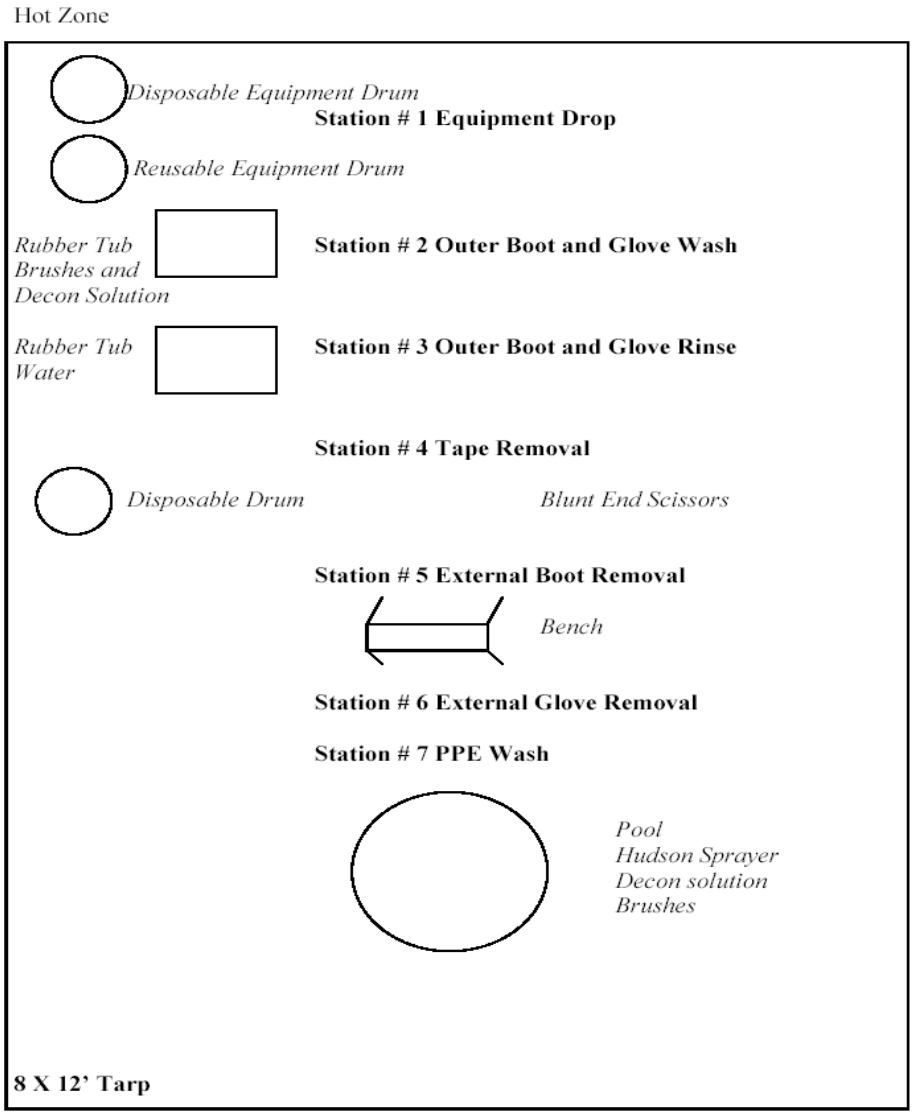
MAXIMUM CONTACT WITH AGENT:

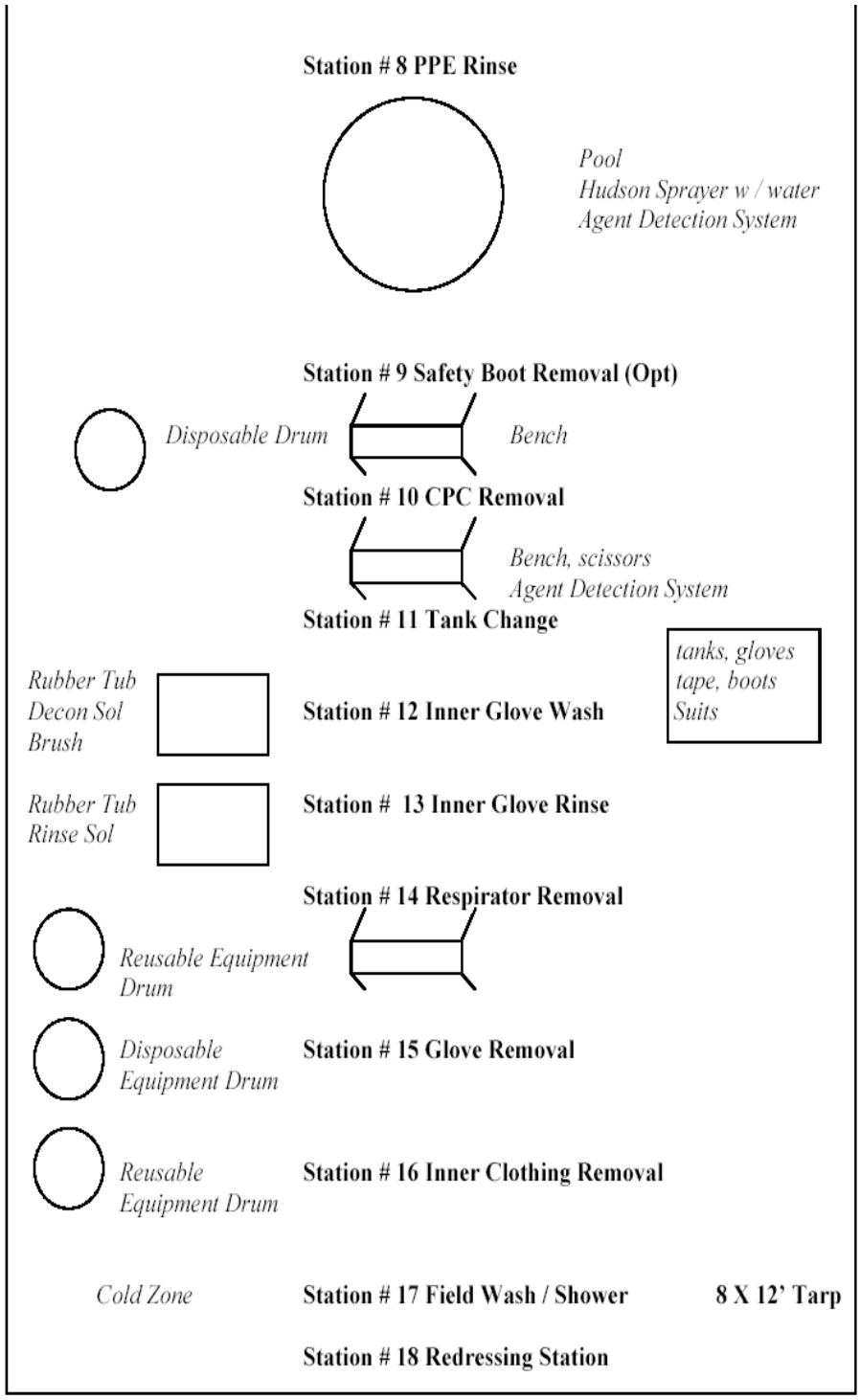
This type of decontamination is intended for responders wearing PPE who have been exposed to contamination in a manner that makes it fairly

certain that their PPE has been contaminated, such as entering atmospheres containing mists or liquid vapors, or falling into puddles. These scenarios represent high-hazard situations for both the responders and the personnel working the decontamination area. A very thorough decontamination must occur for both.

Because the contamination removal procedures are more stringent, the layout offered here requires 18 steps as compared to the seven steps recommended for the minimal contact scenarios. There are so many more steps it will require more distance for the contamination reduction corridor and may take two tarpaulins or a longer sheet of plastic to label the locations of all the procedures and equipment.

Figure 2. Maximum Contact Decontamination Area Layout




Station # 8 PPE Rinse
Pool
Hudson Sprayer w / water
Agent Detection System
Station # 9 Safety Boot Removal (Opt)
Disposable Drum
Bench
Station # 10 CPC Removal
Bench, scissors
Agent Detection System
Station # 11 Tank Change
tanks, gloves
tape, boots
Suits
Rubber Tub
Decon Sol
Brush
Station # 12 Inner Glove Wash
Rubber Tub
Rinse Sol
Station # 13 Inner Glove Rinse
Station # 14 Respirator Removal
Reusable Equipment
Drum
Disposable
Equipment Drum
Station # 15 Glove Removal
Reusable
Equipment Drum
Station # 16 Inner Clothing Removal
Cold Zone
Station # 17 Field Wash / Shower
8 X 12' Tarp
Station # 18 Redressing Station

As mentioned above, this area layout is intended for scenarios where responders wearing Level A have been exposed to highly dangerous substances with a high probability of contamination.

It is essential that decontamination personnel in initial contact with contaminated responders also be wearing Level A protection. Due to the chances of being cross-contaminated, the decontamination team will also require a thorough decontamination.

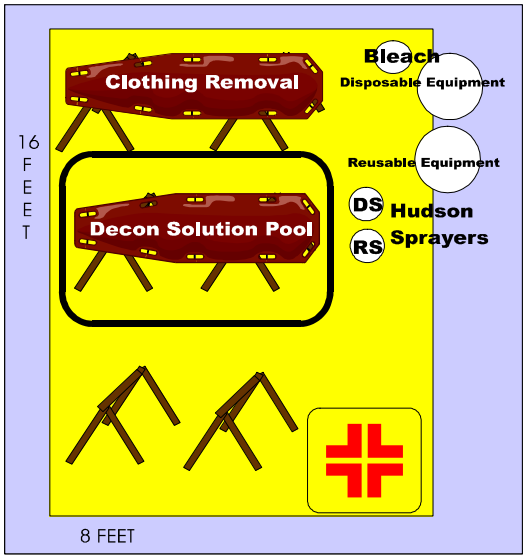
Because thorough decontamination requires tim, and because Level A protection includes limited duration air supplies, it may be prudent to set up two contamination reduction corridors to facilitate the decontamination of multiple responders simultaneously.

Emergency Decontamination

Emergency decontamination implies that either unprotected people or emergency responders have received an exposure to an NBC agent which may or may not have resulted in symptoms for non-ambulatory or ambulatory victims. Controlling the spread of contamination under these circumstances requires exercising extreme caution and common sense. The speed required needs to be balanced against contamination control. Panic of ambulatory patients may result in difficulty controlling the large population of victims and the contamination they carry.

EMERGENCY DECONTAMINATION FOR RESPONDERS:

This decontamination area type should always be set up and available whenever responders are entering the hot zone. The scenario for this area layout is a responder, wearing PPE, has run into trouble and requires immediate medical attention. The function of this area is to remove the responder's PPE rapidly and safely and get the responder to medical attention as quickly as possible.



There are basically three steps to this type of decontamination. In essence, cut the contaminated responder out of his or her PPE, move the responder to a cleaner area to be washed, and then to medical attention.

Lifting the contaminated responder will require a team of personnel. It will take several teams of decontamination personnel to perform this safely. The first team has been exposed to contamination while opening the PPE. A clean team will need to step in and deal with the down responder to reduce the chance of cross contamination.

Stretchers and other means of non-ambulatory patient transfer are the most likely path of contamination spread. Exercising care in where these items are placed facilitates operations aimed at controlling the spread of contamination.

This procedure will require several backboards, because the first backboard the patient is placed on will have a high probability of being contaminated by contact with the PPE. Once the PPE is opened, the responder will have to be transferred to a clean backboard by the clean decontamination team.

Mass Decontamination

Even under ideal conditions, the previous methods for deliberate decontamination could take at least 3 to 5 minutes per person being decontaminated. This would result in unacceptable time frames for removing contamination from large numbers of people, such as crowds of hundreds or thousands of civilians. Mass gross decontamination is intended as a first step in dealing with decontamination of large crowds. After this step, the people should be triaged and if necessary those demonstrating potential contamination should be directed or taken to a more thorough contamination reduction area.

This is the decontamination type that can be performed by the fire department upon arrival. It is intended to deal rapidly with large numbers of ambulatory people who are not in PPE.

Studies have shown that in many instances of terrorist attacks with chemical agents, most people are not affected physically, but are affected psychologically. An SBCCOM report prepared by the U. S. Army Domestic Preparedness Chemical Team entitled *Guidelines for Mass Casualty Decontamination During a Terrorist Chemical Agent Incident* (September 1999) states that we can expect a 5 to 1 ratio of unaffected to affected casualties in these incidents.

However, it is always possible that the terrorists were more efficient with the incident you are responding to.

Ideally, the crowd will cooperate and remove at least the outer layer of clothing. For non-permeating contamination on clothing, properly removing the clothing will also remove the contamination. The amount of potential contamination removed will correlate with the amount of body covered by the removed clothing. Obviously, someone wearing a bathing suit will not reduce the contamination by clothing removal as much as someone wearing full-body cold-weather clothing.

The less exposure to severe weather, the more cooperation you are likely to get with people removing clothing.

More than one disrobing area may be required to gain cooperation. People in our culture are typically shy and the more privacy available the more likely they are to disrobe.

All the personal items being removed should be tagged with the owner's information. These items may be useful during the investigation, for example, by identifying the hazard source area through learning where more seriously contaminated people were located at the time of agent dissemination. If it does not need decontamination and is not needed as evidence, the personal items collected may have to be returned to their owners.

GROSS DECONTAMINATION:

Immediate disrobing and water spray for ambulatory people will remove almost the entire potential contamination hazard for most chemical agents.

CROWD CONTROL AND COOPERATION IS THE KEY TO SUCCESS:

Fire department equipment is ideally suited for the task of rapidly applying running water. The addition of a surfactant, soap greatly enhances removal of non-water soluble materials, but immediate water application is essential. Some types and brands of fire fighting foam will act as surfactants and are safe to use on people, providing a second water spray can be used as a rinse.

Many property owners have garden hoses. Adapters for fire service equipment can be made, prior to response, for garden hose applications. Advantages are lower volume of water used and potential for pre-existing on-site decontamination equipment. Disadvantages are the inherent difficulties in adding a surfactant to the water source and, if that is possible, then providing for a clean water rinse.

For certain situations (such as attacks on schools, or sporting arenas) a decontamination area (shower room) may already be on site. Speed of contamination reduction is the critical issue, so if using these facilities is the quickest way to achieve gross decontamination, then they may be the appropriate choice for the site of decontamination.

MASS DECONTAMINATION OF UNPROTECTED PEOPLE:

This may be the most difficult category of decontamination to perform in a WMD scenario—deliberate decontamination of large numbers of people.

Hazardous materials emergency responders are familiar with concepts of deliberate decontamination, but are accustomed to only applying those concepts to emergency responders, usually in PPE. Performing deliberate decontamination on crowds requires different procedures to be successful in rapidly decontaminating large numbers of people. Do not make the mistake of expecting to put many non-responders through a contamination reduction corridor established for emergency responders.

A variety of options is available for deliberate decontamination of large numbers of unprotected people. This step usually occurs after those people have passed through the gross decontamination procedures previously mentioned.

Aside from the options discussed here, other options are limited only by imagination, budget and potential assets on the scene.

Where possible, use the features of the terrain to assist in the flow of people through the required procedures.

This type of contamination reduction works best if the people being decontaminated work in pairs to assist each other. If a large crowd is the target, it is unlikely there will be enough emergency responders available to assist everyone individually and complete the process in a timely manner.

GENERAL GUIDELINES FOR MASS DECONTAMINATION:

- The faster decontamination occurs, the better the results. Removing clothes and flushing with water will remove most of the problem most of the time. If soap is not available, lots of water will still be useful, even for persistent agents.
- As mentioned previously, studies have shown that in attacks of this nature on large crowds, most of the people will not be contaminated. If the hazard is such that deliberate and thorough decontamination is necessary for contaminated individuals, testing should be done to prevent those who do not need deliberate decontamination from slowing the process, or delaying those who are actually contaminated.
- If deliberate decontamination of large numbers of people is deemed necessary, use appropriate psychological techniques to gain cooperation from the greatest number of people.
- Limit potential for causing harm by carefully selecting and monitoring application of decontamination solutions.
- The only way to be sure contamination reduction efforts are being successful is to test the end results. People finishing contamination removal procedures should be tested to verify contamination was actually removed.
- Law enforcement issues include crowd control, evidence and investigation. Planning and execution of decontamination procedures must include law enforcement to address these issues.
- Logistics for this type of deliberate decontamination of large numbers of people will be difficult. Local department stores could be great resources for large quantities of disposable supplies.

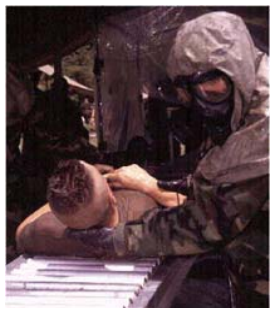
- To minimize the number of responders committed, limit the roles of the responders in assisting the crowd being decontaminated. The essential jobs for emergency responders will be in directing the efforts of the crowd and maintaining essential supplies.
- Where water containment basins are used, a drain rack of some type will allow people to step into the tubs without having to step into puddles of contaminated water washed from others.
- Large numbers of people washing means large quantities of contaminated water. The tubs will fill quickly. Confinement, containment and control of runoff will be another logistical problem to be addressed early in the process.
- The more contamination reduction lines set up, the more people can process simultaneously.

There are mobile contamination reduction facilities designed specifically for the purpose of deliberate decontamination of large numbers of people. There are companies that manufacture these and some who will build them to specifications. There are also imaginative members of many response agencies who can create their own version of these mobile wonders on a shoestring budget.

DECONTAMINATION FOR NON-AMBULATORY:

Contamination reduction of injured, unconscious, or deceased people requires a completely different approach to decontamination. Ambulatory people can deal with most of the contamination reduction procedures on their own, requiring relatively few emergency response personnel for assistance. People who are unable to assist in their own decontamination will require the direct assistance of emergency response personnel in a ratio of at least one to one. Those who must be carried need the services of at least two responders and those who need to be carried and receive medical treatment may require the attention of many responders.

There are a variety of triage systems used across the country for mass casualty situations. The one shown here is the Simple Triage And Rapid Transport (START) system. When there are more casualties than medical resources available, priority must be established for the order in which patients are treated. By quickly assessing each patient's condition and placing a color-coded tag on them, all the responders can easily discern which patients have priority.



All of the contamination reduction procedures must still be performed, but rapidly, and on people whom the decontamination personnel must physically move from procedure area to procedure area. Preplanning for this additional duty of patient movement is critical because additional equipment specifically for this contingency will be needed. Whether it is extra saw horses and backboards, or a more sophisticated line of tables with roller systems like those found in packing plants, acquisition and training will be necessary prior to use in an emergency.

Equipment Decontamination

Preplanning to have certain types of equipment on scene will make the contamination reduction process much easier. When large quantities of liquid runoff will be generated, it is ideal to have hazardous materials transport trucks on scene that can suck up and store hundreds or thousands of gallons and then drive it to a disposal site.

Many contaminated, or potentially contaminated, items will require disposal. To avoid cross contamination, items have to be placed in an appropriate container prior to transport. For large scenes, such as mass casualty incidents, many containers will be needed.

For all decontamination procedures, there must be a method of discerning if the decontamination was thorough. Any hazardous substances at the scene must not be accidentally transported from the scene, allowing the danger to spread.

Though we are not dealing with people in need of decontamination, we may still not have the luxury of time for contamination reduction. It may be critical to get the equipment serviceable for the next response. It is also critical to make sure that equipment is thoroughly decontaminated. Prioritize which items will be decontaminated first based on those that will be most needed for the next event.

For equipment that will be reused, decontamination must be thorough. A deadly agent is just as lethal on a piece of equipment as it is sprayed from

a terrorist's dissemination device. A variety of options are available for cleaning equipment and, as with every other situation involving WMD, the choice should be made based on the agent involved and the assets available.

STEAM: Steam cleaning has the advantage of being able to reach places that cannot be reached by hand, such as the inner workings of machinery, and is effective against both biological and chemical agents.

Commercial car and truck washes may be able to provide steam cleaning options. Research commercial mobile steam cleaning services in the area, but remember that independent contractors called to the scene face the same hazards as emergency responders and must be equipped and trained with the appropriate personal protective equipment.

Steam is water vapor, but it will condense back to water and generate a waste stream which must be controlled.

TRUCK OR CAR WASH: These systems are very useful for the removal of contamination from large equipment. However, most mechanical vehicle cleaning systems use high-pressure water spray that could send contamination great distances. Exercise caution.

One of the greatest advantages to this type of system is that in many cases there will be no need to expose personnel to potential contamination, because the machinery will perform the contamination reduction. One of the greatest disadvantages is that the truck or car wash will need to be decontaminated after the event.

DIP TANK: Completely submersing contaminated equipment in the proper decontamination solutions is an ideal way to solve most contamination problems. For equipment as large as vehicles vast quantities of solution will be necessary and, therefore, will generate vast amounts of contaminated waste.

There are many advantages to this system, including limited exposure to the contaminant by decontamination personnel, using the decontamination solutions most effective for the specific agent and easy control of any runoff.

HAND DECONTAMINATION: This is the most labor intensive form of equipment decontamination. It may be the only option for high dollar, or electronic, or life support

equipment. Personnel wearing the appropriate personal protective equipment should perform this, even though that equipment may make the task more difficult due to physical restrictions inherent in the use of PPE.

Conclusion

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