CSEPP TECHNICAL TRAINING CLASSROOM COURSE

DECONTAMINATION OF PEOPLE POTENTIALLY EXPOSED TO CHEMICAL AGENTS

STUDENT GUIDE

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PREFACE

Decontamination should be considered an integral part of the necessary planning for emergency field response. Adherence to appropriate response phase decontamination guidelines will reduce the potential for injury and save lives during the emergency phase immediately following a significant release of chemical warfare agent or other highly toxic industrial chemical.

Decontamination of people exposed to a chemical agent must begin in the first stages of response, often concurrently with the implementation of other protective actions. The modules in this training cover the basic issues associated with decontamination, self- and buddy-decontamination, and decontamination station siting. The training also describes decontamination procedures for ambulatory and non-ambulatory victims, multiple numbers of presenting victims, animals, and special considerations for special-needs individuals, severe weather conditions, and for radiological and biological contamination.

ACRONYMS AND ABBREVIATIONS

ACT FAST	Agent Characteristics and Toxicology: First Aid, and Special Treatment
ADA	Americans with Disabilities Act (1990)
CBRN	chemical, biological, radiological, nuclear
CEU	continuing education unit
CFR	Code of Federal Regulations
CSEPP	Chemical Stockpile Emergency Preparedness Program
CW	chemical warfare
DHHS	Department of Health and Human Services
DHS	Department of Homeland Security
DoD	Department of Defense
ED	emergency department
EMT	emergency medical technician
EPA	Environmental Protection Agency
F	Fahrenheit
FEMA	Federal Emergency Management Agency
GB	sarin (nerve agent)
HAZMAT	hazardous materials
HCF	health care facility
HD	sulfur mustard (blister or vesicant agent)
HN3	nitrogen mustard (blister or vesicant agent)
MOU	Memorandum of Understanding
OSHA	Occupational Safety and Health Administration
PETS	Pets Evacuation and Transportation Standards Act (2006)
PPE	Personal Protective Equipment (see 29 CFR 1910)
ppm	parts per million
psi	pounds per square inch
PVC	polyvinyl chloride
RSDL	Reactive Skin Decontamination Lotion
SAFETY Act	Support Anti-Terrorism by Fostering Effective Technologies Act (DHS)
SBCCOM	Soldier and Biological Chemical Command (US Army)
START	Simple Triage and Rapid Treatment
TIC	toxic industrial chemical

FIELD ECONTAMINATION RESPONSE TO CHEMICAL AGENTS

MODULE 1. INTRODUCTION

This course as revised is designed to be presented as an independent study course or as part of the *Agent Characteristics and Toxicology: First Aid and Special Treatment (ACT FAST)* classroom course. It was developed for use in the US Department of Homeland Security's civilian responder training for the Chemical Stockpile Emergency Preparedness Program (CSEPP), a program administered jointly by The Department of Homeland Security and the US Department of Army. This training, including the recommended procedures developed for response, is based on much of the research on chemical warfare agents conducted by the Army. For more in-depth information readers are encouraged to review the *Textbook of Military Medicine, Medical Aspects of Chemical and Biological Aspects, Part 1* (1997). It is recommended that readers also view "*Don't Be a Victim: Medical Management of Patients Contaminated with Chemical Agents*" available on-line in streaming video at http://www.emc.ornl.gov/CSEPPweb/CSEPPTraining.html. In addition, the web site provides a number of job aids and posters for easy downloading.

1.1 Target Audience

The target audience includes civilian first responders, emergency planners involved with developing and implementing decontamination protocols and procedures, medical personnel and emergency medical technicians, and other stakeholders such as public health or environmental agencies that may be involved in recovery phase decontamination efforts. The training may be of interest to those who work with special needs populations or people with disabilities, especially those with service animals.

1.2 Goals

The goals of this training are to ensure that CSEPP emergency and health care (HC) providers have the most current information to set up a field decontamination station and to process both ambulatory and non-ambulatory victims of a chemical agent

or other hazardous release through the unit. The training is intended to enhance the reader's knowledge of:

- self- and buddy-decontamination procedures,
- mass decontamination procedures,
- prevention of secondary contamination, and
- special considerations (such as weather and vulnerable individuals) associated with the decontamination process.

While this training will provide some general guidelines on emergency decontamination of casualties, emergency medical personnel should be aware that this training **will not** address the specific procedures of decontaminating open wounds or abrasions nor will it provide continuing education unit (CEU) credits for on-going medical training. Certification is generally a State decision.

1.3 Course Organization

The training is organized into modules as follows. An overview of decontamination concepts is first presented. The discussion then moves to decontamination for vapor and liquid exposure, decontamination solutions, and issues related to secondary contamination. Lessons learned from 4 case studies, including the Tokyo subway Sarin release and 3 chemical exposure incidents here in the US, are presented to illustrate practical issues related to secondary decontamination.

The next section provides an overview of current practices and discusses self- and buddy-decontamination, the general layout of a field decontamination station, procedures for ambulatory and non-ambulatory decontamination, mass decontamination of multiple victims, and animal decontamination. This is followed by a discussion of special considerations for vulnerable populations, psychological aspects, and cold weather issues. The training concludes with brief discussion of radiological and biological exposures.

There are also references and an additional resource section in the appendices in this student guide. Appendix A includes a short exam and answer key for self evaluation. Appendix B contains checklists for developing a decontamination plan. Appendix C contains excerpts from the Memorandum of Understanding (MOU) from the Army clarifying the vapor exposure guidelines and need for decontamination signed by

Raymond Fatz. Appendix D contains further information on the case studies. Appendix E contains copies of the instructor slides. The last appendix contains references.

MODULE 2. FIELD DECONTAMINATION BASICS

2.1 Introduction

Decontamination is defined as the process of reducing or removing hazardous substances, including chemical warfare agents, by physical means so they are no longer in contact with the body, or by chemical neutralization (detoxification) so they are no longer hazards (1, 2). Decontamination is routinely used to remove potentially harmful substances from personnel, equipment, laboratory areas, workplaces, outdoor areas, clothes, food, water, sewage, etc. (3). This training focuses on the emergency decontamination of people and animals exposed to highly toxic chemicals, including chemical warfare agents.

Decontamination can be performed in portable units or specialized mobile or permanent facilities. The process is relatively simple for ambulatory victims, but increases in complexity with non-ambulatory victims, those with special needs, and when treating casualties. Once clothing is removed, washing the skin and hair is of primary concern to remove contaminants, but decontamination of eyes and wounds may also be required. In some instances, when injuries are life-threatening or victims have been exposed to a highly toxic chemical agent that requires an immediate antidote, medical personnel in appropriate personal protective equipment (PPE) may treat victims before they are decontaminated.

There are two general methods of decontaminating people - through physical means or chemical neutralization. After clothing removal, contaminants are removed by flushing the body with copious amounts of water, by scraping, or by blotting with a resinous material or inert powder to absorb the hazardous substance from the skin. Chemical neutralization includes washing with liquid soap solutions, diluted bleach solutions, or using special solutions or other products developed primarily for military use but also distributed commercially in the United States and Canada. While flushing with a soapy water solution is the most common decontamination method, decontamination should never be delayed if only water is available. Whichever process

used, decontamination should be performed as quickly as possible after exposure and contamination.

The major objective of decontamination of victims contaminated by a hazardous substance is the prevention of further harm and optimization of full clinical recovery (2). An important secondary objective is to avoid spreading contamination (called secondary contamination) to others beyond the site of exposure. Potential victims of secondary contamination may include first responders such as police, firefighters, emergency medical technicians (EMTs), and staff of the health care facility (HCF) where victims may be taken or to which they self-evacuate. The underlying goal during the decontamination process is to protect oneself, others, essential assets, and to the extent possible, the environment, from contamination. You can't help others if you become a victim. This training is oriented to developing a decontamination process that is fast, effective, minimizes secondary contamination, and maximizes the potential for complete victim recovery.

2.2 Decontamination Concepts

Decontamination can be a time-consuming process requiring specialized resources and large numbers of personnel if casualties or a large number of victims are involved. For highly toxic industrial chemicals (TICs), including the chemical warfare (CW) agents sulfur mustard and nerve agents, that have significant health effects if the minimal level dose is exceeded, decontamination must be initiated as quickly as possible - within minutes - following exposure, even for vapor exposure. When the primary route of exposure is inhalation and exposure is minimal, taking the victim out of the contaminated environment, having them remove and bag clothes, then having them wash exposed skin, hair and flush eyes, may be all that is needed unless an antidote can be administered to reduce adverse health effects.

Decontamination must be effectively completed **before** the victim is released into a clean environment, especially if that includes entry to a HCF or transport in an ambulance or other vehicle.

It is important that clothes and personal effects be removed, bagged and labeled as contaminated as part of the initial decontamination process because it has been shown that both contaminated clothing and hair can continue to off-gas and result in secondary inhalation contamination of other individuals in close proximity. Clothing removal eliminates the majority of contaminants - some estimate between 80 - 90% of them. However, most of the studies that suggest those figures were conducted by the military on individuals wearing full combat clothing - how much would be removed by someone wearing shorts and a t-shirt or other light clothing has not been fully evaluated but is likely much less.

2.3 Field Decontamination

Field decontamination is generally the task of first responders (firefighters and HAZMAT teams) who process victims through decontamination units at or near the chemical release or outside HCFs while wearing PPE that includes Occupational Safety and Health Administration (OSHA) approved full-face respirators and protective clothing. Any worker using PPE must be trained to operational awareness according to OSHA's standards as recorded in the Code of Federal Regulations (CFR) 1910.120 and, if wearing a respirator, as contained in CFR 1910.134. There are also medical screening requirements for workers. No one should attempt to wear a full-face or hood-type respirator during an emergency without proper fitting and testing of the equipment, the appropriate training for the PPE assigned to them, and having the actual experience of using the PPE, including the respirators, during exercises.

Field decontamination procedures are carried out in both rural and urban settings by full-time trained first responders or part-time volunteers with or without special decontamination equipment or training. Often field decontamination of potentially-exposed victims is performed as a precautionary measure, especially when potential health effects to those exposed are unclear, won't be known for some time, or the contaminant cannot be immediately identified.

Working under the hypothesis that removal of clothing reduces the majority of contaminants - whether chemical, biological or radiological substances - most field decontamination efforts involve clothing removal and showering either in a special decontamination unit such as a trailer or in an expedient unit or setup near the scene of the incident or adjacent to the HCF. In mass-decontamination situations with multiple victims, elements readily at hand such as a deluge of water from firefighting hoses that partially-clothed victims walk through may be used (4). The major objectives of field decontamination is to either transfer a clean victim to a HCF without contaminating the conveying vehicle or exposing others en route or to decontaminate potentially-exposed persons before they leave the incident scene.

Without a definitive means to establish field decontamination effectiveness of contaminants that are often unseen on victims, most victims undergo another round of decontamination at the HCF (sometimes called technical decontamination) to ensure the level of cleanliness needed to protect the HCF assets and staff, an issue that has prompted many complaints from victims. To ensure that secondary contamination is averted, every HCF should have the ability to lock down and secure the premises as soon as the potential for contaminated victims' arrival is detected. This is essential to protect critical assets - healthcare (HC) providers, the HCF environment, and the existing patient population.

Decontamination issues have been explored since the beginning of modern environmental cleanup activities and the invention of chemical warfare agents and consequently some simple principles have been found to achieve consistently good results (1). The most important element of treatment after exposure to a chemical warfare agent or to other highly toxic chemicals is to immediately remove the agent/contaminant through decontamination. Decontamination that is delayed or

ineffective can escalate the number of casualties when very toxic substances such as nerve agents are involved. However, if injuries are life-threatening, victims are sometimes transported to the HCF with minimal attention to decontamination. This problem is exacerbated if communications between the field response units and the HCF fail to describe the event so HCF personnel can take advance precautions, such as donning PPE, performing lock-down, and initiating decontamination set-ups outside the emergency department (ED) environment. In a terrorist event in which a chemical agent is intentionally released into a crowded environment, the number of victims transporting themselves to an unprepared ED without decontamination could quickly overwhelm a HCF's resources. This happened in 1995 when terrorists released sarin in the Tokyo subway system and that resulted in multiple cases of secondary contamination of HCF staff and others (5, 6).

Treating a chemical warfare agent-contaminated patient is similar to handling patients contaminated with other TICs, and requires similar precautions on the part of response and HCF personnel. Most - some estimate 95% - of the surface contaminants are eliminated by removing all clothing and showering with copious amounts of water (7). Others have estimated that only about 80-90% is eliminated by taking off clothing (8). While the process of removing clothing and showering is relatively easy to accomplish for ambulatory victims and first responders, casualties and non-ambulatory, victims with special needs, and animals present additional problems because of the increased number of personnel and resources needed to decontaminate victims, especially if a large number of victims present within a short period of time (8).

2.4 Use of Decontamination Categories

The military identifies three decontamination categories:

• personal decontamination - when an individual decontaminates him/herself or assists another to decontaminate - called self- or buddy-decontamination,

• casualty decontamination refers to decontamination of casualties - by far the most demanding in terms of time and staff especially if victims are non-ambulatory, and

• personnel decontamination that involves large numbers of usually ambulatory, non-casualty, or non-exposed victims (1, 9). Some ambulatory individuals such as the

elderly or young children may need assistance to ensu

Personal decontamination may or may not involve individuals wearing PPE (1, 9). First responders, especially HAZMAT personnel, routinely decontaminate their PPE and themselves after working in a contaminated environment. Army personnel also are expected to decontaminate within minutes after exposure to a CW attack. On occasion, personal decontamination (disrobing, bagging clothing, then showering with copious amounts of liquid soap and water) is required after an unprotected HC provider is exposed while caring for a contaminated patient who presents to the ED without alerting the admitting staff. Individuals may also be advised to decontaminate before leaving their residences following a chemical or radiological release. The CDC publishes recommended procedures in clear wording on their web site for residents unsure of how to decontaminate (see http://www.bt.cdc.gov). The information can be adapted by emergency planners to publicize over radio and television when a chemical release occurs

Decontaminating casualties requires extensive planning, training, and significant resources. It becomes especially difficult if many victims are non-ambulatory or unable to describe their previous health status or answer questions.

Personnel decontamination generally involves individuals that are ambulatory and able to proceed though the decontamination lines with minimal assistance. It is recommended that after proceeding through the decontamination process that individuals be surveyed for adequate removal of contaminants using a chemical monitoring device. Determining that oneself is clean should not be left to the subjective evaluation of victims, especially children (10, 11). This process requires sensitivity and tact when handling civilian casualties, especially in the stressed environment

of the disaster aftermath. Module 4 contains detailed information on the three decontamination categories.

2.5 Vapor versus Liquid Exposure

Current US Army guidance (12) recommends decontaminating people potentially exposed to both chemical agent vapors as well as liquids (droplets and aerosols). While the need for decontamination following liquid exposure has been long recognized, the value of decontaminating for vapor exposure has often been debated. The current policy is based on evidence that vapors absorbed into clothing and hair may continue to pose a health hazard to people and animals (see animal decontamination section) (13).

Decontamination for vapor exposure can be less rigorous than for liquid but it should be done immediately by completely removing clothing, shampooing hair and showering, and rinsing thoroughly. For liquid exposure it is recommended that three cycles of washing skin and hair in warm or hot soapy water be employed. If only cold water is available, use cold water and do not delay decontamination. A single-use sponge or washcloth should be used during the first two cycles (i.e., change the sponge after the first cycle); shampoo can be used to wash hair.

2.6 Decontamination Solutions

Desirable Traits of a Skin Decontaminant

- Neutralizes all chemical and biological agents
- Is safe (nontoxic and non-corrosive)
- Is easily applied by hand
- Is readily available
- Acts rapidly, producing no toxic end products
- Is stable in long-term storage
- Is affordable
- Does not enhance skin absorption of substance
- Is non-irritating and hypoallergenic
- Is easily disposed

Source: Textbook of Military Medicine, Part 1, pg. 352.

Figure 1. Desirable Traits of Skin Decontaminant

Many substances have been evaluated for their ability to remove contaminants from the skin. To be most effective, the decontamination solution should rapidly and completely remove and/or detoxify the contaminant without irritating the skin. Desirable traits are described in Figure 1.

One recent change in decontamination protocols for individuals is the preference for a soap and water solution over the previously recommended 0.5% bleach in water solution for nerve and sulfur mustard agents, although that solution is still acceptable (13). The reason for the change is that soap and water was found to be as effective as the diluted bleach solution, less caustic, and in sufficient quantities takes less time to remove material than the bleach solution. The military also stocks other decontamination solutions that are acceptable alternatives. What is important to remember is that decontamination for CW agents should not be delayed - if water is all that is available, use it and do it immediately. Using copious amounts of water works as well as most other decontamination solutions.

Reactive Skin Decontamination Lotion (RSDL) is a product developed by the Canadian Ministry of Defense and is available commercially through a Canadian company. RSDL is a yellow viscous liquid, impregnated in a sponge pad contained in a foil pouch. It is intended to remove or neutralize CW agents or T2 toxin from the skin. It is minimally irritating and can be removed with water. Research shows that RSDL is very effective for the skin decontamination of nerve agents. It was more effective in tests than either diluted bleach or soap and water (14). Its effectiveness for blister agents is unknown. In 2003, the U.S. Food and Drug Administration gave approval for the use of RSDL by the military. It is currently undergoing final configuration testing by the U.S. Department of Defense (DoD)for eventual deployment with U.S. troops.

The DoD authorized the sale of RSDL to US first responder organizations in September, 2004. Several communities have purchased it for their emergency response programs. In September 2006, the product received certification under the DHS Support Anti-Terrorism by Fostering Effective Technologies (SAFETY) Act of 2002 for use as an anti-terrorism technology. The purpose of the SAFETY Act is to encourage the development and deployment of anti-terrorism technologies that will substantially enhance the protection of the nation. The SAFETY Act creates certain liability

limitations for ‘claims arising out of, relating to, or resulting from an act of terrorism’ where qualified anti-terrorism technologies have been deployed.

2.7 Wastewater Issues

Disposal of contaminated solutions from decontamination of victims should follow the same procedures as disposal for other hazardous material solutions. If the contaminant is unknown or is suspected as benign at time of decontamination, precautions such as holding secured drums of wastewater solution until a definitive negative result is obtained from later laboratory analysis may save the considerable expense of sending the wastewater to a hazardous materials disposal site. The Environmental Protection Agency (EPA), which regulates storm water discharge, notes that in special circumstances, where the protection of populations is critical, contaminated water from decontamination can be diverted to a storm sewer or sanitary disposal (15).

MODULE 3. SECONDARY CONTAMINATION ISSUES

Because of the potential for secondary contamination of response personnel, it is essential that first responders and medical personnel understand the need for and undergo training in the use of PPE that includes respirators and level B or C clothing. Surgical masks and protective eyewear are not sufficient to protect against hazardous vapors from a contaminated patient's fluids, body, or hair (15). Some persistent CW and biological agents are not immediately symptomatic or visually evident on patient's skin, hair, or clothing. For example, sulfur mustard is a persistent oily substance producing signs and symptoms that are delayed for 2 to 24 hours after exposure. It is also mandatory that deceased victims of chemical agent events be removed from body-bags and decontaminated prior to release to prevent secondary contamination of unsuspecting forensic or funerary workers. In addition body-bags should be treated as hazardous waste and disposed of accordingly.

The general absence of criteria to determine the effectiveness of decontamination efforts presents serious safety, health, and security issues for HCFs. Field decontamination performed by HAZMAT personnel is generally considered gross decontamination and should always be considered as inadequate before admitting victims to an ED. This can be a serious problem if the HCF does not have procedures in place to decontaminate victims before they are admitted and HC providers respond to the event without determining the cleanliness of presenting victims (17, 18).

3.1 Secondary Contamination Case Studies

Having procedures in place to avoid secondary contamination from exposed victims is critical, especially for HCFs. The problems of secondary contamination can be illustrated by three case studies of incidents in which secondary contamination actually occurred and by one case study where it had the potential to occur had the contaminant been more toxic. (More detailed information is presented about each case study in Appendix D.)

The first case is the Tokyo sarin release in a subway system, the second occurred in New York where dimethoate - a pesticide similar to nerve agent - was released, the

third occurred when nitrogen mustard was accidentally released at a PVC manufacturing facility in Louisiana, and the fourth occurred at an Indianapolis, Indiana, postal hub where a worker handled leaked mercury. The studies emphasize three key lessons in performing decontamination:

• Responders and first receivers should be trained in 29 CFR 1910.120 and need to wear appropriate PPE they have trained and exercised in.

• Contaminated victims should be isolated until decontaminated to protect response personnel from becoming victims of secondary contamination.

• Responsible managers must make sure everyone follows standardized protocols and procedures, maintain current training, and ensure medical monitoring of staff occurs during the emergency.

3.2 Tokyo Subway Sarin Incident

On the 20th of March, 1995, terrorists initiated a coordinated attack on three subway lines in Tokyo, Japan, during the morning rush hour of 7-8 a.m. The perpetrators placed ten bags each containing about 600 milligrams of 35% diluted liquid sarin (the nerve agent GB) on five subway cars, then released the agent by poking umbrella tips into the bags. Sixteen subway stations were involved as affected passengers rushed out of the trains. The first emergency call reached the police at 8:14 a.m. and between 8:30 and 9:00 a.m. over 11,000 emergency workers were dispatched. An estimated 5500 people were contaminated and 12 victims died. First responders wore no PPE (6).

Most patients were treated at four large hospitals in the vicinity of the attack, although over 275 medical facilities were eventually involved. At St. Luke's hospital, one of the nearest hospitals to the subway, 35% of the approximately 500 patients treated walked on their own to the hospital, 24% were transported by taxi, and 7% arrived via ambulance.

No decontamination was conducted at the scene of the release. Decontamination began at the HCFs only after the nerve agent was identified as the cause 3 hours after the

incident occurred. The decontamination procedure was to undress and shower. There are no official estimates of the number of patients that were decontaminated; however it has been noted that most patients were not decontaminated. Mildly exposed victims were not decontaminated due to lack of changing and showering facilities.

One of the major difficulties encountered was undressing of victims and disposing of clothing due to the sheer volume of victims. The lack of victim decontamination before entry to hospitals resulted in secondary contamination of hospital staff. It was reported that 23% of the staff (110 individuals) at St. Luke's hospital who treated victims indicated acute symptoms of nerve agent secondary contamination. Inadequate ventilation also contributed to secondary contamination. First responders also suffered from exposure, likely both primary and secondary contamination. Of the 39 first responders who were taken to Tokyo Teishin Hospital 25 required admission (6).

The train cars and subway stations exposed to the nerve agent were decontaminated with water and detergent combined with industrial-strength cleansers. It was quickly applied and then washed off immediately, whereas our Department of health and Human Services (DHHS) recommends a 15- to 20-minute application before rinsing (19). The decontamination was performed by both military personnel and firefighters. It took about 3 hours and 20 minutes on two of the subway lines, and was completed 9.5 hours after the release occurred. On the third line it took about 15 hours and was completed 21 hours after the release.

Major findings:

1. Hospitals lacked the space and equipment to decontaminate multiple presenting patients.
2. Secondary contamination at hospitals was a major problem.
3. Lack of PPE on first responders resulted in hospital admission.
4. The Japanese government had no plan for major chemical disasters.

3.3 New York State HAZMAT Incident

On Sept. 14, 2000, workers at a lawn and garden treatment product company in New York State inadvertently overheated an organophosphate pesticide called dimethoate. Instead of heating the pesticide to the prescribed 150^0F, it was overheated to

220^0F and began emitting fumes. Inhalation of dimethoate fumes can quickly result in severe respiratory problems and other symptoms requiring immediate medical treatment. Eleven workers transported themselves to a hospital in a nearby community and walked into the ED without being decontaminated. As a result, several hospital employees treating the workers became ill themselves.

When the ED doctor saw his staff becoming ill, he immediately called the Assistant Fire Chief at his home to ask why his staff was getting sick. The Chief told him to immediately remove all victims from the ED and to treat everyone who had been in contact with them as contaminated. Outside in the parking lot, the male plant workers were decontaminated in a unit set up by the HAZMAT team. The ED staff and three female plant workers were decontaminated inside the hospital ED area where showers were present.

Some male workers initially refused to be decontaminated, stating they worked with the chemicals everyday but they finally agreed. Firefighters wore Level B PPE when decontaminating victims. Approximately 20 people went through the decontamination process, which took approximately one hour. To prevent the runoff containing the pesticide from entering the area drain, neoprene pads were placed over the drain. The wastewater was then pumped into 55-gallon drums and given to the hospital for proper disposal.

On-site hospital housekeeping staff dressed in scrubs, gloves, hairnets and wearing air filters were responsible for cleaning the emergency rooms where the exposed workers had first been taken along with the articles in those rooms. All walls were washed as well. The entire ED was shut down during the 2 hours it took to decontaminate the area. It is unclear who made the decision to reopen the emergency room to patients or what criteria were used to certify that the rooms were safe to reoccupy.

Major findings:

• Procedures for screening for contamination in the emergency room were not in place for unannounced incidents.

• ED staff had no training in identifying the symptoms of a hazardous chemical exposure.

• Lack of communication between jurisdictions was a significant problem. Although victims came from a nearby community, the ED doctor had to call his local fire chief to identify why staff were becoming ill from treating victims and what to do.
• To provide better treatment, hospitals that receive patients from many jurisdictions should have information on all chemicals that could result in potential toxic exposure and contamination.
• The hospital did not have a separate containment area for potentially exposed patients.
• There were no separate decontamination facilities for men and women. Having the female plant workers shower inside avoided the privacy issue associated with a single facility.
• Using housekeeping staff wearing minimum protection allowed the ED to be reopened within 2 hours of shut-down. No testing was done nor were reentry criteria used. No effort was made to follow up housekeeping staff for health effects.

3.4 Mustard Exposure at a Vinyl Chloride Production Facility

This incident occurred on September 24, 1996, when three workers began cleaning a heat exchanger in a vinyl chloride production facility in Plaquemine, LA. The process involved using a hydro-blaster delivering a commercial cleaning fluid at 10,000 psi to remove accumulated sludge from the fin fans and reactor of the heat exchanger. The operation took place in an elevated plywood shell. Around 500 construction workers were at ground level at various locations below the operation.

The hydro-blasting operation began at 4 PM on a Tuesday. The three workers were wearing suits designed for vapor protection. The lead member was using a fresh oxygen supply for respiratory protection. At 6 PM he ran out of oxygen and removed the respirator. For three hours all three workers were exposed to the liquid and sludge from the cleaning.

At 7 PM the hydro-blasters went home. The lead removed his work clothes and showered. At 1:15 AM the next morning he awoke in pain and his wife took him to the ED. At this time the other two workers developed small red spots on their skin. On Wednesday some of the construction workers who were working below the platform went to their doctors with similar symptoms. Wednesday afternoon the chemical

company sealed off the area still wet with water containing the sludge with yellow warning tape suspecting the symptoms were being caused by exposure to the cleaning fluid. Samples were taken and sent to a local commercial laboratory for analysis.

By Thursday about 150 people had reported similar symptoms. These included the workers as well as some spouses who had been exposed to secondary contamination by handling the clothes worn by the workers. The local laboratory could not identify any hazardous substance in the runoff liquid samples.

By Friday four workers had entered the hospital with severe burns over most of their bodies. One of the workers was placed in the hospital's burn center for skin grafts. This triggered an OSHA involvement on Monday, September 30. OSHA sent samples of the liquid to their Salt Lake City laboratory for analysis. Based on the symptoms and the results of a mass spectrometer analysis, OSHA analysts suspected the liquid contained the chemical warfare agent mustard, but technicians there did not have the protocols to confirm. OSHA then sent the samples to the treaty laboratory at the Army's Aberdeen Proving Ground which confirmed the samples contained both sulfur and nitrogen mustard agents.

The following concentrations were found:

• run-off water: 11ppm HD, 30ppm HN3 (forms of chemical warfare mustard agents)
• drips from fin fans: 211ppm
• water in hazardous waste storage system: 3800ppm

The cause of the mustard production in the vinyl chloride production process was never confirmed.

Major findings:

1. Personnel decontamination was not performed after exposure and contamination.
2. No control of contaminated personnel or clothing was exercised.
3. Secondary contamination occurred but at levels unknown.
4. Local physicians did not know how to treat symptoms.
5. Identification of the chemical warfare mustard agents as source of contamination took over one week.
6. Commercial laboratory analysis was inadequate.
7. PPE was not used or used improperly.

Evidence of the potential long-term effects from mustard agent contamination was examined through a follow-up study six years later of 247 workers who had been contaminated. The study found that healing of burns varied according to natural pigmentation of the victim's skin and that multiple and chronic skin infections developed on burns. Liver functions and cardiac conduction were also temporarily altered in the burn cases without other complications but no fatalities resulted. Months after exposure, bronchitis and posttraumatic stress disorder became prevalent among workers regardless of initial signs and symptoms. Other symptoms did not lead to any organ pathology except one case of Barrett's esophagus and another of oral metaplasia. Two infants conceived after exposure appeared healthy. Although the screening protocols administered were effective, clinical follow-up of cases was severely flawed by a lack of cooperation between providers and noncompliance by patients after settlement of lawsuits (20).

3.5 Indianapolis Mercury Incident

One early Friday morning in mid-September, 2000, an employee at a privately operated postal hub in Indianapolis, Indiana, discovered a small amount of mercury (similar to the amount found in a thermometer) on a conveyer belt. He proceeded to handle the mercury and was reported to his supervisor. Treating the incident as a HAZMAT situation, the township fire department was called and arrived about 10:30 AM.

The handler and two others who complained of breathing problems were immediately sent to the hospital via ambulance. Forty others in the vicinity of the conveyer belt were decontaminated and their clothing and personal items bagged. Several decontaminated victims sent to the hospital for evaluation via buses were observed opening their bags and retrieving and using their personal cell phones.

Once victims were at the hospital, a reconnaissance team checked the facility for contamination and the county health department personnel then went to hospital to check for contamination on bagged clothing. Shoes of the employee who initially handled the mercury were found contaminated. They also checked employees' cars but no more contamination was found. Victims were debriefed and told what signs and symptoms to

watch for. Fact sheets on mercury were distributed to all employees. Several employees not in the group originally decontaminated arrived at the ED the next day to be checked for exposure.

Major findings:

• No objective criteria was used for determining the level of contamination until the health department arrived at the hospital with a Jerome meter to measure workers for mercury exposure. No one was found contaminated.

• Decontaminated workers were sent to hospital via buses before the health department arrived.

• Bagged personal items taken with decontaminated workers were opened by workers to retrieve for personal items that could have led to secondary contamination of the HCF. Health department personnel later went to the hospital to check for mercury and found only trace amounts of mercury on the shoes of the original person who handled the mercury.

For more information about these and other case studies, see reference 21, Vogt and Sorensen's document, *How Clean Is Safe: Lessons Learned From Decontamination Experiences.* Oak Ridge National Laboratory, ORNL/TM-2002/178, October 2002 (available at http://emc.ornl.gov/EMCWeb/EMC/PublicationsMenu.html).

MODULE 4. CURRENT PRACTICES

To prevent the spread of contamination, knowing when and how to decontaminate victims is critical. Decontamination of victims brought to a HCF usually requires multiple teams to fully decontaminate non-ambulatory victims. Factors to be considered in planning for a decontamination facility in either a field setting or at HCFs include an estimate of the number of patients that can be processed, the estimated number of trained personnel in PPE needed to process victims, the frequency of rotating those personnel, and the availability of PPE for rotating shifts (22, 23). In this module we discuss current decontamination practices associated with:

- self- and buddy-decontamination procedures,
- PPE requirements,
- the physical layout and operation of a decontamination area for handling both ambulatory and non-ambulatory decontamination,
- mass decontamination techniques, and
- animal decontamination.

4.1 Self- and Buddy-Decontamination

When resources cannot be mobilized quickly enough to perform systematic and assisted decontamination, it is crucial emergency officials have a plan to instruct citizens potentially exposed to a chemical agent or other hazardous contaminant to either perform self-decontamination or assist others in the decontamination process called buddy-decontamination. This will likely be feasible for people in a residential structure or an institution with showers. For people in non-residential settings, such as a business, office buildings, stores, or other commercial locations, this technique may be practically impossible, as most public places have limited facilities to perform these operations. Victims will need to rely on emergency response crews, use large swimming pools that can handle large groups of victims, or relocate to a gym or other recreational facility with multiple showers (generally not an option when time is limited). An alternative is to use dry powders to blot away residue and then transfer to a facility with showers.

Decontamination is best done in a shower. Typical non-conserving showerheads

have flow rates of 5 to 8 gallons per minute, meaning that a typical 5-minute shower would send about 25 - 40 gallons of fresh water down the drain and into the sewer. By contrast, modern low-flow showerheads use only 2.5 gallons per minute, or 12.5 gallons for a 5-minute shower, reducing water demand by at least 50%. Both are considered adequate for decontamination purposes. (See http://www.sahra.arizona.edu/programs/water_cons/home/bathroom_shower.htm)

Instructions should inform people to:

• Remove and bag all clothing. Personal items, such as cell phones, watches, wallets, and jewelry should be placed in a separate sealable plastic bag inside another sealable bag that people can take with them when leaving the area. The bag should not be opened until inspected by officials at the decontamination station. Leather items should be bagged and disposed of because they cannot be effectively decontaminated.

• Then thoroughly shower with copious amounts of soap and water followed by a clean water rinse. Rubbing or using a brush is not advised for chemical exposures to avoid irritating the skin.

• After drying, people should dress in clean clothes and follow official instructions for taking further protective actions. Clothes in drawers and closets of residences should be free of contaminants.

• If people need eyeglasses or other items such as keys or non-leather items to leave the area, they can be decontaminated by washing with soap and water for at least 3 minutes. Prosthetics such as artificial limbs, or canes and walkers can be washed with soap and water during the decontamination process. Rings and waterproof watches can also be decontaminated with soap and water.

While self- and buddy-decontamination will not suffice for entry into the HCF, it will minimize health impacts to the exposed individual and help avoid cross contamination. Officials should anticipate that not all people will follow these instructions. Some will leave immediately without showering. Others may not bag personal items such as wallets, cell phone or jewelry because they view them as essential items to have access to (i.e., money, credit or insurance

cards, identification) or because they have personal or highly sentimental value (i.e., wedding rings).

Cross contamination can be avoided by setting up traffic control points co-located with decontamination stations and directing vehicle occupants to use them. Everyone arriving at a decontamination station, especially at a HCF. should be questioned and monitored for contamination of themselves and their personal effects.

4.2 PPE Requirements

Decontamination usually requires multiple teams to rotate in and out of PPE. While PPE is not difficult to obtain, training and exercising in PPE is often limited. Respirators with face-pieces must also be fit-tested for the individual which limits its use to that individual. When resources are scarce this can restrict the number of personnel capable of wearing PPE.

Federal regulations on worker safety require that an employer provide workers with PPE if it is required to perform the job and train them to use it correctly. The Code of Federal Regulations (CFR)1910.120 and 134 prescribe the guidelines for training, protective clothing and equipment. Other state and local regulations may specify types of PPE for specific positions or tasks in dealing with a range of hazardous materials. Plans should be in place to familiarize all workers with local and job-specific requirements as well as the federal regulations.

Workers who will require PPE include everyone - including volunteers - designated as part of the emergency response to a toxic chemical release. These include police and firefighters, EMTs, medical personnel and others such as those operating decontamination stations or who anticipate being active in a potentially hazardous environment. An emergency worker who has been issued PPE must be certified as physically able to wear the appropriate level of PPE by a medical doctor, trained in the restrictions and limitations of the PPE, know how to inspect and maintain the equipment, and be able to don and doff PPE properly.

Regular drills and training sessions for wearing the equipment should be incorporated into the emergency response protocols to ensure workers remain familiar with the equipment and the work rules regarding its use. This is particularly important in addressing the stay and rest times for workers wearing PPE because most people will want to do all they can for victims of a toxic chemical release and may put themselves - and others - at significant risk if work rules are not followed.

4.3 Siting Decontamination Stations

The first consideration is site location and layout, hopefully predetermined for fixed HCFs. Field decon stations are more problematic with proper positioning - upwind, uphill, and upstream - critical to ensuring the highest safety level for all involved. A properly sited station will also permit drainage of the decontamination water to be directed into a sump, holding pond, or a container that can be emptied later during the recovery phase. One important factor is immediately securing the area to prevent convergence of media and the "walking wounded." The next steps include establishing a reception area for initial screening-called the hot zone and a triage area for rapid medical evaluation and classification. CSEPP protocols follow the Simple Triage and Rapid Treatment (START) approach.

Decontamination stations can be portable for field use or located permanently at HCFs. At least two lines, ideally 3 should be established at the decontamination station - one for ambulatory (mixed or male only), one for non-ambulatory, and a third for female ambulatory victims. A warm water supply is preferable, especially if vulnerable groups such as very young children, the elderly or those with disabilities are involved. Another concern is to respect the privacy of those being decontaminated. The final concern is for controlling run-off of decontamination wastewater solutions whenever possible, or at least holding wastewater until analysis determines what they contain. A properly sited station allows drainage of the decontamination water to be directed into a sump, holding pond, or a container that can be emptied later during the recovery phase.

4.4 Physical Layout of a Decontamination Station

Figure 1 presents one example of a casualty receiving decontamination station using two lines. This can be deployed in a field setting at a safe distant upwind from the incident site, a traffic control point, or at a HCF. The hot (exclusion), warm (contamination reduction area), and cold (clean) areas should be identified during the planning phase. The hot zone is considered contaminated and where potentially contaminated victims and vehicles initially enter the station. It is critical that access, egress, and the perimeter be secured. Staff in the hot zone must wear PPE appropriate for the contaminant identified. Walk-in victims and those who cannot be

confirmed as having received decontamination from a certified hazardous materials unit in the field go to the screening stations in the hot zone before proceeding through the decontamination line. Medical personnel should determine if those decontaminated in the field prior to arrival at the HCF should be decontaminated again or if the patient can proceed directly to the medical treatment area.

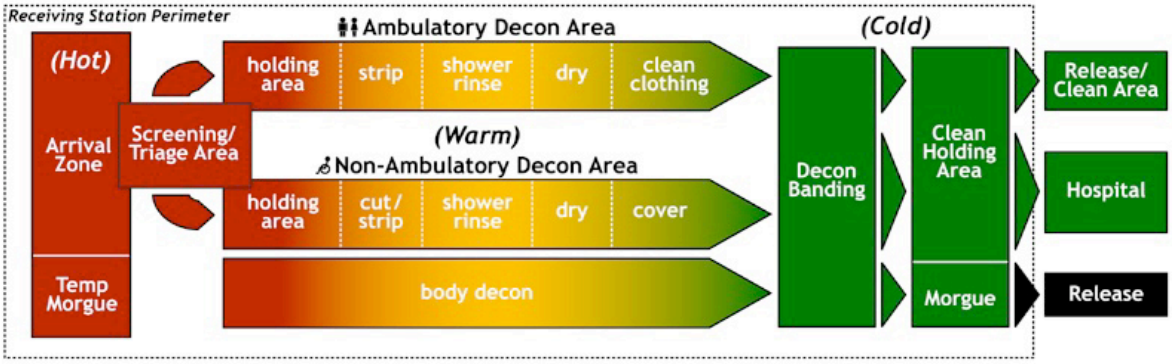


Figure 1. Decontamination Station with 2 Lines

The warm zone is where victims are decontaminated and dried. Staff monitoring the process should be wearing appropriate PPE. The cold zone where victims generally don clean clothing is considered free from contamination and no PPE other than normal precautionary protection is needed. This is where medical treatment generally occurs although for critically injured victims, triage and treatment can be performed before decontamination begins by appropriately protected medical personnel. Those victims are then decontaminated through the non-ambulatory decontamination line. The cold zone should be upwind and uphill from the hot zone with a secure perimeter.

Three decontamination lines are preferable, especially if non-ambulatory victims are expected or if multiple teams of response personnel will need to quickly decontaminate before rest periods. Remember that stay and rest times for response personnel in PPE are not optional and will need to be enforced, especially if responders and HC staff are working in extreme heat or cold weather conditions.

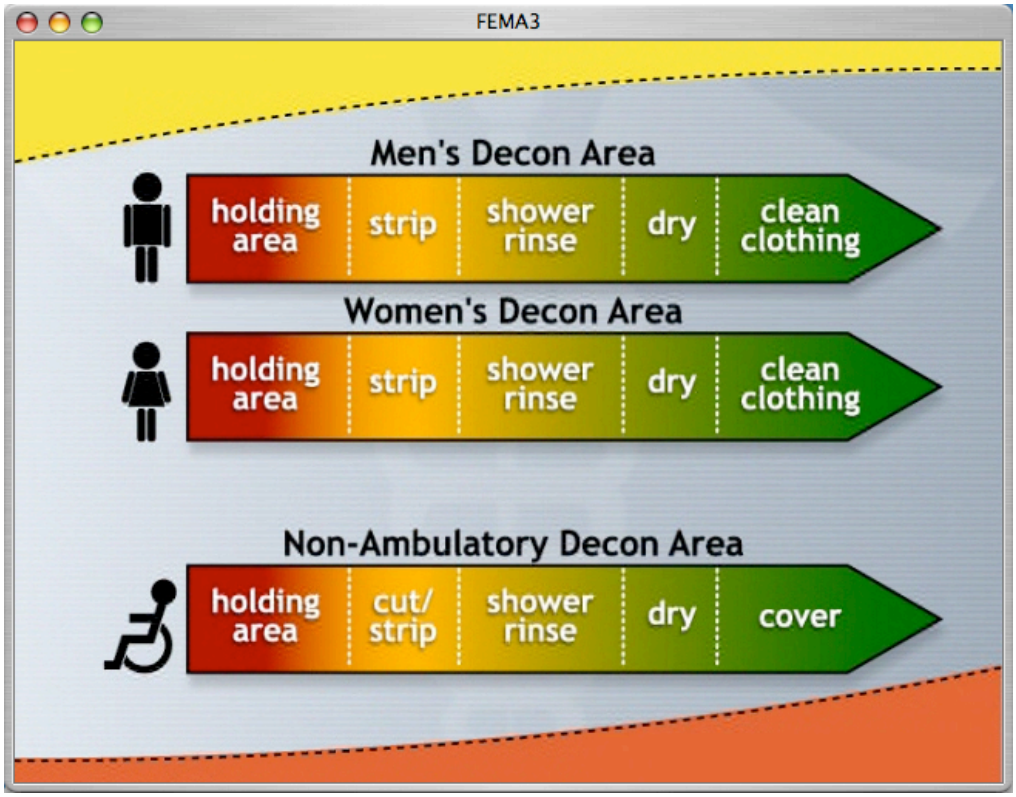


Figure 2. Decontamination Station with 3 Lines

Site location and layout for decontamination at the HCF should be predetermined and well known to HCF managers and staff and immediately communicated to all first responders, traffic controllers, and ambulance operators when an event occurs. Maintaining secure perimeter control and clean work areas is critical to HC staff and decontaminated victim safety. All staff should be aware of the potential problems of cross or secondary contamination and should know how to effectively and efficiently process victims through the decontamination stations. This takes planning, training, and exercising.

A decontamination station could also be temporarily deployed in a parking lot outside the ED entrance to a HCF using a portable unit that includes showers and dressing areas. Many newer or retrofitted HCFs include a more permanent decontamination facility constructed adjacent to the ED that can be used by arriving patients or HC staff in emergencies. Descriptions of permanent facilities are discussed by MacIntyre et al. (8). Common features of most decontamination stations include separate lines for ambulatory patients and non-ambulatory patients. For ambulatory patients separate lines should be established for males and females for privacy reasons. Each is discussed in more detail in MacIntyre et al.

4.5 Decontamination Priorities

Priorities for sending patients through the decontamination station should be made by medical personnel as part of the initial triage process (see video *Don't be a Victim: Medical Management of Patients Contaminated with Chemical Agents*). Priorities may be incident specific and response personnel need to factor these in when establishing priorities for who will be decontaminated and when and where the process will take place. In order, priorities should be given to people who are:

- known or suspected of being contaminated who require prompt medical attention due to toxic agent exposure or other severe injury;
- exhibiting signs and symptoms of toxic agent exposure;
- known to be contaminated but are not exhibiting signs or symptoms and don't urgently require medical attention;
- suspected of being contaminated but show no signs of agent toxicity; or
- not contaminated but accompanied by service animals that are known or suspected to be contaminated (e.g., seeing eye dogs).

4.6 Ambulatory Patient Decontamination

Basically, the process is - receive, triage, decontaminate, and tag. Medical personnel should decide who should process through the ambulatory line and who should receive other attention. The "walking wounded" and others tagged minimal in the initial triage process can usually be sent to the ambulatory decontamination area where only a few personnel are required

to supervise the self-decontamination process. Parents should remain with children whenever possible.

Medical personnel may decide to decontaminate ambulatory victims' wounds and remove bandages before having victims shower. Because bandages can readily absorb liquids or aerosols, passing a victim with bandages across the contamination control line to relatively unprotected medical personnel could create a secondary health hazard. Open wounds should always be decontaminated by medical personnel with a sterile solution, not a liquid soap and water solution. Previously applied dressings and foreign bodies are first removed from the wound. The wound and surrounding areas are then flushed. The wound is then decontaminated by wiping outward, packed, and then prior to full-body decontamination, sealed with a water-tight dressing.

Ambulatory victims should be instructed to remove all clothing and to bag all personal effects separately. Contaminated clothing should be cut away and discarded to avoid potential exposure of the contaminant to the victim's eyes and mucous membranes of the mouth and nose. The victim should then shower with copious amounts of liquid soap and water from the head down, leaning the head back to reduce the chance of contaminated residue contacting the eyes, nose, or mouth. Encourage careful cleaning of warm, moist body areas, such as the armpits, under breasts in females, and the groin, followed by a thorough overall rinse with clean water.

Once decontaminated, victims should dry and don clean clothing – Tyvek® disposables or medical scrubs work well. Victims should then receive a standardized wristband or tag indicating that decontamination has been completed before moving to the cold zone staging area for screening, medical treatment and observation. The best assurance a victim is free of contamination is certification of a thorough decontamination.

Most ambulatory patients will be capable of self-processing through the ambulatory decontamination lines but some, such as young children, the elderly, or those with special needs such as the hearing- or mobility-impaired, may require assistance or other support to adequately decontaminate. If possible, separate decontamination lines should be set up for males and females. When only two lines are possible, it is recommended that the second line be kept for non-ambulatory cases - such as people with wheelchairs or walkers, those on stretchers, or anyone else requiring assistance or supervision.

People who were never in the path of a toxic cloud or in a contaminated area and who are without signs and symptoms of exposure - "the worried well" - do not need to be decontaminated immediately but should be segregated from those that are potentially contaminated. However, if some individuals are still concerned about possible contamination, they should be instructed to return home, remove the outer layers of clothing and take a quick 3-4 minute shower followed by drying and donning clean clothing. Since much of the contamination – whether from liquid or vapor exposure – is removed by discarding clothing, that action followed by a rapid shower will likely eliminate any contaminant.

4.7 Non–Ambulatory Patient Decontamination

Non-ambulatory victims displaying serious signs and symptoms of injury should be the first ones decontaminated through the non-ambulatory decontamination line. Rapid decontamination is critical and involves a similar process of cutting away clothing if necessary to avoid taking clothes over the head, flushing of eyes with clean water or a sterile solution, and a quick, high volume shower focusing on areas of skin and hair that were potentially exposed using the quadrant technique described below. Once patients have been decontaminated by personnel wearing appropriate level PPE, HC providers should follow universal precautions by wearing gloves, masks and eye protection when treating these victims, and may decide to more thoroughly decontaminate a patient if severe signs and symptoms continue. Patients exhibiting moderate signs will be processed in similar fashion once the patients exhibiting serious signs and symptoms are completed. Those with minimal signs and symptoms should be decontaminated following those patients.

Normal decontamination of a non-ambulatory patient without injuries usually takes 2 to 4 staff and 10 to 20 minutes. The casualty's backboard or stretcher should be elevated to limit the

amount of run-off exposure to the victim. Each staff member focuses on a quadrant of the victim's body using the waistline as a midline. Clothing is cut away or otherwise removed. Starting at the midline, staff sprays or wipes the victim laterally or to the side or back of the victim. The sponge or washcloth used to decontaminate should be rinsed in the decontamination solution (i.e., liquid soap and water) after each wipe. Once the front of the body is finished, the patient is rolled on the side and the back is decontaminated going from the highest to lowest point.

Once the actual wiping process is complete, a liberal amount of water should be used to rinse the patient; then the patient is dried. The process usually requires between 35 to 50 gallons of decontamination solution per patient; fresh solution and wipes should be used for each patient. Once washed, the patient is placed onto a clean stretcher or backboard and transferred into the cold (clean) area.

4.8 Mass Decontamination of Multiple Victims

Multiple presenting victims may be decontaminated in one or more large groups - called mass decontamination. CW agents can cause large numbers of casualties if dispersed in a vapor or aerosol form as was manifested in the Tokyo subway incident when sarin was released. Such a situation could also occur in a crowded public venue such as a stadium, concert arena, or a major airport. The mass decontamination process requires cordoning off several areas in close proximity to the exit of the venue where a decontamination corridor can be set up with fire department aerials and/or deluge guns in close proximity. The nozzles are set at low volume (fog nozzles) so as not to inflict damage while maximizing the amount of water each victim receives. Ambulatory victims can be grossly decontaminated as they proceed through the deluge. In conjunction with removal of outer clothing, this method will likely suffice to decontaminate those victims not exhibiting signs or symptoms of exposure.

Another mass decontamination method is to set up sprinkler heads near exit points of the hot zone as rudimentary decontamination showers. In this scenario, water delivered at 500 gallons a minute will produce 8 gallons per second. In both scenarios some clothing is left on, which reduces the effectiveness if the agent has penetrated to the skin.

Potentially contaminated run-off from mass decontamination stations generally must be contained and disposed of in compliance with local or state environmental regulations. EPA has

published guidelines on this issue and determined if containment interferes with saving lives, waste water can be directed into sewers or into the environment (15). EPA recommends that once imminent threats to human life are addressed, reasonable attempts should be made to contain wastewater and prevent potential environmental damage.

4.9 Animal Decontamination

You should be aware that in October, 2006, President Bush signed the Pets Evacuation and Transportation Standards Act that amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act and requires local and state emergency preparedness authorities to include in their evacuation plans procedures to accommodate household pets and service animals in case of a disaster. Local and state authorities must submit these plans in order to qualify for FEMA grants.

The PETS Act grants FEMA the authority to assist states and local communities in developing disaster plans to accommodate people with pets and service animals. It also authorizes federal funds to states to help with developing pet-friendly shelter facilities. And it allows FEMA to provide assistance for individuals with pets and service animals, and other animals, following a major disaster.

Most animals with hair can be decontaminated using a soap and water solution. Everyone performing decontamination should wear appropriate PPE, be trained to use the PPE, and be trained to handle potentially traumatized animals. It is critical that volunteers without training not be allowed to decontaminate animals because of the potential for bites or punctures or harm to the animal itself. Plans should also include procedures for animals used for search and rescue in or around structures demolished in explosions or fires who will need to be decontaminated before taking breaks to ensure debris on animal's hair and feet will not result in secondary contamination of clean break or relief areas.

Owners should not attempt to decontaminate animals unless they are certain the substance will not cross contaminate the person from contact with residue on the hair or from off-gassing. Owners should be vigilant about being exposed to persistent substances such as the oily residue from chemicals or entities causing disease transmission from animals to humans (zoonotic diseases) from water-borne contaminants if animals were

found roaming after a flood. Some, but not all, first response teams are trained to decontaminate animals and should be included in the development of the jurisdiction's emergency plan annex on providing animal care in disasters. Owners and managers of animal-care facilities should be careful to sequester a potentially contaminated animal until the decontamination process is completed.

It is important to dispose of and replace any items made of leather such as leashes and collars following a potential exposure to chemicals. Leather readily absorbs chemicals and cannot be decontaminated. Thus, replacement collars and leashes must be stockpiled as substitutes for leather ones in order to ensure control of animals.

At the decontamination site, an animal decontamination line can be set up by trained animal control or veterinary personnel wearing appropriate PPE. At the arrival point animals are appropriately controlled (consider muzzling), tagged, and evaluated for injuries and the extent of possible contamination. If necessary, the animal will be tranquilized to ease the decontamination process or euthanized if injuries or exposure are too severe to permit it to survive decontamination. The animal is placed on a disposable leash and moved to the gross decontamination area where the actual process is begun. The temporary leash remains on during the process for control of the animal, and then discarded after the gross decontamination is complete. A clean leash should then be placed on the animal, and when possible, the animal should be wrapped in a large blanket or towel to prevent environmental exposure. Much like the human decontamination process, the animal should be constantly evaluated for changing signs and symptoms.

In the clean area, the animal is tagged as clean and is evaluated by a veterinarian or animal control personnel. Any wounds are treated and, if serious enough, the animal will be transported to a veterinary clinic. If possible, animals will be reunited with its owners. Unclaimed animals should be transported to a local animal shelter or holding area, and their picture displayed at the clean side of the human decontamination line. The information should be circulated to media and others for publication. This will assist in the reuniting of the owner and pet as quickly as possible, reducing additional trauma for owner and animal.

Medical protocols should be determined prior to the actual process of animal decontamination. Dosages for sedatives should be prepared by a licensed veterinarian

and stored and procedures tested in drills. Other issues to consider in preparing plans include procedures to determine if animals need to be muzzled to protect the care providers and the type of identification system to track the animal through the decontamination process, especially if in the owner is unavailable or missing.

Deceased animals should be placed in an appropriate container on-site and left in the hot zone. A hazardous materials contractor performing the cleanup should be responsible for the eventual disposal of deceased animals. A list of animals and their identifying data from collars and/or tags together with a digital photograph should be retained for use in informing owners afterwards if owners are not present at the time of euthanizing.

MODULE 5. SPECIAL CONSIDERATIONS

This module describes some aspects of decontamination that planners and responders should consider in developing protocols and procedures. These include working with individuals that require special consideration, such as the very young and the elderly, the potentially significant psychological and social consequences of the decontamination experience, and the impact of very cold weather during decontamination efforts. The section also discusses the decontamination process for radiological and biological contamination and jurisdictional issues that may complicate the decontamination process.

5.1 Infants/Children/Elderly

Children may have greater difficulty decontaminating than adults, especially if parents or guardians are not present during the process. Skin decontamination is more problematic for children and infants who, because of their proportionally larger body surface area, lose heat rapidly when showered with water. While a 5-minute shower is generally recommended as adequate to remove contaminants, young children may take up to 15 minutes to complete the process. This can greatly slow the number of people that can be processed through the decontamination station. Special provisions such as heat lamps or other warming apparatus and blankets or large towels may be needed after showering to maintain the child's body temperature. It is recommended that children shower with warm water unless the chemical contaminant is oily, in which case liquid soap and water is the recommended approach. Mass decontamination with cold water or deluge from fire hoses is not recommended for infants and children.

Some elderly people and those with disabilities may also require assistance when decontaminating, even if ambulatory. Responders should be aware that some will find the event extremely disturbing or confusing, and procedures should be in place to help them through the process. Making local government emergency preparedness and response programs accessible to people with disabilities is required by the Americans with Disabilities Act (ADA) of 1990. One way to ensure that accessibility protocols are in

place in a community's emergency planning or decontamination response activities is to involve people with disabilities or their organizations or advocacy groups in identifying needs for specific groups and evaluating effective decontamination protocols. One issue with great impact on people with disabilities is having access at all times to their mobility devices, such as wheelchairs, scooters, walkers, canes or crutches, and service animals. Emergency plans should describe the protocols for decontaminating such items as well as how to treat service animals and their equipment at decontamination stations.

Plans also need to include provisions for people who use oxygen or respirators, are blind or have low vision, are deaf or hard of hearing, have a cognitive disability or mental illness, and those with other types of disabilities that limit their stamina. They may not self-identify their constraints and responders should be trained to recognize and deal with those factors during the decontamination process. Planning should also include representatives of mental health care agencies as they may have teams trained in going into the community to deal with individuals having a crisis. Such teams could be of great help pin assisting the mentally ill who may have difficulty cooperating with the decontamination process and treatment.

4.2 Psychological and Social Consequences

The psychological and social consequences and impacts of decontamination experiences have only been examined conceptually or anecdotally and have not been well researched using a scientific method. Cole (24) conducted case studies on 6 anthrax hoax events. He concluded that the methods used for decontamination were profoundly embarrassing and discomforting for many victims. Among the problems Cole noted were showering while naked in front of emergency workers and television cameras, having to tolerate extremely hot or cold water, walking barefoot in the snow, being decontaminated multiple times (as many as four times) and being placed in a body-bag after decontamination. Such experiences left people bitter and distrustful of officials and responders.

Disasters involving TICs and especially CW agents have the potential to leave many survivors (exposed and non-exposed) with psychological problems including post-traumatic stress syndrome. This has been documented in a 10-year following of the

Japanese sarin-attack survivors(6). Adding the often traumatic aspects of decontamination process to the unavoidable trauma of the incident itself should be avoided or minimized to the greatest extent possible.

4.3 Cold Weather

Outdoor decontamination in cold weather should be carefully evaluated by first responders because of the potential risk for cold shock and hypothermia to victims, especially when wind is present. As the ambient air temperatures decreases, some wet decontamination processes present risks that must be balanced against potential hazards posed by chemical warfare agents and other highly toxic chemicals.

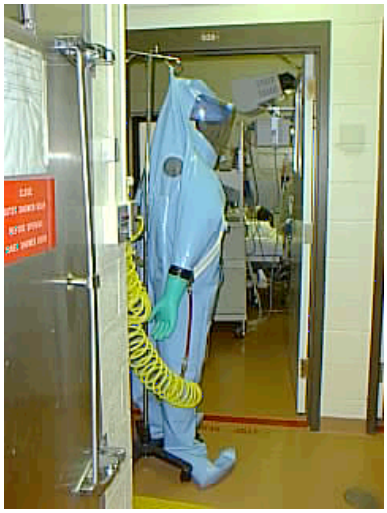
Except for the more susceptible individuals (the elderly, the very young, and those with pre-existing medical problems), most people can be safely decontaminated outdoors or in unheated units at ambient air temperatures at or above 65^0F. As the ambient air temperature decreases below 65^0, the risks of serious health complications increase for some people. Cold shock refers to the sudden onset of physiological responses such as an increase in blood pressure triggered by cold-water exposure. It occurs almost immediately and should be anticipated by emergency personnel in mass decontamination events.

Between 36^0F and 64^0F, decontaminated victims should immediately move to heated enclosures after showering if they cannot be decontaminated in heated enclosures with warm water. Victims should not be decontaminated with water outdoors when temperatures are below 35^0F. Other methods suggested for very cold temperature decontamination include initially using dry powders or dirt, blotting exposed skin with paper towels before transporting victims to a heated structure with adequate shower facilities, or using a very large heated swimming pool where large numbers of victims can quickly immerse (25).

5.4 Decontamination for Biological Contamination

For biological agents, contamination is defined as the introduction of microorganisms into tissues or sterile materials; decontamination is the disinfection or sterilization of articles to make them usable. Disinfection is defined as the selective

elimination of undesirable organisms to an acceptable level that prevents them from causing infection. Sterilization is the complete killing of all organisms and is not used on humans.



Decontaminating victims exposed to biological agents is aimed at disinfecting the skin and sterilizing exposed removed clothing by chemical or physical means. Decontaminating skin after a biological attack is of lesser concern than for a chemical release because most biological agents are not by themselves dermally active (except for some mycotoxins). The real threat is inhalation of enough organisms or toxins to cause infection. Biological agents may be transmitted to medical personnel from secondary aerosolization of dry agents. No specialized protective equipment is usually necessary other than standard barrier protections, unless the patient is infected with plague bacillus, smallpox, or a hemorrhagic fever virus, or if procedures will create bloody aerosols. In such cases it is recommended a filtered respirator be worn (1: pg 356).

Skin exposure to biological agents should be treated with liquid soap and water, followed by rinsing with a diluted (0.5%) bleach solution and thorough final rinsing with water. Victims should use a brush and scrub exposed skin to ensure a mechanical loosening of the contaminating agent from the skin.

5.5 Decontamination for Radiation Contamination

Radiation contamination occurs when material containing radioactive particles is deposited on skin, clothing, or any surface area of an inanimate object (26). A person contaminated with radioactive material will continue to be irradiated until the source of radiation is eliminated. External contamination occurs when radioactive materials are deposited on skin, hair, or clothing. Internal contamination occurs when radioactive materials are inhaled, ingested, injected into, or enter the body through wounds.

Decontaminating victims contaminated with external radioactive materials follows a process similar to that for chemically contaminated victims: remove all

clothing, wash skin and hair with a liquid soap solution, rinse, dry and don clean, uncontaminated clothes. Care should be taken not to irritate the skin. Decontaminated victims can be surveyed for residual radioactivity by the use of the newer portable and compact radiation monitoring equipment that can measure alpha, gamma, and/or beta radiation (26).

Once at the HCF, it is necessary for medical staff to remove all foreign materials from wounds as alpha and beta emitters left in a wound can cause extensive internal injury and may be absorbed into the circulatory system. Surgical solutions used to flush wounds should be removed by suction rather than wiping or sponging. Nasal swabs of each nostril may be taken and labeled for later laboratory analysis to identify the specific radioisotope and to assess the potential for internal contamination of the victim.

5.6 Jurisdictional Issues

Field decontamination of victims can be viewed as a health issue, an environmental issue, a crime scene issue, or a combination of all three. The decision to label an incident as a crime scene or potential terrorist incident can essentially shut down the incident site until all evidence is collected. Responders, health officials, owners, managers, and HCFs will likely encounter significant delays while the investigation is on-going. Chain-of-evidence procedures which might be adhered to after a CBRN event suggests that first responders to a suspicious event or staff of a HCF to which victims self-evacuate should have protocols in place to quickly establish containment identity and tracking of contaminants. This is because some substances have an identifying element that allows them to be traced to their original source. However, some chemical warfare agents can only be identified by specialized military laboratories.

Another issue is who determines whether decontamination is appropriate. The philosophy to decontaminate as soon as possible without input from medical or poison control centers should be questioned. It is appropriate in the CSEP program because the communities and first responders are told what the chemical warfare agent is and know where it is going geographically. However, decontamination as a precautionary measure, especially for children without parental consent, should be rethought by first responders. At the very least, first responders should be in direct communication with health officials,

poison control centers, or other medical resources to determine the need for mass decontamination instead of thorough self- or buddy-decontamination at an appropriate venue.

5.7 Summary

The number of administrative and logistical problems that can hinder effective decontamination efforts may seem overwhelming at first, but with planning, training, exercises management support, and appropriate resources, such events can be managed with less chaos and confusion. There are two primary considerations. The first is that decontamination should be initiated as quickly as possible after exposure to CW agents and other TCIs. The second factor is the importance of protecting the emergency responder, the HCF and its assets, and the HC providers from becoming victims themselves through secondary contamination. With repeated training and practice, this can be accomplished while optimizing care provided to patients and victims and keeping secondary contamination to a minimum.

APPENDICES

APPENDIX A

DECONTAMINATION COURSE SELF-REVIEW TEST

Multiple Choice

1.Decontamination of chemical agents is done by:

a. Physically removing the agent.
b. Neutralizing the agent.
c. Either a and b.
d. None of the above.

2. Which of the following statements best describes the proper handling of the exposed person's personal articles?

a. They should be thrown away since they can not be adequately decontaminated.
b. Look them over carefully; if they do not appear to be contaminated give them back to the victim.
c. Handle all articles as though they are contaminated; place articles in agent-impermeable bags and label bag with person's name.
d. Label each item with the person's name and whether or not the article has been decontaminated, wrap in a bleach-soaked cloth and send with person.

3. Decontamination is needed for:

a. Liquid nerve agent exposure only.
b. Both liquid nerve and vesicant agent exposure.
c. Liquid and vapor nerve and vesicant agent exposure.
d. None of the above.

4.The most important and urgent category for decontamination is:

a. The general environment.
b. Drinking water.
c. Foods.
d. People.

5. It is critical that decontamination be done quickly and correctly for chemical warfare contamination in order to:

a. Minimize adverse effects to the exposed person and prevent secondary contamination.
b. Prevent the agent molecules from multiplying and causing uncontrolled, widespread injuries.

c. Keep the contamination centralized on one person instead of spreading to several others.
d. Reverse the effects of the agent.

6. The most effective method for performing decontamination is:

a. At a HCF only.
b. At a designated decontamination station only.
c. Thorough self- and buddy-decontamination followed by technical decontamination.
d. None of the above.

7. The preferred decontamination solution to use is:

a. Undiluted bleach.
b. Diluted bleach.
c. Liquid soap and water.
d. Commercial solutions.

8.According to the EPA, decontamination wastewater may be diverted to storm sewers when:

a. Disposal containment is inconvenient.
b. It interferes with public safety.
c. It's too costly for the jurisdiction.
d. All of the above.

9. Because agent vapors can penetrate a victim's clothing the decontamination procedure requires that:

a. All clothing be removed and bagged.
b. All clothing that has been contaminated by liquid agent be removed and discarded.
c. Decontaminant solution be poured over the victim making sure to drench all clothing.
d. The part of the clothing that is penetrated by the agent be specially decontaminated.

10. To document decontamination treatment, the person who has been decontaminated should:

a. Be told what treatment she/he has received.
b. Be given a tag that indicates decontamination has been performed.
c. Be given standardized wristbands that indicate that decontamination occurred.
d. Ether b or c.

<u>True or False</u>

11. Clothing that is normally removed over a person's head should be cut away from non-ambulatory patients.

12. Less rigorous decontamination is required for vapor exposure in comparison to liquid exposure.

13. People self-reporting to a hospital after a chemical event should be screened in the emergency department to determine if decontamination is needed.

14. It is best to segregate males and females when decontaminating.

15. It is best to decontaminate with cold water.

16. The best way to decontaminate pets is to spray them with a high velocity fire-hose.

17. Life-threatening wounds should be treated before decontamination occurs.

18. A field decontamination station should be set up immediately adjacent to the accident site.

19. Most chemicals are removed from the victim by taking off or cutting away clothing.

20. People near the release showing no signs of exposure should be sent home and told to shower with soap and water.

Answer Key

1. C

2. C

3. C

4. D

5. A

6. C

7. C

8. B

9. A

10. C

11. T

12. T

13. F

14. T

15. F

16. F

17. T

18. F

19. T

20. T

APPENDIX B

DECONTAMINATION PLANNING CHECKLIST

The following checklist was developed to aid in the development of a decontamination plan.

Develop Decontamination Plan

___ A decontamination plan should be incorporated into the hazard-specific appendix of a jurisdiction's Emergency Operations Plan. The decontamination plan may be developed separately by the jurisdiction or jointly with the installation or chemical facility and other state and local jurisdictions.

Decontamination Plan Content

Agencies Responsible

___ The plan should identify the organization(s) responsible for the decontamination of people and of animals that provide critical support of humans (e.g., seeing eye dogs). This may include departments of the jurisdiction's government, agencies of other levels of government, private contractors, or volunteers.

___ The plan should identify officials and agencies responsible for establishing and implementing as strict quarantine of all potentially contaminated materials and property that will not be immediately decontaminated. (The strict quarantine will prohibit entry by the unprotected public until responsible officials determine through monitoring and sampling that unrestricted reentry and use by the public is safe.

____ The plan should identify agencies and officials responsible for determining if the incident area will be handled as a crime scene or terrorist attack scene and determine how the issues of access, decontamination, and treatment will be handled.

Resources

___ Each decontamination station should provide for a personnel decontamination station to be established at each reception center and at each host hospital identified in the evacuation plan and at other locations as needed.

___ Each decontamination station should be located where adequate supplies of water and electricity are/can be made available.

___ Each decontamination station should be designed to contain and collect all used decontamination solutions and rinse water for later disposition. A supply of clean clothing or clothing substitutes should be available at each station.

___ Each decontamination station should be staffed with personnel who are trained, equipped, and clothed to decontaminate potentially contaminated people while incurring minimal risk of self-contamination. Each decontamination station will be adequately staffed and equipped to decontaminate the maximum number of contaminated individuals expected to arrive at the decontamination station.

___ Each decontamination station should be capable of being staffed quickly after the public has been alerted and notified of the emergency (at a minimum, sufficiently staffed to detain and provide expedient decontamination to potentially contaminated individuals until full operability achieved).

___ Each decontamination station should have the capability to perform decontamination concurrently with life-saving first aid for people suffering from agent exposure or other injury. A supply of auto-injectors for nerve agent treatment should be available.

___ Each decontamination station should be capable of screening people who have been decontaminated, as well as other evacuees, for symptoms of chemical agent toxicity.

Planning Procedures

__ The plan should establish guidelines for determining when decontamination is needed, what decontamination resources are available, and which decontamination concerns must be addressed through pre-event planning.

___ The plan should include a list of priorities for the decontamination or other treatment of people to guide the allocation of resources in the aftermath of a chemical agent release producing contamination.

___ The plan should have an evaluation procedures for deciding which individuals require decontamination as well as procedures for immediately decontaminating people (including infants and individuals who are injured, handicapped, or elderly) likely to have been contaminated by chemical agent.

___ The plan should have operating procedures for handling the personal property and animals of potentially contaminated persons.

___ The plan should describe the jurisdiction's plans for educating the public on personal self-decontamination and decontamination of others (i.e., self- and buddy-decontamination). These plans should apply to all people in areas at risk of exposure to agent.

Public Education/Information

___ Public education program may include instructions on self- and buddy-decontamination, a list of necessary supplies, and guidance on other means of expedient personal decontamination.

___Public information releases at the time of the emergency should clearly identify the population segments that may have been in the chemical agent plume or may have come in contact with people, animals, or objects (e.g., vehicles) that have been in the plume and therefore should perform self- and buddy-decontamination.

___ Public information releases at the time of the emergency should clearly identify the locations of decontamination stations and stress that no one should enter a HCF without first being decontaminated.

APPENDIX C

Excerpts from the U.S. Department of the Army. *Implementation Guidance Policy for New Airborne Exposure Limits for GB, GA, GD, GF, VX, H, HD, and HT* June 18, 2004 signed by Ray Fatz.

In Appendix A: Paragraph 4-5,c. states:

"(1) Vapor-exposed nerve agent casualties should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing.

(2) Liquid-exposed nerve agent casualties (particularly their skin and hair) should be decontaminated by -

(a) Washing the skin surface and hair in warm or hot water at least three minutes. The rapid physical removal of a chemical agent is essential. Scrubbing of exposed skin with a stiff brush or bristles is discouraged, because skin damage may occur and may increase absorption of agent. Use liquid soap (dispose of container after use and replace), copious amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. The third wash should be a rinse with copious amounts of warm or hot water. Shampoo can be used to wash the hair. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. Two permissible alternative skin decontaminates include the M291 Skin Decontamination Kit (SDK) and a 0.5% sodium hypochlorite solution. If used, the 0.5% sodium hypochlorite should be applied with mild to moderate friction, with a single-use sponge or washcloth in the first and second washes. The third wash should be a rinse to remove any residual sodium hypochlorite with copious amounts of warm or hot water."

Appendix B: Paragraph 4-5,c. states:

"(1) Vapor-exposed mustard agent casualties should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing.

(2) Liquid-exposed mustard agent casualties (particularly their skin and hair) should be decontaminated by -

(a) Washing the skin surface and hair in warm or hot water at least three minutes. The rapid physical removal of a chemical agent is essential. Scrubbing of exposed skin with a stiff brush or bristles is discouraged, because skin damage may occur and may increase absorption of agent. Use liquid soap (dispose of container after use and replace), copious amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. The third wash should be a rinse with copious amounts of warm or hot water. Shampoo can be used to wash the hair. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. Two permissible alternative skin decontaminates include the M291 Skin Decontamination Kit (SDK) and a 0.5% sodium hypochlorite solution. If used, the 0.5% sodium hypochlorite should be applied with mild to moderate friction, with a single-use sponge or washcloth in the first and second washes. The third wash should be a rinse to remove any residual sodium hypochlorite with copious amounts of warm or hot water."

APPENDIX D

CASE STUDIES OF SECONDARY CONTAMINATION

The following case studies illustrate the problems associated with secondary or cross-contamination. For more information about these and other case studies see: Vogt, B. and J. Sorensen. *How Clean Is Safe: Lessons Learned From Decontamination Experiences*. Oak Ridge National Laboratory, ORNL/TM-2002/178, October 2002 (available at: http://emc.ornl.gov/EMCWeb/EMC/PublicationsMenu.html).

WORKERS EXPOSED TO MUSTARD AGENT AT LAWN AND GARDEN TREATMENT PRODUCT COMPANY

Occurrence Date:	14 September 2000
Location:	Bonide Corporation, New York Mills, New York
Source:	Overheated substance
Material:	Dimethoate
Impacts:	11 workers sent to hospital, 7 hospital employees exposed to victims also treated for exposure
Quantity Discharged:	Unknown

Background

Dimethoate, a pesticide, is described as an organophosphate cholinesterase inhibitor similar to nerve agent. When inhaled, it may cause increased watery nasal discharge, a sensation of chest tightness, and prolonged wheezing. Absorption by the lungs may produce these and other symptoms of cholinesterase inhibition within a few minutes or up to 12 hours after exposure. It is recommended that emergency personnel wear gloves and avoid secondary contamination. The incidence of secondary contamination affecting hospital emergency room personnel reported in CIRC document 2000-4958 suggested this was an appropriate case study. Anecdotal reports from hospital staff have indicated that wearing PPE in the emergency room is difficult when treating patients and recommendations to do so are often disregarded. Secondly, without knowledge of the substances to which patients reporting to the emergency room have been exposed, it is uncommon for staff to routinely don PPE to treat patients.

Incident Timeline, Response, and Consequences

Workers at a lawn and garden treatment product company inadvertently overheated an organophosphate pesticide. Instead of heating the dimethoate to the prescribed 150^0F, the material was overheated to 220^0F and began emitting fumes. Inhalation of dimethoate fumes can quickly result in severe respiratory problems and other symptoms requiring immediate medical treatment. Eleven workers transported themselves to a nearby hospital in Utica, New York, and walked into the emergency room without being decontaminated. Several hospital employees treating the workers became ill themselves.

When the emergency room doctor saw his staff becoming ill, he immediately called the Assistant Fire Chief (and HAZMAT coordinator for Utica) at his home to ask why the staff was getting sick. The Chief told him to immediately remove the people from the emergency areas and to treat everyone who had been in contact with them as contaminated. Outside in the parking lot, the male plant workers were decontaminated in a unit set up by the HAZMAT team. The emergency room workers and the three female plant workers were decontaminated inside the hospital emergency room area where showers were present.

Some male workers refused at first to be decontaminated, stating they worked with the chemicals every day but they finally agreed to undergo decontamination. Fire department personnel wore Level B PPE when decontaminating victims. Approximately 20 people altogether went through the decontamination process, which took approximately 1 hour. The decontamination process is a four-step procedure using a corridor. To prevent the pesticide from entering the area drain, neoprene pads were placed over the drain. The wastewater was then pumped into 55-gallon drums and given to the hospital for proper disposal.

Hospital housekeeping staff dressed in scrubs, gloves, hairnets and wearing air filters were responsible for cleaning the emergency rooms where the exposed had first been taken and for the articles in those rooms. All walls were washed as well. The entire emergency room was shut down during the 2 hours it took to decontaminate the area. It is unclear who made the decision to reopen the emergency room to patients.

Major findings:

1. Procedures for screening for contamination in the emergency room were not in place for unannounced incidents involving persons contaminated with a toxic chemical.
2. Hospital personnel had no training in identifying the symptoms of a hazardous chemical exposure.
3. Lack of communication between jurisdictions was a significant problem. Although people exposed came from New York Falls, the emergency room doctor had to call the Utica fire chief to help identify the problem of his staff getting ill from treating victims.
4. Hospitals that receive patients from many jurisdictions should have information on all chemicals that could result in potential toxic exposure to better treat patients.
5. The hospital did not have a separate containment area for potentially exposed patients.
6. There were no separate decontamination facilities for men and women. Having the female plant workers shower inside in separate facilities from the male plant workers

showering outside the hospital avoided the privacy issue associated with a single facility.
7. Even though male workers did not feel it necessary to decontaminate, they eventually decontaminated as recommended.
8. Using housekeeping staff wearing minimum protection allowed the area to be cleaned rapidly and the emergency room to be reopened within 2 hours of shut-down.

MERCURY RELEASE AT INTERNATIONAL AIRPORT POSTAL HUB

Occurrence Date:	15 September 2000
Location:	Indianapolis International Airport, Indianapolis, Indiana
Source:	Leaking package
Material:	Mercury spill
Impacts:	3 workers transported directly to hospital, 40 others taken to hospital by airport shuttle
Quantity Discharged:	Unknown

Background

This incident was investigated because airports have been identified as primary targets for terrorist chem/bio attacks. Employees at this postal hub at a large international airport routinely handle very large quantities of materials and how they react to a toxic substance in such an environment is largely unknown in the literature. The postal hub is operated by a private firm, not the U.S. Postal Service.

Incident Timeline, Response, and Consequences

On an early Friday morning, a small amount of mercury about the size "found in a thermometer" was discovered on a conveyer belt in a sorting area of a large international airport postal hub. A supervisor was informed that an employee had picked up and handled some mercury. The supervisor decided the incident should be treated as a HAZMAT situation and the company called the airport fire department that in turn called the Wayne Township fire department. About 10:30 the fire department arrived on scene. The one employee who had been in contact with the mercury and two others who complained of breathing problems were sent to the hospital by ambulance. The fire department then proceeded to decontaminate approximately 40 others including anyone in the vicinity of the sorting area around the conveyor belt. Persons placed their clothes in one bag and personal articles in another bag, both of which they were allowed to carry

with them into the hospital. One respondent observed several employees take cell phones from the bagged articles and use the equipment while in the hospital.

The Wayne County Emergency Department has a decontamination truck that was used to decontaminate female employees inside the unit. Male employees were decontaminated by firefighters outside in the parking lot near the facility. Both men and women had warm water for showering. Once decontaminated, persons were dressed in Tyvek® jumpsuits and told to go to the waiting buses for transport to the hospital.

About 11:30 a.m., representatives arrived from the County Health Department. Health officials reported conflicting statements by company personnel about the incident. Seeing the airport shuttle buses waiting to take the people to the hospital, they requested permission to check people for mercury contamination using a Jerome meter. They also checked another 40-50 people in street clothes for possible contamination. No contamination was found on anyone, and the employees who had been decontaminated were taken to the hospital. At the hospital, people were interviewed, charted, and checked for vital signs.

Urine and blood samples were collected and analyzed checked for mercury. After each person was evaluated, the patients were sent to the hospital auditorium for debriefing and told what signs and symptoms to watch for. One respondent reported that several people not in the original group that had been decontaminated arrived the day after the incident to be evaluated for mercury exposure.

Once all the employees had been taken to the hospital, a reconnaissance team entered the building to check for contamination and a commercial cleanup team hired for cleanup started decontamination. At that time the county health department personnel went to the hospital to check the clothing for contamination. One pair of shoes worn by the employee who had handled the mercury was found contaminated and disposed of. The health department then went back to the airport to check for contamination in employees' cars. None was found. Informational fact sheets on mercury were distributed to all employees.

Meanwhile a commercial company had been hired to provide air monitoring. Once everything checked out, the company requested the health department personnel to certify the building was safe to begin work in again. The health department went through with the Jerome monitor and okayed the building for re-entry.

Major findings:

1. There were no objective criteria to distinguish people who were contaminated from those who were not.
2. County health department equipment and personnel arrived an hour after the incident, well after decontamination efforts had started.
3. Bagged articles taken with employees to hospital were not checked for contamination before being brought into the hospital.
4. Removing cell phones and other items from bags could have led to secondary contamination at the hospital. Information about the importance of keeping bagged items secure should have been conveyed to all victims.

TOKYO SUBWAY SARIN RELEASE

Occurrence Date:	20 March 1995
Location:	Tokyo Subway in 5 cars
Source:	10 bags 35% diluted sarin
Material:	Intentionally released liquid sarin (GB)
Impacts:	12 killed, 5,500 contaminated
Quantity Discharged:	600 mg in each bag

Background

This incident is the largest release of a chemical agent targeted to a civilian population. The event took place at 5 train stations in metropolitan Tokyo during the commute. The train cars were overcrowded with passengers on their way to work

Incident Timeline, Response, and Consequences

On the 20th of March 1995 there was a coordinated terrorist attack on three subway lines in Tokyo, Japan during morning rush hour (7-8 a.m.). The nerve agent sarin was released as a liquid by poking umbrella tips into bags containing the agent in five subway cars. Sixteen subway stations were affected as passengers rushed out of the trains. The first emergency call reached the police at 8:14 a.m. and between 8:30 and 9:00 a.m. over 11,000 emergency workers were dispatched. Most patients were treated at four large hospitals in the vicinity of the attack, although over 275 medical facilities were eventually involved. At St. Luke hospital, one of the nearest hospitals, 35% of the approximately 500 patients treated walked to the hospital, 24% were transported by taxi, and 7% arrived by ambulance. An estimated 5500 people were contaminated.

In the Tokyo subway incident, there was no decontamination conducted at the scene of the accident. In that incident, it took about 3 hours to determine GB was the chemical involved. Decontamination began only after the nerve agent was identified as the cause. The decontamination procedure was to undress and shower. There are no estimates of the number of patients that were decontaminated, however it has been noted that most patients were not decontaminated. Mildly-exposed victims were not decontaminated due to lack of changing and showering facilities.

DHHS has noted that decontamination in the Tokyo incident was not needed for most of the victims because most people were exposed to low level vapors.

One of the major difficulties in the Tokyo subway attack was undressing of victims and disposing of clothing due to the sheer volume of exposure. A major impact of lack of decontamination areas at the hospitals was secondary contamination of hospital

staff. It was reported that 23% of the staff at St. Luke's hospital indicated acute symptoms of nerve agent exposure. Lack of ventilation also contributed to secondary exposure.

The train cars and subway stations exposed to sarin in the Tokyo incident were decontaminated with water and detergent combined with industrial-strength cleansers. It was quickly applied and then washed off immediately, whereas a 15- to 20-minute application before rinsing would be recommended (DHHS 1995). The decontamination was performed by both military personnel and firefighters. It took about 3 hours and 20 minutes on two of the lines, and was completed 9.5 hours after the release occurred. On the third line it took about 15 hours and was completed 21 hours after the release (Watson 1998).

Major findings:

1. The Japanese government had no plan for chemical disasters.
2. Most hospitals did not have a plan for a chemical incident.
3. Hospitals lacked the space and equipment to decontaminate patients.
4. Secondary contamination at hospitals was a major problem.

PVC PRODUCTION PLANT IN PLAQUEMINE, LOUISIANA

Occurrence Date:	24 September 1996
Location:	Vinyl Chloride Processing Plant in Plaquemine, LA
Source:	Heat Exchange Unit in Process Line
Material:	Nitrogen and Sulfur Mustard
Impacts:	4 workers seriously burned, about 250 contaminated
Quantity Discharged:	Unknown

Background

On September 24 three workers began cleaning a heat exchanger in a vinyl chloride processing plant in Plaquemine, LA. The process involved using a hydro-blaster at 10,00 PSI to remove sludge from the fin fans and reactor. They used a commercial cleaning fluid as part of the process. The operation took place in an elevated plywood shell. Around 500 construction workers were at various locations on the ground level below the operation.

Incident Timeline, Response, and Consequences

The hydro-blasting operation began at 4 PM on Tuesday. The three workers were wearing suits designed for vapor protection. The team leader was using a fresh oxygen supply for respiratory protection. At 6PM the team leader ran out of oxygen and removed the respiratory protection. For three hours all three workers were exposed to the liquid and sludge from the cleaning.

At 7 PM the hydro-blasters went home. The leader removed his work clothes and showered. At 1:15 AM on the morning of the September 25 he awoke in pain and his wife took him to the emergency room. Around this same time the two other hydro-blasters were experiencing the development of small red spots on their skin. On Wednesday some of the construction workers go to their doctors with similar symptoms. Wednesday afternoon the chemical company seals off the area with yellow warning tape. They suspect that the symptoms are being caused by exposure to the cleaning fluid. Samples are taken and sent to a local commercial laboratory for analysis.

By Thursday about 150 people are reporting symptoms. These include the workers and some spouses who have been exposed to secondary contamination by handling the clothes worn by the workers. The local laboratory cannot identify any hazardous substance in the runoff liquid samples.

By Friday four workers have entered the hospital with severe burns over most of their bodies. One of the workers was placed in the hospital's burn center for skin grafts. This triggers an OSHA involvement on Monday, September 30. OSHA sent samples of the liquid to their Salt Lake City laboratory for analysis. Based on the symptoms and the results of a mass spectrometer analysis, OSHA suspected the liquid contain the chemical warfare agent mustard, but do not have the protocols to confirm. OSHA sent the samples to the treaty laboratory at Aberdeen Proving ground which confirms the samples contain both sulfur and nitrogen mustard agents. The following concentrations were found:

Run-off water: 11ppm HD, 30ppm HN3 (both CW mustard agents)
Drips from fin fans: 211ppm; and
Water in hazardous waste storage system: 3800ppm

The cause of the mustard production in the vinyl chloride production process was never confirmed.

Major findings:
1. Personnel decontamination not performed after exposure and contamination.
2. No control of contaminated personnel or clothing is exercised.
3. Secondary contamination occurs but levels unknown.
4. Physicians do not know how to treat symptoms.
5. Agents not identified for over one weeks time.
6. Commercial laboratory analysis inadequate.
7. Workers not wearing proper PPE
8. Workers improperly use PPE.

A follow-up study 6 years later of 247 workers exposed (see reference number 20) found these results:

"Healing of burns varied according to natural pigmentation of skin and that multiple and chronic skin infections developed on burns. Liver functions and cardiac conduction were temporarily altered in burn cases without other complications. No fatalities were noted. Months after exposure, bronchitis and posttraumatic stress disorder became prevalent regardless of initial presentation. Other symptoms did not lead to any organ pathology except one case of Barrett's esophagus and another of oral metaplasia. Two infants conceived after exposure appeared healthy. Although the screening protocol administered became an effective screening tool, follow-up of cases was severely flawed by a lack of cooperation between providers and noncompliance by patients after settlement of lawsuits."

For more information about these and other case studies see: Vogt and Sorensen's document, *How Clean Is Safe: Lessons Learned From Decontamination Experiences.* Oak Ridge National Laboratory, ORNL/TM-2002/178, October 2002. (Available at: http://emc.ornl.gov/EMCWeb/EMC/PublicationsMenu.html)

Appendix E

INSTRUCTOR SLIDES

CSEPP Technical Training Classroom Course

Decontamination of People Potentially Exposed to Chemical Agents

Instructor Slides

Target Audience

- Civilian first responders
- Emergency planners
- Medical personnel
- Other stakeholders
  - With special needs
  - With service animals

Training Goals

- Ensure emergency providers understand
  - How to set up station to process both ambulatory and non-ambulatory victims
  - Self- and buddy-decontamination
  - Mass decontamination procedures
  - How to prevent secondary contamination
  - Special considerations such as weather and vulnerable individuals associated with the process

Course Organization

Overview of decontamination concepts

- 4 case studies
- Current practices
- Mass decontamination
- Animal decontamination
- Special considerations

Module 2
Field Decontamination Basics

- Reduction or removal of agents by physical means or by chemical neutralization
- Occurs in portable or fixed units
- Clothing removal, wash skin and hair
- Non-ambulatory decon process more complex and time-consuming
- Medical personnel may need to work in PPE

Decontamination

- Reduction or removal of agents by physical means or by chemical neutralization
- Physical means: flushing, scraping, and powders
- Neutralization: soap, bleach, and special solutions
- Decontaminate as quickly as possible

Purposes of Decontamination

- Prevent further damage from chemical exposure
- Prevent secondary or cross contamination

Basic Concepts

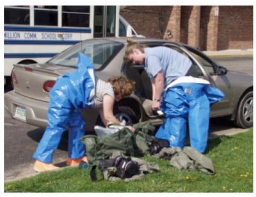
- Must be done
- immediately
- Must be done
- effectively
- Clothes must be removed to eliminate possible contamination

Decon Before Transport

- Complete before entry/transport
- Off-gassing often a problem
- Clothing removal essential

Field Decontamination

- OSHA approved PPE
- CFR 1910.120
- CFR 1910.135
- Various settings



Field Decontamination

- Remove clothing
- Shower
- Transfer to HCF
- May include second decontamination
- Purpose is to protect HCF assets

Decontamination Principles

- Remove agent
- Do not delay
- Communicate with HCF
- Self-transport of victims could overwhelm HCF

Non-Ambulatory

- Decon difficult for non-ambulatory
- Requires additional personnel,resources
- Multiple victims especially problematic

Three Decontamination Types

- Personal
  - self
  - buddy
- Casualty
  - non-ambulatory
- Personnel
  - non-exposed
  - ambulatory

Monitoring Necessary

- Monitor for agent removal
- Do not leave to chance
- Requires tact and sensitivity

Liquid versus Vapor

- Decontamination is needed for both liquid and vapor exposure
- Vapor is absorbed by clothing,exposed skin, and hair
- Rigorous decontamination is needed for liquid exposure
- Less rigorous decontamination is needed for vapor exposure

Desirable Traits of Decontamination Solution

- Neutralizes all chemical and biological agents
- Is safe (nontoxic and non-corrosive)
- Is easily applied by hand and readily available
- Acts rapidly, producing no toxic end products
- Is stable in long-term storage
- Is affordable
- Does not enhance skin absorption of substance
- Is non-irritating and hypoallergenic
- Is easily disposed

Decontamination Solutions

- Soap and water is the preferred solution
  - as effective as diluted bleach solution
  - less caustic
  - takes less time than diluted bleach solution
- A 0.5% solution of household bleach is an acceptable alternative solution
- Military developed solutions are also acceptable alternatives
- Do NOT delay decontamination if only water is readily available

RSDL

- Reactive Skin Decontamination Lotion
- New product from Canada
- Removes or neutralizes CW agents and T2 toxin
- FDA approved for military use
- DoD approved for First Responder use
- Sept. 2006 received DHS SAFETY certification

Wastewater Issues

- Same as HAZMAT
- Hold until identified
- EPA regulations has exceptions

Module 3
Secondary Contamination Issues

Avoid Secondary Contamination

- Training in use of respirators and PPE essential for HC providers
- Surgical masks not adequate
- Some chemical warfare agents highly persistent but no immediate signs or symptoms
- General lack of criteria to ensure safety
- Especially problematic for a HCF

Case Studies

- Case studies
  - Tokyo sarin
  - NY HAZMAT
  - LA mustard exposure
  - IN mercury exposure
- Lessons learned
  - Need appropriate PPE and training
  - Need to isolate people exposed
  - Need to follow standardized protocols and procedures

Tokyo Subway Sarin Incident

- 3 subway lines attacked in morning rush hour
- Estimated 5,500 persons exposed; 12 died
- No on-scene decontamination
- Decontamination initiated at medical facilities 3 hours after exposure
- Secondary contamination at hospitals was a major problem

Tokyo Subway Sarin Incident

- Hospitals lacked space and equipment to handle large number of victims
- Secondary contamination at hospitals was a major problem
- First responders wore no PPE; 25 of 39 required hospital admission
- No national plan for chemical disasters

NY State HAZMAT Event

- Dimethoate (systemic insecticide similar to nerve agent) overheated and released fumes
- Quickly resulted in respiratory problems
- Eleven workers self-reported to hospital ED
- ED staff become ill; HAZMAT called
- Evacuated ED and decontaminated victims and ED staff (1 hour)

NY State HAZMAT Incident

- ED washed down by hospital staff and reopened 2 hours later
- No testing conducted or reentry criteria used

NY State HAZMAT Incident

- No screening
- No training of ED staff in signs and symptoms
- Lack of communication and info on chemicals
- No containment area for victims
- Separate facilities unavailable
- No testing conducted or reentry criteria used

Mustard Exposure in Vinyl Chloride Plant

- Inadvertently produced nitrogen and sulfur mustard in Louisiana chemical facility
- Over 150 workers exposed during hydro-blasting operation, 3 seriously
- Latent symptoms

Mustard Exposure in Vinyl Chloride Plant

- 150 people report symptoms 2 days later
- OSHA involved after 3rd hospitalization
- Over a week to determine mustard involved
- Considerable secondary contamination from worker's clothing to spouses

Mustard Exposure in Vinyl Chloride Plant - Findings

- Personnel decontamination not performed
- No control of contaminated personnel or clothing
- Secondary contamination at unknown levels
- Local physicians did not know how to treat victims
- Agents were not initially identified
- Commercial laboratory analysis inadequate
- PPE not used or used improperly

Mustard Exposure in Vinyl Chloride Plant

- Follow-up 6 years later
  - Skin infections developed on burns
  - No fatalities
  - Bronchitis and PTSD prevalent
  - One case each Barrett's esophagus and oral metaplasia
  - Conception after exposure normal

Indianapolis Mercury Incident

- Health dept. arrived well after decontamination initiated to test for mercury contamination
- Bagged items taken with victims to HCF
- At HCF decontaminated victims observed retrieving items (cell phones) from bags

Indianapolis Mercury Incident

- No objective criteria for determining contamination until health dept. arrived
- Decontaminated taken to hospital anyway
- Bagged items taken with victims to HCF were potential sources of secondary contamination

Module 4. Current Practices

Self- and buddy-decontamination
Decontamination station
Ambulatory decontamination
Non-ambulatory decontamination
Mass decontamination
Animal decontamination

Self- and Buddy-Decontamination

- Insufficient time to set up station
- Need to instruct public to decontaminate themselves

Self- and Buddy-Decontamination

- Remove and bag clothing
- Shower and rinse
- Don clean clothes
- Eyeglasses, keys can be deconned
- Inadequate for HCF

Self- and Buddy-Decon

- Anticipate that not all people will follow instructions

Field and Hospital Decontamination

- Requires staff in PPE
- Federal - CFR 1910.120 and 134 prescribe guidelines for wearing PPE and training required
- State and local regulations

PPE Requirements

- Requires staff in PPE
- Federal - CFR 1910.120 and 134 prescribe guidelines for wearing PPE and training required
- State and local regulations

PPE Requirements

- Requires medical certification
- Trained to use PPE
- Know how to inspect and maintain
- Be able to don and doff correctly
- Need periodic drills and training using PPE
- Familiarity with stay and rest times

Siting Decontamination Stations

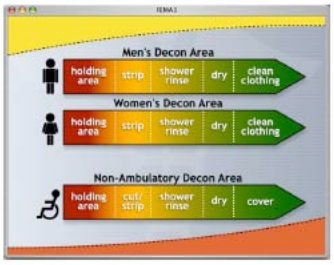
- Site the facility upwind, uphill, and upstream with security to control scene
- Establish reception area for initial screening
- Establish triage area for rapid medical evaluation and classification
- Simple Triage and Rapid Treatment (START)
- At least 2, ideally 3 decon lines
- Site to control run-off when possible

Important Considerations

- Deployment
  - portable for field use
  - permanent facilities at HCFs
- At least two lines, ideally 3
  - ambulatory (mixed or male only)
  - non-ambulatory
  - female ambulatory
- Warm water supply
- Privacy
- Run-off control

Decontamination Station 2 Lines

Decontamination Station 3 Lines



Site Location and Layout

- Should be predetermined
- Known to staff
- Immediately communicated in event
- Secure perimeter and clean areas
- Takes planning, training and exercising
- HCF may have temporary or permanent stations

Decontamination Priorities

- People who are known or suspected of being contaminated and who require prompt medical attention due to agent exposure or other severe injury
- People who are exhibiting signs/symptoms of agent exposure
- People who are known to be contaminated but are not exhibiting signs/symptoms and don't urgently require medical attention
- People who are suspected of being contaminated but show no signs of agent toxicity
- Animals that provide critical support to humans (e.g., seeing eye dogs) that are known or suspected to be contaminated

Ambulatory Decontamination

- Receive, triage, decon and tag
- Treat wounds (optional)
- Remove and bag all effects

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Ambulatory Decontamination

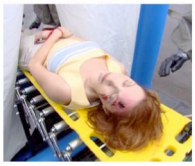
- Thoroughly shower with soap and water
- Rinse and dry
- Don clean clothes and tag
- Remove to clean zone

Ambulatory Needs

- Children, elderly
- Special needs such as hearing- or mobility-impaired
- Separate lines for males and females
- Second line for non-ambulatory
- Advise non-exposed to go home, take shower, don clean clothes

Non-Ambulatory Patient Decontamination

- Receive, triage and tag
- Send through line on backboard
- Clothing cut away and bagged



Non-Ambulatory

- Flushed with soap solution, scrubbed, rinsed with clean water and dried
- Tagged and covered
- Transferred to clean zone for treatment

Mass Decontamination

- Used to process large number of people
- Water only is recommended
- Several options

Ladder and Truck

Over-head Shower

Mass Decontamination

- Run-off water and EPA

Animal Decontamination

- PETS Act (2006)
- Pets, livestock, and service animals can be contaminated in a variety of disasters
- Need plan to set up decontamination facility for animals
- Scrub with liquid soap and water and dry

Animal Decontamination

- Discourage owners decontaminating pets
- Zoonotic disease transmission
- Sequester contaminated animals
- Dispose leather items

Animal Decontamination Line

- Staff wears appropriate PPE
- Animal controlled, tagged, evaluated
- Consider tranquilizing
- Placed on temporary leash
- New leash after gross decontamination completed

Animal Decontamination

- Animals evaluated for treatment
- Handling issues of animal/owner separation
- Establish medical protocols prior to process

Module 5
Special Considerations

Special Considerations

- Infants/children/elderly
- People with disabilities
- Psychological effects
- Cold weather
- Considerations for rad and bio

People with Disabilities

- ADA Act of 1995
  - accessibility
  - emergency plans
- Include them in plans
- Protocols for decon of mobility devices
- Include mental health workers

Psychological and Social Consequences

- Psychological and social consequences
  - often embarrassing
  - often discomforting

Cold Weather Considerations

- Should be carefully assessed
- Can usually safely decon above 65^{0}F
- 36^{0}F to 64^{0}F move decon to heated area
- Below 35^{0}F outdoor decon not recommended
- Use other methods

Considerations for Biological Contamination

- Decon disinfects skin
- Most bio agents not dermally active
- Major threat is inhalation
- Decon using soap and water, rinse with 0.5% bleach solution, rinse with water

Considerations for Radiological Contamination

- Occurs when radioactive particles deposited
- Must remove all foreign material from wounds
- Decon by removing clothing, soap and water wash,rinse
- Do not irritate skin
- Survey for residual radiation using portable devices

Jurisdictional Issues

Event can be viewed as
- Health issue
- Environmental issue
- Crime scene
- Combination

- Shuts down scene
- Chain-of-evidence procedures essential to identify and track substances

Is Decontamination Appropriate?

- Decide who determines when decontamination is appropriate
- CSEPP communities would be told
- Precautionary decon for children problematic
- Consult and communicate

Summary

- Develop decon plan, train personnel, exercise
- Decon as quickly as possible
- Protect emergency responder, HCF and assets, and HC providers
- Don't become a victim!

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