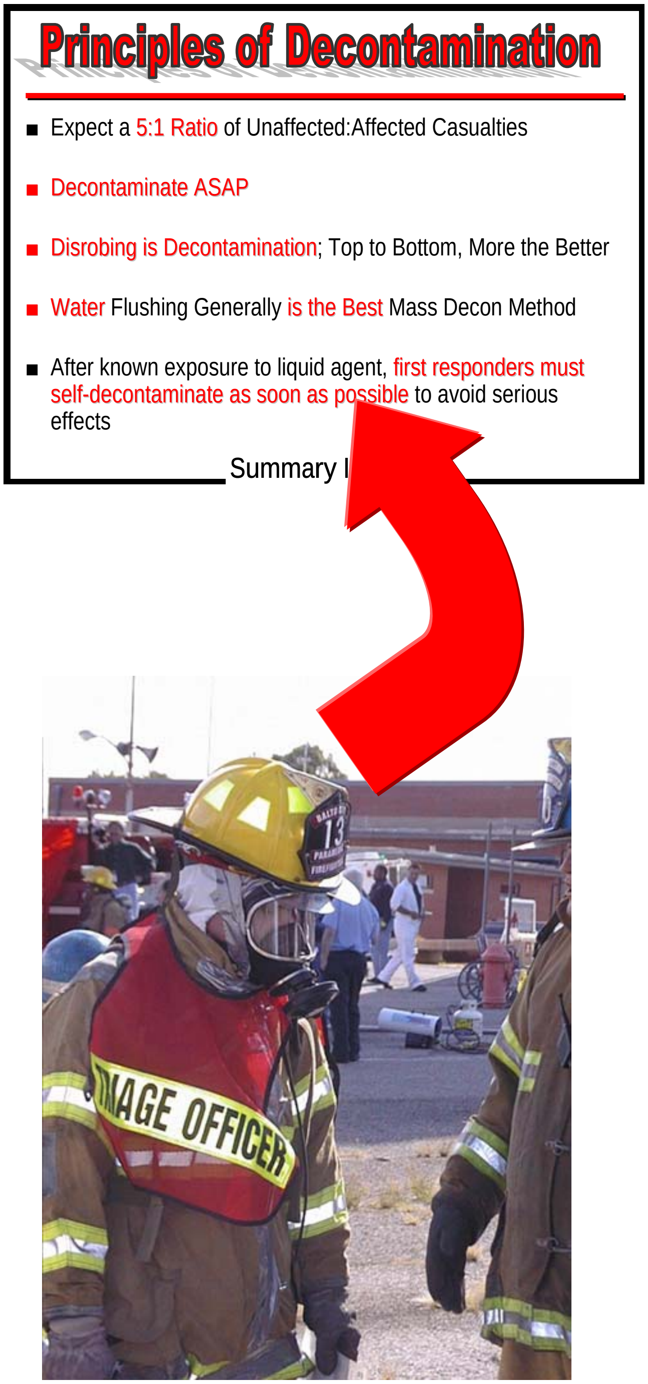

SBCCOM

Guidelines for Mass Casualty Decontamination During a Terrorist Chemical Agent Incident

Prepared by:

U.S. Army Soldier and Biological Chemical Command (SBCCOM)

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13. ABSTRACT *(Maximum 200 words)* The Mass Casualty Decontamination Research Team (MCDRT) collectively addressed the issue of how to effectively decontaminate large numbers of people. Emphasis was placed on decontamination methods that could be performed with equipment and expertise readily available to most responder jurisdictions. The general principles identified to guide emergency responder policies, procedures, and actions after a chemical agent incident were:

- Expect at least a 5:1 ratio of unaffected to affected casualties
- Decontaminate victims as soon as possible
- Disrobing is decontamination; head to toe, more removal is better
- Water flushing generally is the best mass decontamination method
- After a known exposure to liquid chemical agent, emergency responders should be decontaminated as soon as possible to avoid serious effects.

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PREFACE

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The fiscal year (FY) 1997 Defense Authorization Bill (P.L. 104-201, Sept 23, 1996), commonly called the Nunn-Lugar-Domenici legislation, funded the U.S. Domestic Preparedness initiative. Under this initiative, the Department of Defense (DoD) was charged with enhancing the capability of federal, state, and local emergency responders in incidents involving nuclear, biological, and chemical terrorism. The U.S. Army Soldier and Biological Chemical Command (SBCCOM), Aberdeen Proving Ground, Maryland, was assigned the mission of developing an Improved Response Program (IRP) to identify problems and develop solutions to the tasks associated with responding to such incidents. The Chemical IRP was established to deal specifically with terrorists using chemical weapons.

A Mass Casualty Decontamination Research Team (MCDRT) was formed by SBCCOM under the Chemical IRP in February 1998 to address specific technical and operational issues associated with the performance of mass casualty decontamination after a terrorist incident involving chemical weapons of mass destruction (WMD). The MCDRT was assembled from affected emergency response and technical disciplines. The research team included a broad scientific and operational knowledge base, both with general experts and specialized staff, including medical doctors with direct knowledge of the physiology and toxicological effects of chemical agents, emergency responders drawn from government organizations at all levels, and from contract research organizations.

Over several months, the MCDRT collectively addressed the issue of how to effectively decontaminate large numbers of people. Emphasis was placed on decontamination methods that could be performed with equipment and expertise readily available to most responder jurisdictions. Effective physical and medical approaches were identified by review of over 200 research papers, books, articles, manuals, and Internet sites. Through review and the experience of the MCDRT team members, several basic decontamination principles were identified. Using these principles as a basis, decontamination processes were developed to effectively address operational decontamination of large numbers of people.

The general principles identified to guide emergency responder policies, procedures, and actions after a chemical agent incident were:

- Expect at least a 5:1 ratio of unaffected to affected casualties
- Decontaminate victims as soon as possible
- Disrobing is decontamination; head to toe, more removal is better
- Water flushing generally is the best mass decontamination method
- After a known exposure to liquid chemical agent, emergency responders should be decontaminated as soon as possible to avoid serious effects.

To acquire a final consensus for the general principles identified, the MCDRT conducted several meetings to discuss the findings and resolve any technical or operational concerns. A panel of experts from the chemical defense and emergency response communities studied each principle identified to ensure that they represented the best recommendations that provide the most benefit to the largest number of victims in the shortest possible time.

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GUIDELINES FOR MASS CASUALTY DECONTAMINATION DURING A TERRORIST CHEMICAL AGENT INCIDENT

1.0 INTRODUCTION

The FY97 Defense Authorization Bill (P.L. 104-201, Sept 23, 1996), commonly called the Nunn-Lugar-Domenici legislation, funded the U.S. Domestic Preparedness initiative. Under this initiative, the Department of Defense (DoD) was charged with enhancing the capability of federal, state, and local emergency responders in incidents involving nuclear, biological, and chemical terrorism. The U.S. Army Soldier and Biological Chemical Command (SBCCOM), Aberdeen Proving Ground, Maryland, was assigned the mission of developing an Improved Response Program (IRP) to identify problems and develop solutions to the tasks faced in responding to such incidents. Under this authorization, the SBCCOM Domestic Preparedness Office Chemical Team conducted this study to recommend methods for civilian mass casualty decontamination after a chemical terrorist incident.

The Chemical IRP includes a broad cross-section of operational and technical experts from local, state, and federal agencies. Emergency responders from the Baltimore-Washington DC area, as well as experts from across the nation were included to ensure that solutions were broad-based and usable by any jurisdiction. Chemical IRP members participated from fire departments, emergency management offices, law enforcement agencies, and military test and evaluation agencies, included legal experts, medical doctors, computer modelers, operations researchers, and environmental scientists. The Chemical IRP formed specific “research teams” to address issues that evolved from a series of tabletop exercises called BALTEX (Baltimore Exercise).

This study addressed decontamination in mild temperatures only. Decontamination in cold weather is the subject of another study.

For easy dissemination, this report is available at the following Web site: http://www.ecbc.army.mil/hld/ip/reports.htm.

2.0 OBJECTIVE

The objective of this study is to identify technical and operational issues associated with mass casualty decontamination after a terrorist incident involving chemical weapons of mass destruction (WMD) and recommend the most efficient and effective techniques and procedures to best cope with a large-scale decontamination effort.

3.0 TECHNICAL APPROACH

Through the BALTEX series, the IRP identified the need for methods of decontaminating large numbers of people. Although hazardous materials (HAZMAT) teams have experience and procedures for decontaminating small numbers of chemical victims, the emergency response community has no formal procedures for decontaminating hundreds of victims. In February 1998, the Mass Casualty Decontamination Research Team (MCDRT) was formed to study the decontamination process and recommend operational approaches for the effective decontamination of large numbers of potential terrorist victims after a terrorist chemical incident. The MCDRT's focus was to ensure the technical merit, operational feasibility, and overall consensus within the emergency responder and medical communities on the report recommendations.

To address the decontamination process and develop decontamination recommendations, the research team was composed of representatives from all affected emergency response and technical disciplines with a broad scientific and operational knowledge base. The team's staff included scientists with expertise in chemical agent properties and dispersion processes, medical doctors who have direct knowledge of the physiology and toxicological effects of chemical agents, and emergency responders who are thoroughly familiar with emergency operations and emergency response equipment. Team members were drawn from government and emergency response organizations at all levels. Responder and emergency management organizations participating with the Chemical Weapons IRP are from Maryland and the surrounding area, and include Montgomery County Department of Fire and Rescue Services, Baltimore City Fire Department, Baltimore County Fire Department, District of Columbia Fire and Emergency Medical Services, Howard County Department/Office of Emergency Management, City of Baltimore Health Department, and Baltimore Police Department.

The MCDRT had to deal with several constraints associated with mass decontamination. Successful decontamination approaches must be executable with resources available in most response jurisdictions, the approaches must save lives and preserve the health of chemically contaminated victims, and they must reduce the chemical hazards faced by medical personnel who subsequently treat chemical victims. To ensure that the developed recommendations satisfy these constraints, the MCDRT applied the process shown in Figure 3-1. Through workshops, tabletop exercises, and functional exercises with first responders and the Chemical Weapons IRP, the problem of decontamination and its associated constraints were identified. Through scientific and technical investigations, the MCDRT then developed operational approaches to meet the decontamination needs. The developed approaches were reviewed and exercised by the Chemical Weapons IRP, to ensure that they are executable by most responder jurisdictions, that they do protect the lives and health of chemical victims, and that they will ensure the safety of personnel who subsequently process the chemical victims.

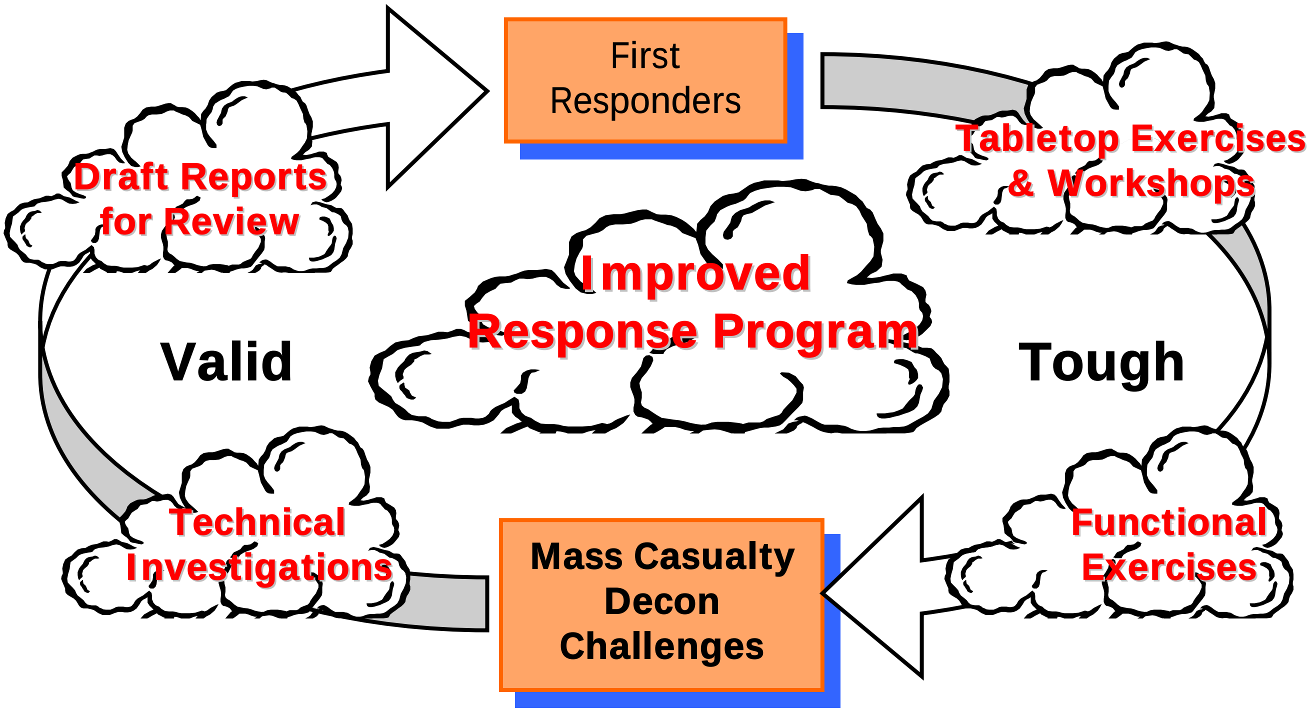

Figure 3-1. MCDRT's Relationships and Process

The effort of the MCDRT concentrated on:

- Providing technical solutions to specific issues on the efficacies and priorities of decontaminating people contaminated with chemical agents.

- Identifying mass decontamination methods that can be readily applied, using existing resources, and that are consistent with current emergency responder procedures, training, logistic feasibility, and other potential considerations (human nature and psychology) and constraints (resource limits, civil liberty, environment preservation).

Over several months, the MCDRT acquired data from multiple searches of 8 databases containing medical, scientific, and operational test and evaluation findings. Information was acquired and reviewed from over 200 research papers, books, articles, manuals, and Internet sites. Through review and the experience of the MCDRT members, five basic decontamination principles were identified.

The general principles identified to guide emergency responder policies, procedures, and actions after a chemical agent incident were:

- Expect at least a 5:1 ratio of unaffected to affected casualties
- Decontaminate victims as soon as possible
- Disrobing is decontamination; head to toe, more removal is better
- Water flushing generally is the best mass decontamination method
- After a known exposure to liquid chemical agent, emergency responders should be decontaminated as soon as possible to avoid serious effects.

Using these principles as a guide and staying within the constraints associated with emergency response equipment and operational considerations, recommendations for decontamination procedures were established.

To acquire a final consensus on the recommended decontamination procedures, the MCDRT conducted several meetings to discuss their recommendations and resolve any technical or operational concerns. Experts from the chemical defense and emergency response communities studied each recommendation to ensure that it represented the most beneficial approach to decontaminating the largest number of victims in the shortest possible time.

4.0 RESULTS

4.1 Purposes of Decontamination

Research revealed that the three most important reasons for decontaminating exposed victims are:

- Remove the agent from the victim's skin and clothing, thereby reducing further possible agent exposure and further effects among victims
- Protect emergency responders and medical personnel from secondary transfer exposures
- Provide victims with psychological comfort at, or near, the incident site, so as to prevent them from spreading contamination over greater areas.

Rapid physical removal of agent from the victim is the single most important action associated with effective decontamination.[C] Physical removal includes scraping or blotting off visible agent from the skin, disrobing, using adsorbents to soak up the agent, and flushing or showering with large quantities of water.

After a chemical agent attack, vapor or aerosol hazards still may be present, especially if the agent was disseminated within an enclosed structure. Furthermore, potentially toxic levels of chemical agent vapor may be trapped inside clothes and could continue to affect people, even after they leave the incident site.

Since the most important aspect of decontamination is the timely and effective removal of the agent, the precise methods used to remove the agent are not nearly as important as the speed by which the agent is removed. From scientific literature showing the effectiveness of different types of solutions in preventing chemical effects and the wide-spread, ready, availability of large quantities of water that can be rapidly used in decontaminating large numbers of people, the MCDRT determined that mass decontamination can be most readily and effectively accomplished with a water shower system.

First responders may become contaminated during the conduct of decontamination operations. It is recommended that all responders participating in these procedures to follow

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[C] Medical Management of Chemical Casualties Handbook; Sept 1995, Second Edition; United States Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, MD 21010.

guidance outlined in National Fire Protection Administration (NFPA) 471 “Recommended Practices for Response to Hazardous Materials Incidents”.

WARNING

Even small amounts (several droplets) of liquid nerve agent contacting the unprotected skin can be severely incapacitating or lethal if the victim or responder is not decontaminated rapidly (within minutes) and treated medically.

4.2 Methods of Mass Decontamination

Decontamination must be conducted as soon as possible to save lives. Firefighters should use resources that are immediately available and start decontamination as soon as possible. Since they can bring large amounts of water to bear, the most expedient approach is to use currently available equipment to provide an emergency low-pressure deluge.

The following forms of water-based decontamination were considered:

- Water alone. Flushing or showering uses shear force and dilution to physically remove chemical agent from skin. Water alone is an excellent decontamination solution.

- Soap and water. By adding soap, a marginal improvement in results can be achieved by ionic degradation of the chemical agent. Soap aids in dissolving oily substances like mustard or blister agent. Liquid soaps are quicker to use than solids, and reduce the need for mechanical scrubbing; however, when scrubbing, potential victims should not abrade the skin.

  A disadvantage of soap is the need to have an adequate supply on hand. Additionally, extra time may be spent employing it, and using soap may hydrate the skin, possibly increasing damage by blister agents.

- Bleach and water. Bleach (sodium hypochlorite) and water solutions remove, hydrolyze, and neutralize most chemical agents. However, this approach is not recommended in a mass decontamination situation where speed is the paramount consideration for the following reasons:

  - Commercial bleach must be diluted and applied with equipment not generally available to firefighters.

  - Skin contact time is excessive. Laboratory studies show that chemical agents and relatively nontoxic, aqueous decontaminants may need to be in contact for durations longer than expected shower durations for significant reaction to occur.

– Laboratory studies suggest that bleach solutions at the 0.5% level may not be better than flushing with water alone.[D, E]

– Medically, bleach solutions are not recommended for use near eyes or mucous membranes, or for those with abdominal, thoracic, or neural wounds.[F]

In summary, the issues associated with the use of soap and bleach solutions include time delay, dilution and application, medical contraindications, and its efficacy compared to water. These limitations make the use of soap or bleach solutions less desirable than using water alone.

The MCDRT recommends rapid use of water, with or without soap, for decontamination. However, the process should never be delayed to add soap or any other additive.

4.3 Decontamination Procedures

Decontamination by removing clothes and flushing or showering with water is the most expedient and the most practical method for mass casualty decontamination. Disrobing and showering meets all the purposes and principles of decontamination. Showering is recommended whenever liquid transfer from clothing to skin is suspected.[G] Disrobing should occur prior to showering for chemical agents; however, the decision to disrobe should be made by the Incident Commander based upon the situation. Wetting down casualties as they start to disrobe speeds up the decontamination process and is recommended for decontaminating biological or radiological casualties. However, this process may:

- Force chemical agents through the clothing if water pressure is too high
- Decrease the potential efficacy of directly showering skin afforded by shear forces and dilution
- Relocate chemical agent within the actual showering area, thereby increasing the chance of contamination spread through personal contact and shower water runoff.

The MCDRT recommends that victims remove clothing at least down to their undergarments prior to showering. Victims should be encouraged to remove as much clothing as possible, proceeding from head to toe. Victims unwilling to disrobe should shower clothed before leaving the decontamination area. It is also recommended that emergency responders use a high volume of water delivered at a minimum of 60 pounds per square inch (psi) water pressure (standard household shower pressures usually average between 60-90 psi) to ensure the

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[D] Hypochlorite Solution as a Decontaminant in Sulfur Mustard Contaminated Skin Defects in the Euthymic Hairless Guinea Pig; 1994; Gold, M.B., Woodard, Jr., C.L., Bongiovanni, R., Schraf, B.A., and Gresham, V.C.; Drug and Chemical Toxicology 17(4), 499-527.
[E] Evaluation of the Effects of Hypochlorite Solutions in the Decontamination of Wounds Exposed to Either the Organophosphonate Chemical Surety Material VX or to the Vesicant Chemical Surety Material HD (1992); Hobson, D.W. and Snider, T.H.; Final Report for Contract DAMD17-89-C-9050, Task 89-04; Battelle.
[F] Decontamination, Chapter 15 in Medical Aspects of Chemical and Biological Warfare; 1997; Hurst, Charles G.; in Textbook of Military Medicine, Part 1: Warfare, Weaponry, and the Casualty; Specialty editors: Sidell, F.R., Takafugi, E.T., and Franz, D.R.
[G] Personnel Decontamination Station, AD HOC Study team report, U.S. Army Armament Research and Development Command, DITC-AD041888, 1979.

showering process physically removes viscous agent. The actual showering time will be an incident-specific decision but may be as long as two to three minutes per individual under ideal situations. When large numbers of potential casualties are involved and queued for decontamination, showering time may be significantly shortened. This may also be dependent upon the volume of water available in the showering facilities.

In the course of deconning victims, first responders may inadvertently become contaminated. High-pressure, low-volume decontamination showers are recommended primarily for wet decontamination of emergency responders in Level A suits after a HAZMAT incident. This gross decontamination procedure forcibly removes the contaminant from the personal protective equipment (PPE) worn by the emergency responders while conserving water. Often a secondary wash, and possible a tertiary wash, and rinse station are used. However, for decontaminating potential victims, a consensus exists among the MCDRT medical experts that high pressure could force chemical agent through the victim's clothing onto the skin. Therefore, the Occupational Safety & Health Administration (OSHA) standard for a chemical accident (high-volume, low-pressure) is the recommended "default standard".

4.4 Decontamination Approaches

4.4.1 Ladder Pipe Decontamination System. To provide a large capacity shower of high-volume, low-pressure water spray, one proposed method is to employ a Ladder Pipe Decontamination System (LDS). Ladder pipes, wagon pipes, monitor nozzles, and 22" fog nozzles attached to pump dischargers and other fire apparatus (i.e., fire engines or trucks) are positioned strategically to create decon corridors for large quantities of exposed people to travel through. Once the decon corridor has been formed, the objective is to spray water from every feasible direction. The Howard County, MD Fire Department demonstrated the LDS, shown in Figure 4-1, during the BALTEX V exercise. A single ladder pipe decontamination system is comprised of two engines (also creating the corridor) that provide water spray from both sides using hoselines and deck guns, while the ladder pipe provides a high-volume, low-pressure flow from above. Multiple ladder pipe decontamination systems employ more than one ladder pipe in order to increase the decon corridor length to accommodate extremely large groups of victims. Multiple corridors can be established for ambulatory or non-ambulatory victims; victims are woven through multiple overhead sprays.

Figure 4-1. The Ladder Pipe Decontamination System

The Washington, DC Department of Fire and Emergency Medical Services developed similar internal guidelines:

> …Position two engine companies approximately 20 feet apart to form a decontamination corridor between the apparatus. Two and one-half inch fog nozzles, set at a wide fog pattern, are attached to the pump discharges. Position a truck company in line with one of the engine companies with a fog nozzle placed on the ladder pipe. The ladder is slightly elevated and rotated to provide a downward fog pattern in the corridor created by the placement of the two engine companies. Hydrant pressure alone may be enough to provide a high volume, low-pressure shower. Care should be exercised to prevent injuries from over pressurization.[H]

Figure 4-2 shows a schematic for mass decontamination developed by the Baltimore County, MD, Fire Department. It is modeled after the Washington, DC, model; however, firefighters with hoses have been positioned at the end of the shower area to apply the final wash. Victims are decontaminated between two engines, shown as E-1 and E-2, with nozzles on the rear and side discharges. Deck guns and a ladder pipe is also used. At the end of the line, two firefighters using hose lines complete a gross decontamination of the victims. All victims should wait in the shower area until hosed off. This serves the additional critical functions of controlling traffic flow, lengthening the duration of the wash, and increasing the efficiency of the decontamination process.

[H] Washington, DC Department of Fire and Emergency Medical Services Internal Operating Procedure.

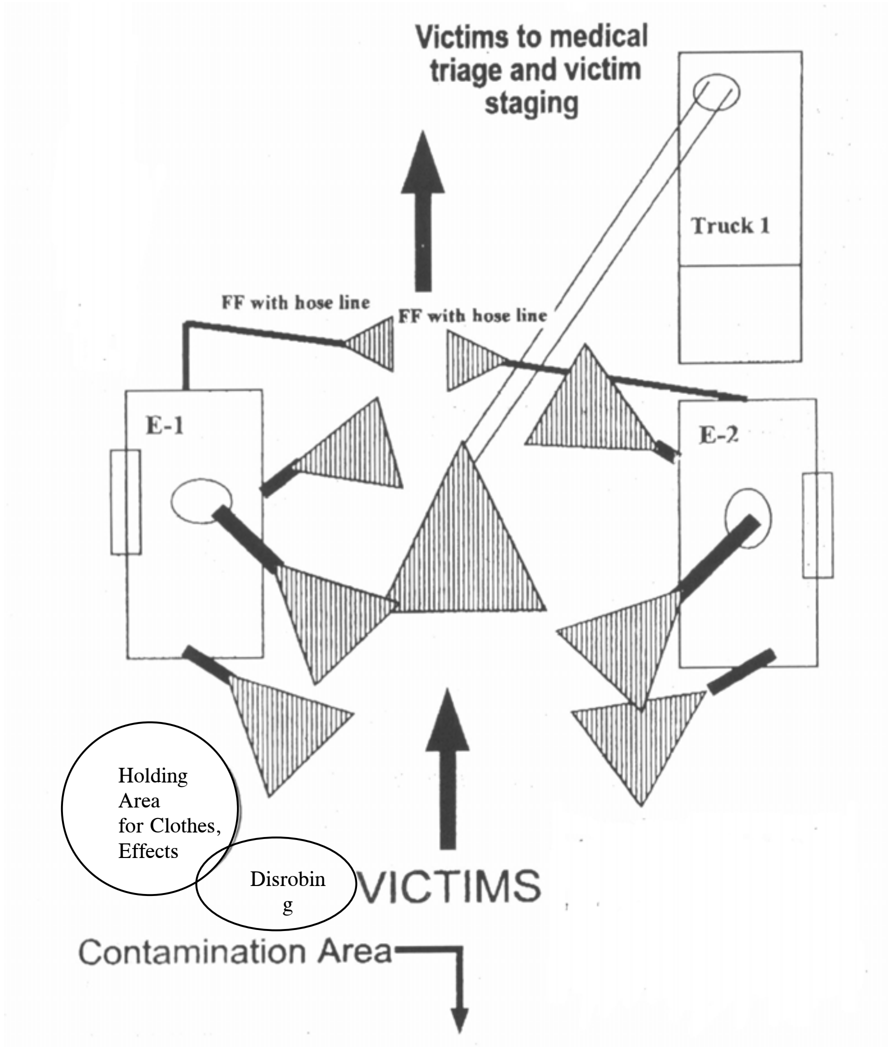


Figure 4-2. Schematic for Mass Decontamination

4.4.2 Emergency Decontamination Corridor System. Another field-expedient approach to mass casualty decontamination developed by Montgomery County, MD, Fire and Rescue Service is to use available equipment and responding fire and emergency units. The Emergency Decontamination Corridor System (EDCS) (Figures 4-3 and 4-4) uses fire apparatus, ladders, and salvage covers to create a privacy barrier and corridors for decontaminating victims. Two pumpers are positioned approximately 20 feet apart and parallel to each other. Three ladders (or ropes) are placed across and secured to the top of each pumper. Another ladder is centered atop and perpendicular to the three ladders and secured. Two nozzles are secured to this ladder and allowed to hang into the corridors. Salvage covers are attached to or draped over the ladders (or ropes) to provide two separate corridors as shown in Figure 4-5. It may be noted that although ropes serve the purpose, it is difficult to tie them with enough tension to hold up the covers without sagging. Water from the two nozzles is used to shower victims as they pass through the corridors. Plastic cable ties may be used to secure the covers and nozzles to the ladders.

Figure 4-3. The Emergency Decontamination Corridor System

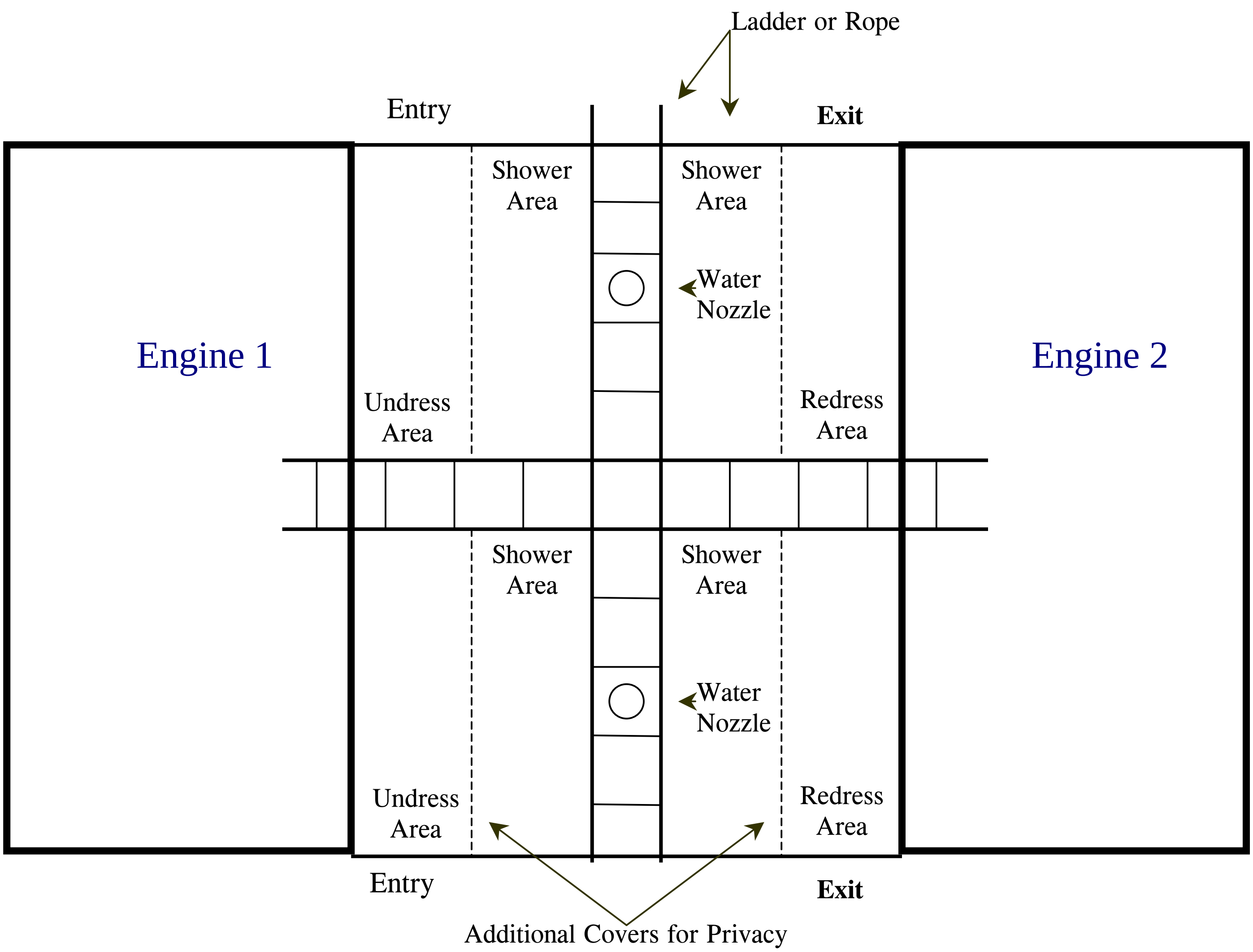


Figure 4-4. Schematic for EDCS

Figure 4-5. Proper Positioning of Salvage Covers Provides Adequate Privacy to Victims

Inside the corridor, two covers can be suspended from the ladder, one on each side of the nozzle. These covers provide additional privacy to the person who is showering and allow other people to prepare for showering in the corridor. A salvage cover (or other translucent or opaque material) is placed on top of the two corridors to provide privacy from building tops and news media helicopters. To prevent excessive noise and carbon monoxide buildup in the proximity of the corridors, both pumpers might be shut down. A third pumper can be used to supply water to the two nozzles. To conserve water, remote shutoff valves may be used to control water flow from each open nozzle. With proper planning and practice, the EDCS could be set up within 15 minutes of arrival at an incident site.

A variation to the EDCS uses an aerial ladder or tower that is extended horizontally 20 to 30 feet and is enclosed by covers as shown in Figure 4-6. Draping or suspending covers from both beams of the ladder forms a single EDCS. End covers (covers placed at the two ends of the corridor) are attached to provide additional privacy. Additional covers are draped over the ladder as needed to provide victim privacy as needed.

Irrespective of the system used, the system should be located upwind and uphill. Where practical, efforts should be made to control runoff water.

Figure 4-6. Alternative EDCS Configuration Using Ladder Truck

4.4.3 Commercially Available Decontamination Systems. An example of a commercially available system is shown in Figure 4-7.

Figure 4-7. Example of Commercial Decontamination System Available to Emergency Responders

Most of these systems are mounted to, or are carried on, special trailers that require transportation and setup at the incident site. The use of trailer-mounted systems may cause unreasonable delays in physically removing agent from the victims as soon as possible. If these systems can be centrally pre-positioned or immediately on hand, they may offer an advantage over the identified field-expedient systems. Potential advantages include:

- Heated showers may reduce the chance of hypothermia among victims
- Covered areas provide privacy that may encourage more complete disrobing and more thorough showering
- Methods to control contamination runoff.

Potential disadvantages over the field-expedient systems include:

- Systems cannot be employed as rapidly
- Systems with household showerheads for each victim will likely have lower throughput rates.

4.4.4 Other Field-Expedient Water Decontamination Methods. Emergency responders should not overlook existing facilities when identifying means for rapid decontamination methods. For example, although water damage to a facility might ensue, the necessity of saving victims' lives would justify the activation of overhead fire sprinklers for use as showers. Similarly, having victims wade and wash in water sources, such as public fountains, chlorinated swimming pools, swimming areas, etc., provides an effective, high-volume decontamination technique.

4.4.5 Non-Aqueous Methods. The use of dry, gelled, or powdered decontaminating materials that adsorb the chemical agent are appropriate if their use is expedient. Commonly available absorbents include dirt, flour, Fuller's earth, baking powder, sawdust, charcoal, ashes, activated carbon, alumina, silica gels, zeolites, clay materials, and tetracalcium aluminate. Although these absorbents may be expedient means of decontamination, their efficacy has not been determined.

The M291 and M295 Skin Decontamination Kits, which employ a charcoal-based resin as a sorbent, are used in the U.S. military and may be purchased commercially. However, while these kits are effective in removing spots of liquid chemical agent contamination, they may not be suitable for treating mass casualties due to potentially limited availability, relatively high labor requirements, and the need to use these kits quickly after the victim is contaminated.

Reactive foams are often polymeric materials with reactive sites that can readily decontaminate chemical warfare agents. Oxidants, nucleophiles, and/or enzymes are bound to the polymeric backbone of the foams or gels, and when the chemical warfare agents contact the foam or gel, they encounter the reactive site and are detoxified. Bacterial organophosphorus acid anhydrases have been placed in firefighting foam to increase decontamination efficiency within 30 minutes with low residual contact hazard (~1 g/cm^2). They have also been placed into the firefighting spray ColdFireϑ and have shown >99% decontamination efficiency within 15 minutes with the same low residual contact hazard as in firefighting foam. Enzyme samples have been provided to the U.S. Army Technical Escort Unit (TEU) for use in firefighting foams. Enzymes were also used by TEU in support of the 1997 G7 summit in Denver. The foams can be mixed with water and various co-solvents to aid in their deployment. Foams can be engineered to use limited amounts of solvent in order to reduce their dependency upon solvent volume and to aid in the cleanup after deployment. After the solvent evaporates, the foams collapse and turn into a powder, allowing for a simplified, final clean-up operation. However, since researchers have not identified a single enzyme that is effective on all classes of chemical agents, several enzymes would have to be used simultaneously.

4.5 Types of Chemical Victims

Three recent, large-scale casualty events provide insight into the operational issues associated with casualty distribution and subsequent assessment that may be encountered during a response to a chemical terrorist incident. During Operation Desert Storm, 39 Iraqi Scud missiles reached the ground, with some landing in or around Tel Aviv, Israel. The attacks resulted in approximately 1,000 treated casualties with only two deaths. Even though it was never demonstrated that any of the Scuds contained chemical agents, the well known possibility that the Scuds might contain chemical agents stimulated 544 anxiety attacks and 230 atropine overdoses. Approximately 75% of the overall casualties resulted from fears and reactions of the victims.

The second event occurred in Bhopal, India on 2-3 December 1984. During the night, several thousand gallons of highly volatile methylisocyanate was accidentally released over a three-hour period. This release was caused by the introduction of water into a methylisocyanate storage tank. The release resulted in over 200,000 people being exposed to the deadly gas. As many as 5,000 died and over 60,000 were seriously and/or permanently injured.

The third event was the Japanese subway incident where a reported 5,510 victims sought medical treatment in 278 different hospitals and health clinics. Of the 5,510 victims, 12 were casualties that died, 17 were casualties that were considered critically ill, 37 were casualties that were considered seriously ill, and 984 were casualties that were considered moderately ill. Approximately 4,000 of the 5,510 victims were deemed to have not been exposed to any significant amount of the chemical agent, yet they sought medical treatment.

Although these incidents contain many of the elements that might typify an attack within our nation, without a history of directly related incidents, a realistic characterization of potential casualty distribution after a chemical agent terrorist incident is difficult to assess. However, to provide on-scene commanders a perspective on the probable types of and range of victims, the MCDRT suggests anticipating at least a 5:1 ratio of victims to actual casualties as a guideline. For every casualty that actually is exposed to chemical agent, more than five victims who are not exposed to the chemical agent will be evaluated. While this ratio may typify an outside open-air incident, a realistic casualty assessment is incident-dependent.

4.6 Prioritizing Casualties for Decontamination

The consensus from emergency responders and medical practitioners associated with the MCDRT is that the term “decontamination prioritization” be used to describe the process of deciding the need for and order of victim decontamination. Triage is the medical process of prioritizing treatment urgency within a large group of victims. Both processes may be executed at the same time. The number of apparent victims from a chemical agent terrorist incident may exceed emergency responders’ capabilities to effectively rescue, decontaminate, and treat victims, whether or not they have been exposed to chemical agent. Responders, therefore, must prioritize victims for receiving decontamination, treatment, and medical evacuation, while providing the greatest benefit for the greatest number. Although many emergency response services prepare for such incidents, few are currently capable of treating victims inside the Hot Zone. Therefore, whenever large numbers of victims are involved, it is recommended that they be sorted into ambulatory and non-ambulatory triage categories as defined in Figure 4-8. Prioritization for decontamination can effectively be performed in a manner that will maximize treatment while minimizing the number of emergency responders exposed to chemical agent.

Triage Definitions
• **Ambulatory Casualties:** Victims able to understand directions, talk, and walk unassisted. Most ambulatory victims are triaged as minimal (green tag/ribbon or Priority 3) unless severe signs/symptoms are present. • **Non-Ambulatory Casualties:** Victims who are unconscious, unresponsive, or unable to move unassisted.

Figure 4-8. Definition of Ambulatory and Non-Ambulatory Casualties

4.6.1 Ambulatory Casualties. Ambulatory casualties are those victims who are able to understand directions, talk and walk unassisted, and are triaged as minimal (i.e., green tag, green ribbon, or priority 3), unless severe signs and symptoms are present. These casualties should be directed to move upwind into an assembly area within the Warm Zone where they can be prioritized for decontamination by on-site medical personnel. Factors that are recommended for determining the highest priority for ambulatory victim decontamination are highlighted in Figure 4-9. The highest priority for ambulatory decontamination are those casualties who were closest to the point of release and report they were exposed to an aerosol or mist, have some evidence of liquid deposition on clothing or skin or have serious medical symptoms (e.g., shortness of breath, chest tightness, etc). The next priority are those ambulatory casualties who were not as close to the point of release, and may not have evidence of liquid deposition on clothing or skin, but who are clinically symptomatic. Victims suffering conventional injuries, especially open wounds, should be considered next. The lowest decontamination priority goes to ambulatory casualties who were far away from the point of release and who are asymptomatic. Emergency responders should direct ambulatory victims in a prioritized fashion into the Warm Zone for decontamination. Care must be taken to ensure that the victims do not traverse contaminated areas in the Hot Zone or transfer contamination to the decontamination area.

Factors That Determine Highest Priority for Ambulatory Victim Decontamination
• Casualties closest to the point of release • Casualties reporting exposure to vapor or aerosol • Casualties with evidence of liquid deposition on clothing or skin • Casualties with serious medical symptoms (shortness of breath, chest tightness, etc) • Casualties with conventional injuries

Figure 4-9. Factors in Decontamination Prioritization of Ambulatory Victims

4.6.2 Non-Ambulatory Casualties. Non-ambulatory casualties are victims who are unconscious, unresponsive, or unable to move unassisted. These victims may be more seriously injured than ambulatory victims and will remain in place while further prioritization for decontamination occurs. It is recommended that prioritization of non-ambulatory victims for decontamination should be done using medical triage systems, such as START (Simple Triage and Rapid Treatment/Transport), as described in Figure 4-10.

Four S.T.A.R.T. Categories

S.T.A.R.T. Category	Decon Priority	Classic Observations	Chemical Agent Observations
IMMEDIATE Red Tag	1	Respiration is present only after repositioning the airway. Applies to victims with respiratory rate >30. Capillary refill delayed more than 2 seconds. Significantly altered level of consciousness.	• Serious signs/symptoms • Known liquid agent contaminaiton
DELAYED Yellow Tag	2	Victim displaying injuries that can be controlled/treated for a limited time in the field.	• Moderate to minimal signs/symptoms • Known or suspected liquid agent contamination • Known aerosol contamination • Close to point of release
MINOR Green Tag	3	Ambulatory, with or without minor traumatic injuries that do not require immediate or significant treatment.	• Minimal signs/symptoms • No known or suspected exposure to liquid, aerosol, or vapor
DECEASED/ EXPECTANT Black Tag	4	No spontaneous effective respiration present after an attempt to reposition the airway.	• Very serious signs/symptoms • Grossly contaminated with liquid nerve agent • Unresponsive to autoinjections

Figure 4-10. START Medical Triage System

The highest priority for overall decontamination will be those casualties who are medically triaged as immediate (i.e., red tag, red ribbon, or priority 1) and are in need of immediate life-saving medical procedures that can be done quickly with the medical resources available on-site. Usually these casualties have breathing or circulatory problems but might also include those victims with severe nerve agent poisoning whom need antidote or ventilation immediately. Severely intoxicated nerve agent casualties may be the highest priority for decontamination within this category; for these casualties, decontamination completed as soon as possible after the exposure may be lifesaving.

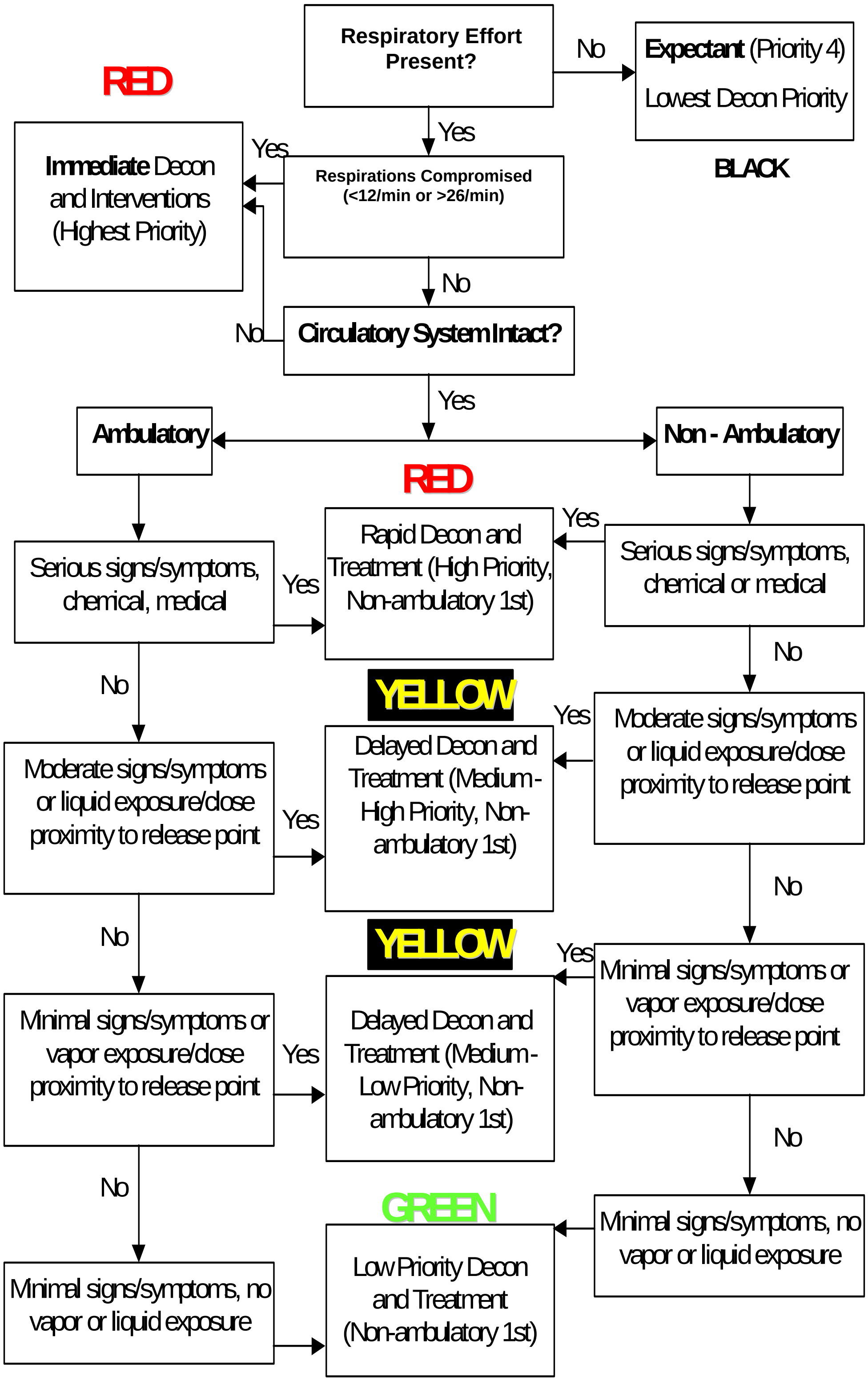
Depending on local protocols, responders in the Hot Zone may perform some treatments, such as Mark I antidote injections. Responders may need to recategorize victims in a chemical terrorist event. Those victims who are non-ambulatory priority 1 red might need to be tagged as black priority 4 non-viable victims (Figure 4-10). If these victims have not received Mark I kit treatment or decontamination within 5 minutes of exposure and if they are suffering from severe agent symptoms, they will die regardless of what type of medical intervention is provided.

The next priority for non-ambulatory decontamination will be those casualties medically triaged as delayed (i.e., yellow tag, yellow ribbon or priority 2). These are casualties who may have serious injuries and require definitive care but can wait for a short period of time without compromising the outcome (for example, a victim with a fractured lower leg). These victims may also have mild exposure to chemical agent vapor or liquid but not a life-threatening dose.

Priority 3 victims, those with no known or suspected exposure to any chemical contamination, follow treatment of priority 2 victims. The lowest priority for overall decontamination will be those casualties medically triaged as expectant (i.e., black tag, black ribbon, or priority 4) as discussed above.

4.7 Casualty Processing

The Incident Commander must quickly assess the scene and assign personnel to coordinate and manage both the medical triage and decontamination functions. If sufficient resources exist, two mass casualty decontamination systems (e.g., LDS, EDCS, commercial system) should be established: one for ambulatory victims and one for non-ambulatory victims. If available resources are only sufficient for a single system, non-ambulatory victims triaged as immediate are higher priority than the ambulatory victims triaged as immediate; therefore, they may be decontaminated as depicted in Figure 4-11. It is recommended that the remaining casualties should be processed in the same manner, with non-ambulatory victims being decontaminated before ambulatory victims. Due to the complex nature of some of these casualties (i.e., mixed chemical and conventional casualties), the medical triage and decontamination sectors should work closely together to maximize their collective sorting and management of casualties.



Notes: Immediate decontamination may only involve removal of clothing unless victim is grossly contaminated with liquid agent. Once initial triage and/or decontamination prioritization is performed and adequately trained responders are available, ambulatory victims should be placed in a separate collection area in the upwind area of the Hot Zone for secondary triage. Should a second decontamination system be placed in operation at the same site, ambulatory victims may be assigned to the second station, leaving the initial station for the non-ambulatory victims. It is recommended that all non-ambulatory victims who are exhibiting serious chemical signs and symptoms receive highest priority for decontamination. However, the MCDRT recognizes that some of these victims will not survive, and decontamination resources would be better spent on other victims.

Figure 4-11. Mass Casualty Decontamination Algorithm

In some circumstances, a severely injured, non-chemically exposed casualty cannot wait for the ideal treatment of showering or flushing with water to occur before departing the Hot Zone. Clothing removal may be the only field-expedient decontamination before the victim is removed to the support area. Additionally, severely intoxicated nerve agent casualties with extreme respiratory distress may require antidote administration and definitive airway intervention prior to showering or flushing with water. The reality is that medical triage and decontamination prioritization are often performed simultaneously and are both resource-dependent field measures. Figures 4-12 and 4-13 demonstrate the layout of EDCS's for ambulatory and non-ambulatory victims.

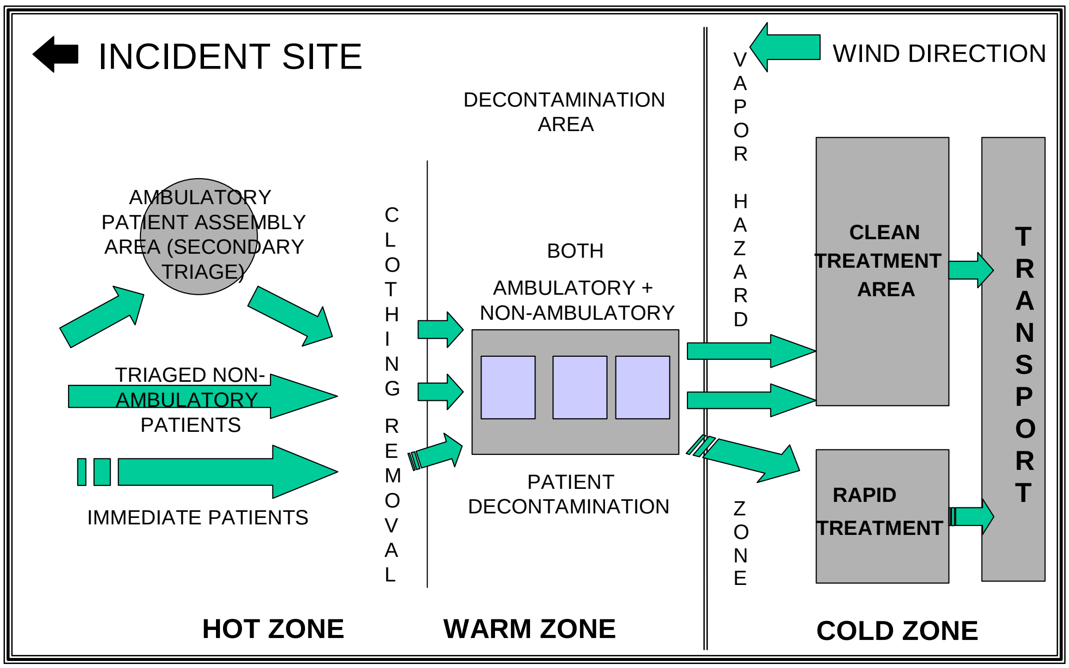


Figure 4-12. Emergency Decontamination Corridor System (1 Corridor)

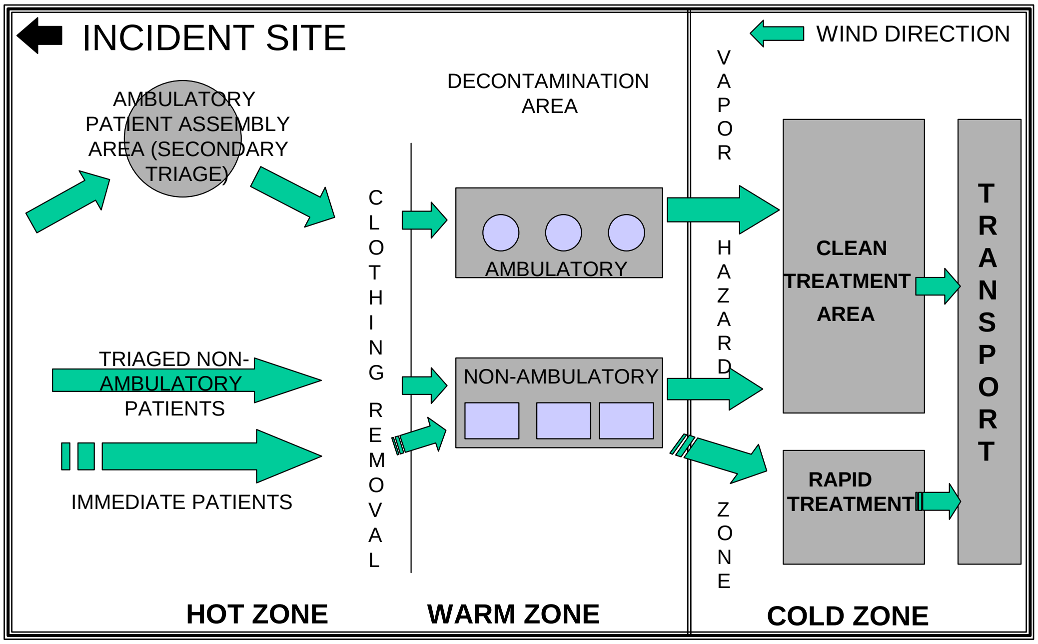


Figure 4-13. Emergency Decontamination Corridor System (2 Corridors)

If victims can walk, responders should have the victims remove their contaminated clothing and then lead them out of the Hot Zone to the Warm (decontamination) Zone. These victims should be instructed to remove contact lenses, if present, and flush skin, eyes, and hair with water. If victims are unable to walk, the rescuers should assist the victims with the removal of their contaminated clothing before transporting them on a backboard, gurney, etc. If there is no other means of transport, the victims should be carefully carried or dragged to safety; however, responders need to ensure that they do not drag victims through a contaminated area or transfer visually identifiable contamination on clothing or personal items from the Hot Zone to the Warm Zone. The contaminated items, such as clothing and personal belongings, must be left in the Hot Zone.

If responders do not have sufficient resources to decontaminate all potential victims, priority 3 victims may not need to be showered. They may be transferred immediately to the Cold (support) Zone. Doing this introduces the risk that a contaminated victim might pass through the decontamination process and contaminate others in the Cold Zone. However, when situations are severe enough, some risks may be accepted in attempts to expedite the decontamination process so that more lives can be saved. However, in any situation, victims that present physical/clinical signs and symptoms of chemical agent exposure must be decontaminated before removal from the Warm Zone.

The triage personnel positioned at the entrance of the Cold (support) Zone must be certain that victims have either undergone basic decontamination or are not suspected of having been contaminated, before leaving the Warm Zone. It is recommended that triage personnel question all people leaving the site that have not showered. If possible, the first 25 meters of the Cold Zone should be treated as a vapor hazard zone where only victims and responders in transit should be allowed in the area.

Victims who have undergone proper decontamination, or have no more than one physical sign and indicate verbally no known exposure, pose less risk of causing secondary contamination. These victims should be retained at the site in a safe area for observation for up to several hours if possible. Cold Zone emergency response personnel require no specialized respiratory protective gear when treating these people, provided they are properly positioned outside of the Hot and Warm Zones.

The triage of non-ambulatory victims in a Hot Zone may be difficult to perform and may be highly incident-specific. These victims are the only group that should receive medical treatment within the Hot Zone; however, timely removal of the victims from the contaminated area is essential for their survival. They may need to receive an autoinjection of atropine and Oxime (2-Pam C1) (Figure 4-14) prior to their removal or decontamination. For additional information on Mask I kits, see Appendix B. Immediate decontamination may need to occur within the Hot Zone, and responders must remove visible contamination from the victim prior to medical treatment within the Cold Zone.

There may also be victims that have expired by the time triage personnel arrive. Expired victims and those who are black tagged are the last concern for emergency responders, and they may choose not to address these victims at all, leaving these victims to be handled later, during site cleanup and remediation.

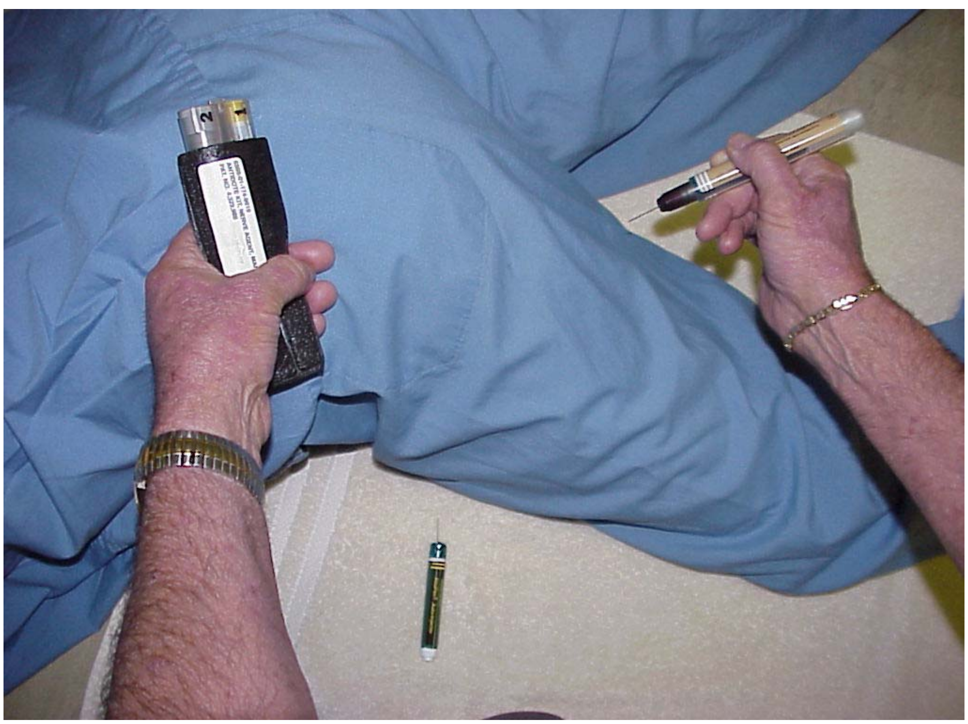


Figure 4-14. Administration of Atropine and Oxime (2-Pam CI) by Autoinjector

4.8 Additional Considerations

4.8.1 Environmental Concerns. The Environmental Protection Agency (EPA) has addressed the issues of acceptable levels of contamination in runoff and first responder liability for the spread of contamination caused by efforts to save lives; EPA website is provided at Appendix C.[I] Regarding the liability issue, the EPA's interpretation of The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) indicates that "no person shall be liable… for costs or damages as a result of actions taken or omitted in the course of rendering care, assistance or advice in accordance with the National Contingency Plan (NCP) or at the direction of an On-Scene Coordinator appointed under such plan…"

On the subject of accepted runoff, the EPA recognizes that any level of contamination represents a threat to the environment. The threat is also dependent on many variables, including the involved chemicals, their concentrations, and the runoff watershed. However, life and health considerations are again paramount. "… first responders should undertake any necessary emergency actions to save lives and protect the public and themselves. **Once any imminent threats to human health and lives are addressed, first responders should immediately take all reasonable efforts to contain the contamination and avoid or mitigate environmental consequences.**"[I] The EPA allows that the highest priority be given to responder actions taken to save lives and preserve health during a chemical terrorist incident. The EPA indicates that, when taking federally recommended actions in response to a chemical terrorist incident, responders are protected under the law.

4.8.2 Legal Concerns. The BALTEX exercises highlighted that laws and the body of legal findings that may govern the actions and liability of the emergency responder community after a chemical terrorist incident are sometimes poorly defined. Ultimately, each local jurisdiction should tailor their policies, plans, training, and procedures based on local interpretation of applicable regulations, statutes, and laws.

5.0 RECOMMENDATIONS

The efforts of the MCDRT during this study resulted in the consensus development of several general guidelines for emergency responder mass casualty decontamination policies, procedures, and actions after a chemical agent incident. The most imperative principle of mass casualty decontamination is the timely physical removal of the agent from the skin of the victim. To support this, the following should be conducted:

- Decontaminate victims as soon as possible
- Consider disrobing as part of decontamination; head to toe, more removal is better
- Flushing with water generally is the best mass decontamination method.

Decontamination approaches most readily available to first responders involve the use of water-pumping capability to create showers for decontamination. Several equipment configurations are possible and have been described. The fundamental goal is to use pumping capability to set up showers as quickly as possible and get people disrobed, into, and through the

[I] EPA website: http://www.epa.gov/swercepp/pubs/onepage.pdf, subject: First Responders' Environmental Liability Due to Mass Decontamination Runoff.

showers, before further chemical agent effects can occur. It is not advised to delay the decontamination process, while obtaining soaps or other decontamination materials. If immediately available, such materials may be of benefit, but it is more important to begin decontamination as soon as possible.

Decontamination prioritization helps ensure the maximum benefit for the maximum number of victims. Decontamination prioritization should be performed using medical triage systems, such as START. Prioritizing casualties for decontamination becomes more important when the number of victims overwhelms the available resources. Procedures should be implemented to assist in preventing triage personnel from becoming overwhelmed. In such situations, the Incident Commander must often decide how to best adjust the prioritization to maximize the benefit.

Decontamination prior to leaving the Hot and Warm Zones is essential for protecting people in the Cold Zone. However, during the response to a chemical agent terrorist incident, the MCDRT notes that emergency responders should expect at least a 5:1 ratio of unaffected to affected casualties expecting emergency care and decontamination. Therefore, when the situation is severe enough and resources are overwhelmed, individuals who show no chemical agent contamination or symptoms, and who are not otherwise suspected of being contaminated, may be allowed to proceed to the Cold Zone. The Incident Commander may make this allowance, if it is believed that such action will speed the decontamination process for genuinely contaminated and symptomatic people, and ultimately result in more lives saved.

Finally, after a known exposure to liquid chemical agent, emergency responders wearing firefighter PPE should be prepared to self-decontaminate using procedures discussed in NPFA 471, Recommended Practices for Response to Hazardous Materials Incidents.

REFERENCES

All references below were consulted during this study. Several web sites have changed addresses or servers since the research began, and may not be current.

CHEMICAL DEFENSE/CHEMICAL BIOLOGICAL INFORMATION ANALYSIS CENTER (CBIAC)

Listed below are the search queries used by CBIAC personnel from which output was received for review.

<u>CBIAC's Database</u>
Personal Decontamination
Terror* and Decon*
Disaster Preparedness
Casualty Decon*
Skin Decontamination

<u>DTIC's DROLS Database</u>
$cwa , $bwa AND $first aid
$cwa, $bwa, AND ?00%DECON AND emergencies

$cwa, $bwa, AND %civil defense
$CHEMICAL WARFARE AGENTS, $BIOLOGICAL WARFARE AGENTS AND %DISASTER
$CHEMICAL WARFARE AGENTS, $BIOLOGICAL WARFARE AGENTS AND EMERGENCY CONTROL, EMERGENCY FEEDING AND LODGING, EMERGENCY MEDICAL CARE, EMERGENCY MEDICAL CARE SUBSYSTEMS, EMERGENCY MEDICAL CARE SYSTEMS, EMERGENCY NETWORK, EMERGENCY OPERATING CENTERS, EMERGENCY OPERATIONS, EMERGENCY OPERATIONS CENTERS, EMERGENCY OPERATIONS PLANNING, EMERGENCY PREPARATION, EMERGENCY PREPAREDNESS PLANNING,
EMERGENCY PREPAREDNESS PROGRAM, EMERGENCY PREPAREDNESS (NS/EP), EMERGENCY PROCEDURES, EMERGENCY PROCESSES
(TPS - CBIAC Searches.doc 9/15/03)

National Library of Medicine: search terms were decontamination, chemical or biological warfare, terrorism

Medline, 1965-1997, Toxline, Sulfur (W) Mustard and Skin and (Protect? Or Barrier? Or Penetrate?)

AGRICOLA 1970-1997,Sulfur (W) Mustard or Soman or organophosphonate and Percutaneous and Analgesic? Or Anesthetic? Or Animal Model? Or Pain? Or Animal Test? Or Alternative? Or Drug Therapy? Or Analytical Method?

CAB Abstracts, 1972-1977, Sulfur (W) Mustard or Soman or organophosphonate and Percutaneous; and Analgesic? Or Anesthetic? Or Animal Model? Or Pain? Or Animal Test? Or Alternative? Or Drug Therapy? Or Analytical Method?

Medline, 1966-1977, Sulfur(W)Mustard or Soman or organophosphonate and Percutaneous; and Analgesic? Or Anesthetic? Or Animal Model? Or Pain? Or Animal Test? Or Alternative? Or Drug Therapy? Or Analytical Method?

Toxline, 1965-1997, Sulfur(W)Mustard or Soman or organophosphonate and Percutaneous; and Analgesic? Or Anesthetic? Or Animal Model? Or Pain? Or Animal Test? Or Alternative? Or Drug Therapy? Or Analytical Method?

EMBASE, 1974-1997, Sulfur(W)Mustard or Soman or organophosphonate and Percutaneous; and Analgesic? Or Anesthetic? Or Animal Model? Or Pain? Or Animal Test? Or Alternative? Or Drug Therapy? Or Analytical Method?

OUTPUT FROM CBIAC SEARCHES

General References

1. Hazardous Materials: Managing the Incident; 1995; Noll, G.G., Hilderbrand, M.S., and Yvorra, J.G.; Stillwater, OK; Fire Protection Publications.

2. Studies on Skin Decontamination. Part I. Protective Ointments M5, Water and Bleaches on Skin Decontaminants for GB; 1953; Zvirblis, P. and Kondritzer, A.A.; Medical Laboratories Research Report No. 193, Army Chemical Center, MD.

3. Studies on Skin Decontamination. Part II. Bleaching Powder and Related Items as Decontaminants for Liquid GB; 1954; Zvirblis, P., Mayer, W.H., and Kondritzer, A.A.; Medical Laboratories Research Report No. 307; Army Chemical Center, MD.; DITC No. AD-043038.

4. 1996 Annual Report of PG.31 (NATO ARMY ARMAMENTS GROUP), 11 November 1996; DTIC CB-100671.02.

5. Sulfur-Mustard: Its Continuing Threat as a Chemical Warfare Agent, the Cutaneous Lesions Induced, Progress in Understanding the Mechanism of Action, Long-term Health Effects, and New Developments for Protection and Therapy; 1995; Smith, K.J., Hurst, C.G., Moeller, R.B., and Sidell, F.R.; J. Amer. Acad. of Dermatology 32, 767-776.

6. Chemical Warfare Agents: II.. Nerve Agents; 1992; Sidell, F.R., Borak, J.; Annuals of Emergency Medicine 21(7), 865-871.

7. Clinical Considerations in Mustard Poisoning; 1992; Sidell, F.R., and Hurst, C.G.; In Chemical Warfare Agents (ed. Somani, S.M.), 52-67, Acad. Press, Inc.: New York.

8. Progress in Medical Defense Against Nerve Agents; 1989; Dunn, M.A. and Sidell, F.R.; JAMA 262: 649-52.

9. Civil Emergencies Involving Chemical Warfare Agents: Medical Considerations; 1992; In Chemical Warfare Agents (ed. Somani, S.M.), 341-356, Acad. Press, Inc.: New York.

10. Methodology for Mass Casualty Characterization, Extracted From a Document Prepared by District Chief Rick Long and Captain Barry Reid (Montgomery County, Maryland, Fire and Rescue and Provided by Deputy Chief Ted Jarboe).

11. Mustard Agent Poisoning: Pathophysiology and Nursing Implications; 1993; Moore, D.W., and Keeler, J.R.; Critical Care Nurse 139(6), 62-68.

12. Medical Defense Against Blistering Chemical Warfare Agents; 1991; Smith, W.J., and Dunn, M.A.; Arch. Of Dermatology 127, 1207-1213.

13. Surgeon General of the Army and Director of Military Support EXERCISE TERMINAL BREEZE After Action Report; CB101631-01; Oct 1996.

14. Environmental Temperature and the Percutaneous Absorption of a Cholinesterase Inhibitor, VX; 1977; Craig, F.N., Cummings, E.G., and Sim, V.M.; J. of Invest. Dermatol. 68: 357-361.

15. Studies on Skin Decontamination, Part 1; MLRR 193, June 1953; Zvirbles, P., and Kondritzer, A.A.

16. Aqueous Sodium Hypochlorite and Protective Ointment M-5 as Skin Decontaminants for V Agents; CWLR 2303, Aug 1957; Mayer, W.M., and Kondritzer, A.A.

17. National Health and Medical Services Response to Incidents of Chemical and Biological Terrorism, Policy Perspectives; Aug 1997; Tucker, J.B.; J. Amer. Med. Assoc. 278 (5), 362-368; From the Center for Nonproliferation Studies, Monterey Institute of International Studies.

18. The Threat of Biological Terrorism – Prophylaxis and Mitigation of Psychological and Social Consequences; Aug 1997; Hollaway, H.C., Norwood, A.E., Fullerton, C.S., Engel, C.C., and Ursano, R.J.

19. Medical Management of Biological Casualties Handbook; Aug 1996, Second Edition; United States Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD 21702

20. North American Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Hazardous Materials Incident; 1996; Response and Special Programs Administration, Washington, DC, United States Dept. of Transportation.

21. International Hazardous Materials Response Teams Conference: Nuclear, Biological, and Chemical Problems as They Relate to Terrorism; 1997; International Association of Fire Chiefs, Fairfax, VA; United States Dept of Transportation.

22. Chemical and Biological Terrorism; Aug 1996; Briefing in Jane's Defense Weekly

23. Control of Communicable Disease Manual; 1995, Sixteenth edition; Beneson, Abram S., Editor; An Official Report of the American Public Health Association.

24. Personal Decontamination Station Standing Operating Procedures; 1994; United States Army Technical Escort Unit; Aberdeen Proving Ground, MD 21010

25. Evaporation of Agents from Saudi Soil Arabian Soils 1. Mustard; 1992; Penski, E.C., Walker, H.M., Ellzy, M.W., Mitchell, P.C., and Janes, L.G.; DTIC AD-B168 071.

26. Evaporation of Agents from Saudi Soil Arabian Soils II. G-Agents; 1992; Penski, E.C., Walker, H.M., Szafraniec, L.L., Ellzy, M.W., Mitchell, P.C., and Janes, L.G.; CRDEC-TR-378; DTIC AD-B168 627.

27. Technical Escort Operations; 1988; United States Army Technical Escort Unit; Headquarters, Dept. of the Army, Washington, DC.

28. Task 4C08-02-023-04, CWL Notebook 879, Toxicology Division, Field Toxicology Branch; Feb 1957; U.S. Army Chemical Research and Development Laboratories.

29. Casualty Decontamination – Training for Chemical and Medical Personnel; 1990; Russell, R., SFC; Army Clinical Review, PB 3-90-1; DTIC CB 014025, Pg. 12-16.

30. Technical Options for Protecting Civilians from Toxic Vapors and Gases; 1988; Chester, C.V.; ORNL/TM-10423, Oak Ridge National laboratory, Oak Ridge, Tenn.

31. Compressed Air Breathing Apparatus. Firefighter Escape Sets. Manufactures Brochure, Siebe Gorman and Company, Ltd.; Siebe Gorman and Company, Ltd.; 1985; Avondale, Way, Gwent, United Kingdom.

32. Defense Against Toxin Weapons; 1994; Franz, D.R.; DTIC AD286301, CB-027310.03.

33. Efficacy of the Proposed Reactive Skin Decontaminant Lotion Against Challenge by GD, VX, and HD; Suffield Report No. 516; Mar 1989; Bide, R.W., Sawyer, T.W., and Parker, D.; Defense Research Establishment Suffield, Ralston, Alberta Canada; DTIC AD-B132 575

34. Development of a Safe and Effective Skin Decontamination System: Demonstration and Validation; Feb 1987; Rohm and Haas Company; USAMRDC Contract DAMD17-85-C-5200; Borenstein, N., Horsey, D.W., MacDuff, J.H., Steigerwalt, R.B., and Miller, H.H.; DITC AD-B134 687.

35. Comparison of Three Skin Decontamination Systems for Activity Against G and H Agents; May 1989; Suffield Memorandum No. 1265 Project No. 0513Q-12T, Task DNBCC 007, DRDHP 11; Defense Research Establishment Suffield, Ralston, Alberta Canada; Bide, R.W., Armour, S.J., Sawyer, T.W., Parker, D., and Risk, D.

36. Civilian-Military Health Services Contingency Program for a Mass Casualty Situation and Wartime in Israel; 1991; Shemer, J., Heller, O., Danon, Y.L.; Israel J. of Medsci, Nov, 27(11-12):613-615.

37. Field Expedient Dermal Decontamination of Low Molecular Weight Toxins (T-2 Mycotoxin); DTIC CB014066.01, D751 481; Bunner, B.L., Pace, J.G., and Wannemacher, Jr., R.W.

38. Primary Dermal Irritation Potential of Components of the M258A1 Decontamination Kit; Apr. 1982; Fruin, J.T., and Haynes, M.A.; Letterman Army Institute of Research Report No. 120; DTIC AD-A114 803, AD 105 977 (Study 1); 107-382 (Study 4).

39. NBC Decontamination; 1993; U.S. Army Field Manual (FM) 3-5; CB 025412.03

40. Chemical Casualty Treatment Protocol Development – Treatment Approaches (HSD-TR-87-007); Sept 1986; Augerson, W.S., Sival, A., and Marley, W.S.; CB-000001-03, B112 914; Prepared by Arthur D. Little, Inc. for HQ Human Systems Division, Chemical Defense SPO (HSD/YA), Air Force Systems Command, Brooks AFB, TX 78235-5000.

41. NBC Defense – An Overview; Part 2: Detection and Decontamination; 1984; Benz, K.G.; International Defense Review, 159-164

42. Assessment of Capability of Special Operations Forces (SOF) to Handle Chemical Warfare Casualties; Jun 1990; Metz, G.G., Hutton, M., and Llewelly, C.; DTIC No. AD-B146 109.

43. The Economic Impact of a Bioterrorist Attack: Are Prevention and Postattack Intervention Programs Justifiable; Kaufmann, A.F., Meltzer, M.I., and Schmid, G.P.; Emerging Infectious Diseases 3 (2): Apr-Jun 1997.

44. Chemical Biological Incident Response Force Handbook Decontamination Element Proposed Operational Requirements Document (ORD) for Chemical and Biological Incident Response force (CIBRF) Capability.

45. The Detoxification and Natural Degradation of Chemical Warfare Agents; 1985; Trapp, R.; Stockholm International Peace Research Institute.

46. D'Agostino, P.A.; Provost, L.R., The Identification of Compounds in Mustard Hydrolysate (U), DRES Suffield Report 412, Ralston, Alberta, Canada, 1985; DTIC AD-A156381.

47. Rosenblatt, D.A.; Miller, T.A.; Dacre, J.C.; Muul, I.; Cogley, D.R., Problem Definition Studies on Potential Environmental Pollutants II. Physical, Chemical, and Biological Properties of Sixteen Substances, Technical Report 7509, U.S. Army Medical Research and Development Command, Washington, DC, 1975, AD-A020428, pp. B-6, B-7.

48. Price, C. C.; von Limbach, B., Further Data on the Toxicity of Various CW Agents to Fish, OSRD No. 5528, Division 9, National Defense Research Committee of the Office of Scientific Research and Development, 1945.

49. Hazardous Materials: Managing the Incident, 2nd edition; 1995; Noll, G.G., Hildebrand, M.S., and Yvorra, J.G.; Fire Protection Publications, Oklahoma State University, Stillwater, OK 74078

50. Managing Hazardous Materials Incidents; Vol. 2; Hospital Emergency Departments: A Planning Guide for the Management of Contaminated Patients; U.S. Dept. of Human Services, Public health Service, Agency for Toxic Substances and Disease Registry.

51. Managing Hazardous Materials Incidents; Vol. 3; Medical Management Guidelines for Acute Chemical Exposures; U.S. Dept. of Human Services, Public health Service, Agency for Toxic Substances and Disease Registry

52. EPA Solid Waste 846, method 8260B.

53. Gordon, J. J.; Leadbeater, L., Toxicol. Appl. Pharmacol., 1977, 40, 109.

54. Chemical Agent Data Sheets, Vol. I, EO-SR-74001, Edgewood Arsenal, 1974.

55. Chem. Eng. News, 1953, 31, 4676-4678.

56. The King Has No Clothes: The Role of the Military in Responding to a Terrorist Chemical/Biological Attack; Jun 1996; Osterman, J.L., Naval War College.

57. Individual and Group Behavior in Toxic and Contained Environments; Dec. 1986; Ursano, R.J. (ed); Department of psychiatry, F. Edward Hebert School of Medicine, Uniformed Services University of the Health Sciences; DTIC No. AD-A203 267.

58. Treatment of Chemical and Biological Warfare Injuries: Insights Derived from the 1984 Iraqi Attack on Majnoon Island; 1991; Kadivar, H., and Adams, S.C.; Military Medicine Apr, 156(4):171-177.

59. Managing Hazardous Materials Incidents; Vol. 1; Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients; U.S. Dept. of Human Services, Public health Service, Agency for Toxic Substances and Disease Registry.

60. Chemistry and Toxicology of Water Treated With Hypochlorite to Detoxify Chemical Agent VX; 1987; Kalkwarf, D.R., Zangar, R.C., and Springer, D.L.; Battelle Pacific Northwest Lab, Richland, WA.; ADA 194559.

61. JAMA 278(5): 362368; Aug 6, 1997

62. The Effect of Time and Removal of Contaminated Clothing on the Prevention of Death from VX Poisoning; CRDLR 3028, SEPT 1960, Vande Wal, Jr., A, and Wiles, J.S.

63. Toxicity of Certain G and V Agents Through Clothing; CWLR 2295, Aug 1955; Wiles, J.S., Alexander, J.B.

64. Proceedings of the Seminar on Responding to the Consequences of Chemical and Biological Terrorism, July 11-14, 1995; Sponsored by the U.S. Public Health Service Office of Emergency Preparedness; NTIS PB97-121248.

66. Validation of an *In Vitro* Model Used to Characterize the Evaporative, Penetrative and Fixative Properties of ^{14}C-Labeled Sulfur Mustard, Lewisite, and VX Applied Topically to Fresh Pig Skin (1987); Joiner, R.L., Harroff, H.H., Jr., Feder, P.I., and Snider, T.H.; Final Report on Contract No. DAMD17-83-C-3129, Task 84-3, Battelle.

67. Personal communication with Scott Wright, Emergency Response Coordinator, Agency for Toxic Substances and Disease Registry (ATSDR), Atlanta Georgia (1-404-639-6360) on 28 April 1998.

Additional References Supporting-High Volume Low-Pressure Showers

1. 29 CFR 1910.151, Medical Services and First Aid

2. American National Standard for Emergency Eyewash and Shower Equipment, Section 4.5.1(4)

3. ANSI Z358.1-1990, Lawrence Livermore National Laboratory Health & Safety Manual, Chapter 6

4. 40 CFR 165.10(c)(4)

5. MIL-HDBK-1028/8, Pest Management Facilities

Internet Resources

http:/www.cdc.gov/wonder/prevguid: Medical Management Guidelines for Acute Chemical Exposures; U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substance and Disease Registry; Recommendations from their web site entitled Unidentified Chemical Pre-hospital Management

www.apgea.army.mil ERDEC Safety Office MSDSs

www.cdc.gov BMBL-Section VII-Agent Summary Statements, Bacterial Agents

http://atsdr1.atsdr.cdc.gov:8080/hazdat.html Agency for Toxic Substances and Disease Registry, Hazardous Substance Release/Health Effects Database

www.apgea.army.mil SBCCOM Web Site Home page

http://www.ecbc.army.mil/hld/ip/reports.htm SBCCOM/Homeland Defense website

www.nbc-med.org Field Manual 8-285

www.emergency.com Hazmat

http://www.emergency.com/hzmtpage.htm Hazardous Materials Operations Page

www.nbc-med.org The Nuclear, Biological, and Chemical Medical Web Page

www.cbiac.apgea.army.mil CBIAC Home Page

http://www.epa.gov/chemfact/ Chemicals in the Environment: OPPT Chemical Fact Sheets

http://www.cdc.gov/ CDC Home page

http://www.os.dhhs.gov/ USAD Health and Human Services Home Page

http://research.nwfsc.noaa.gov/ Northwest Fisheries Science Center: Material Safety Data Sheet Searches

http://www.disasters.org/emgold/Terrism.html Disaster Management Central resource

http://ww.disastercenter.com/medical.html NBC Medical Defense Library

http://www.usamriid.army.mil Biological Agent Information Papers, USAMRIID

www.emergency.com Emergency Response and Research Institute

http://ccc.apgea.army.mil/ USAMRICD open literature publications and books, 1981-1996 www.opcw.org/chemhaz/decon.htm: Website from the Organization for the Prohibition of Chemical Weapons (OPCW) in The Hague, the Netherlands. OPWC is responsible for implementing the Chemical Weapons Convention (CWC); Decontamination of Chemical Warfare Agents: An Introduction to Methods and Chemicals for Decontamination.

Medical Publications

Field Manuals | Government Documents | Department of Defense Reports | Case Studies | Other | National Academy Press | Newsletters | Periodicals

Field Manuals

1. FM 3-5; NBC Decontamination

2. FM 3-21; Chemical Accident Contamination Control

3. FM 8-9; Handbook on the Medical Aspects Of NBC Defensive Operations

4. FM 8-10-7; Health Service Support in a Nuclear, Biological, and Chemical Environment

5. FM 8-285; Treatment Of Chemical Agent Casualties And Conventional Military Chemical Injuries

6. FM 21-10; Field Hygiene And Sanitation

7. FM 21-10-1; Unit Field Sanitation Team

8. FM 21-11; First Aid for Soldiers-See Chapter 7 for NBC First Aid

Other Government Documents

1. Biological Information Papers; U.S. Army Medical Research Institute of Infectious Diseases

2. Medical Products for Supporting Military Readiness (GO BOOK); U.S. Army Medical Research and Materiel Command-Medical Biological Defense and Medical Chemical Defense

3. Medical Management of Biological Casualties Handbook; U.S. Army Medical Research Institute of Infectious Diseases

4. Medical Management of Chemical Casualties Handbook; U.S. Army Medical Research Institute of Chemical Defense

5. The Defense Against Toxin Weapons Manual provides basic information on biological toxins for military leaders and health care providers.

6. Joint Doctrine for Nuclear, Biological, and Chemical (NBC) Defense (10 July 1995) Joint Publication 3-11

7. TB MED 296; Assay Techniques for Detection of Exposure to Sulfur Mustard, Cholinesterase Inhibitors, Sarin, Soman, GF, and Cyanide

8. "Chemical Facts Sheets", U.S. Army Center for Health Promotion & Preventive Medicine Chemical Facts Sheets

Department Of Defense Reports

1. Domestic Preparedness in the Defense Against Weapons of Mass Destruction, May 1, 1997.

2. NBC Defense Annual Report To Congress, March 1997

3. Proliferation: Threat and Response, Nov 25, 1997

4. Quadrennial Defense Review, May 1997

5. Report on Activities and Programs for Countering Proliferation and NBC Terrorism, May 1997.

6. Decontamination Systems for the Skin; AD Number: ADA193370 and ADA194133

7. A Survey and Evaluation of Chemical Warfare Agent-Decontaminants and Decontamination: AD Number: ADA202525

8. Decontamination of Casualties from Battlefield Under CW and BW Attack, AD Number: ADA211477

9. Formulation of Topical Protectants/Decontaminants; AD Number: ADA213246

10. Full Scale Development and Initial Production of the Personnel/Casualty Decontamination System Skin Decontamination Kit (PCDS SDK), AD Number: ADA244438

11. Reactive Skin Decontaminant Reactivity Studies: The Effect of O-Acetyl 2,3-Butanedione Monooxime on the Stability of 2,3-butanedione monooximate, AD Number: ADA251165

12. Decontamination of Chemical Warfare Agents; AD Number: ADA261882

13. Enzyme Decontamination of O-P Toxins; AD Number: ADA275937

14. Development of a Safe and Effective Skin Decontamination System: Demonstration and Validation.; AD Number: ADB134687

15. Chemical Warfare Agent Decontaminant Solution Using Quaternary Ammonium Complexes. AD Number: ADD017924

16. CW Agents and the Skin Penetration and Decontamination; AD Number: ADD750392

17. Simple Methods for the Removal of Chemical Agents from the Skin; AD Number: ADD750394

18. Decontamination and Detection by Grafted Polymer Films and Powdered Clays; AD Number: ADD750496

19. Microemulsions Containing Reactive Decontaminants: Formulation, Efficacy, and Optimization; AD Number: ADD750529

20. A Multi-Component Decontamination System: Studies of Component Compatibility and Effectiveness; AD Number: ADD750565

21. The Detoxification and Natural Degradation of Chemical Warfare Agents; AD Number: ADD750632

22. Knowing Agents and Decons - An NBC NCO Shares His Knowledge, AD Number: ADD751327

23. Decontamination of Agents of Biological Origin: A Potential Shipboard System; AD Number: ADD751477

24. Field Expedient Dermal Decontamination of Low Molecular Weight Toxins (T-2 Mycotoxin); AD Number: ADD751481

25. The Immediate Decontamination of the Skin; AD Number: ADD751488

26. The Development of a Mass Decontamination Unit for Air Base Operations; AD Number: ADD751587

27. Hydrolysis of 1,2,2-trimethylpropyl methylfluorophosphonate (Soman) By Some Reactive Tenzides; AD Number: ADD752641

28. Use of the Sorption-,Mechanical Principle in the Personal Skin Decontamination; AD Number: ADD753165

29. Development of Chemically Reactive Fibers and Films for Decontamination; AD Number: ADD753384

30. Evaluation of Candidate Decontaminants Against Percutaneous Sulfur Mustard and Thickened Soman Challenges.; AD Number: ADP008788

31. Skin Decontamination of G, V, H & L Agents by Canadian Reactive Skin Decontaminant Lotion.; AD Number: ADP008793

32. Domestic Preparedness Training Manual - Train the Trainer; 1997; Chemical and Biological Defense Command; Aberdeen Proving Ground, MD.

<u>Case Studies</u>

1. Accidental Leakage of Cesium-137 in Goiania, Brazil, in 1987

2. Sverdlovsk Anthrax Outbreak of 1979

<u>Other</u>

1. Chemical Agent Terrorism, Frederick R. Sidell, M.D.
    - Introduction
    - Chemical Warfare Agents
        - Nerve Agents
        - Vesicants
        - Cyanide
        - Pulmonary Agents
        - Incapacitating Agents
    - Medical Response
    - Summary

2. National Academy Press: An Evaluation of Radiation Exposure Guidance for Military Operations: Interim Report (1997); Committee on Battlefield Radiation Exposure Criteria

3. The Nuclear Weapons Complex: Management for Health, Safety, and the Environment

4. Management and Disposition of Excess Weapons: Plutonium: Reactor-Related Options

5. Management and Disposition of Excess Weapons: Plutonium

6. Alternative Technologies for the Destruction of Chemical Agents and Munitions

7. Proliferation Concerns: Assessing U.S. Efforts to Help Contain Nuclear and Other Dangerous Materials and Technologies in the Former Soviet Union

8. Post-Cold War Conflict Deterrence

9. Dual-Use Technologies and Export Administration in the Post-Cold War Era

<u>Newsletters</u>

1. The ASA NEWSLETTER published six times a year by Applied Science and Analysis, Inc.

2. The CBIAC Newsletter - a quarterly publication of the Chemical Warfare/Chemical and Biological Defense Information Analysis Center

3. The CBW Chronicle- a periodic newsletter from The Henry L. Stimson Center.

4. Chemical/Biological Arms Control Dispatch - a bi-monthly report from Chemical and Biological Arms Control Institute

5. HTIS BULLETIN - a publication of the Hazardous Technical Information Services

Periodicals

1. Journal of the American Medical Association (August 6, 1997); Biological Warfare - JAMA Theme Issue

2. Scientific American (12/96); The Specter of Biological Weapons

Products

1. CANADIAN REACTIVE SKIN LOTION – Patent information provided by Nancy McBean, Licensing Associate for University Technologies, Inc. per my phone request for additional information concerning scientific literature for their product. She provided me "patent" information, which did contain some additional *in vivo* animal study data.

2. Reference CB-019399; Mediclean^{R} 1000 and 2000; Produced by American Kleaner Mfg. Co., Inc; Mobile Systems for Military and Special Clients; High pressure Cleaning Systems

3. Electro-Chemical Activated Solution (ECASOL) presently under evaluation by Battelle, MREF.

4. Canadian Reactive Skin Decontaminant Lotion – RSD - (2,3-butanedione monoximate in polyethyleneglycol monomethylether); reduced vesicant damage if applied within 60 seconds post application of agent; as the dose is decreased the decon time post application of agent can be increased (out to 300 seconds).

5. Canadian Decontaminating Mitt (Mitt) was compared to the US Personnel / Casualty Decontamination System: Skin Decontamination Kit (SKD) and the Canadian Reactive Skin Decontamination Kit (RSD) and all showed some efficacy against G and H agents.

6. Germany: Karcher – decontaminating equipment using high pressure steam spray

7. MODEC Mobile Decontamination Systems

Hazardous Incidents Reviewed

1. 1915, WW1; Germans released 150 tons of chlorine form 6000 cylinders, +800 dead casualties; 2500-3000 incapacitated, Approximately 95% of the soldiers injured by chemical agents survived; WW1, US suffered 250,000 casualties; 13%KIA, 87% wounded and 30% of these 225,000 casualties were due to gas; British experienced 180,000 casualties with similar death ratio – 11% in the Russian Army because of the lack of gas masks

2. Saturday, November 10, 1979, 11:54 PM, Mississauga, Ontario, Canada, Series of tank cars including one with 90 tons of chlorine, 4 cars filled with caustic soda, a string of cars containing propane, and three cars carrying styrene derailed; propane cars ruptured creating explosions which punctured the chlorine car, and the contents of the styrene and caustic soda poured onto the tracks, No deaths or major injuries; 250,000 people evacuated; eye irritations, respiratory problems, chest pains, psychosomatic illnesses, food poisoning, aggravated existing illnesses, bruises, pain, sprains, broken bones

3. Saturday, April 11, 12:29 PM, Pittsburgh, PA, Two trains sideswiped each other, 4 derailed tank cars containing hazardous materials – phosphorous oxychloride, fire but no explosion

4. Wednesday, May 6, 4:10 AM, train derailment in Confluence PA, cars carrying only residue of hazardous materials, no deaths or major illness.

5. Reston, VA (Ebola) 1990

6. NY, World Trade Center

7. Oklahoma Federal Bldg.

8. Tokyo and Matsumota, Japan

9. Russian Biological Warfare Program

10. Operation Desert Storm, 18 Jan – 28 Feb 1991; 39 scud missiles reached Israel – most off target or malfunctioned – some landed in or around Tel Aviv resulting in approximately 1000 treated casualties; 2 deaths, 544 anxiety attacks, 230 Atropine overdoses; 75% of the casualties resulted from inappropriate actions or reactions on the part of the victims.

11. Studies on Disaster Medicine in India. Poison Gas Accident in Bhopal, 2-3 December 1984; DTIC ADA317495; (Swedish text); Internet site: (**www.connect.net/dreggie/Methyl) Ken's Ph.D. Thesis, Biochemical Studies on the Toxicity of Isocyanates, From a Ph.D. Thesis submitted to the University College Cork, (Ireland), May 1996;** 2 AM, 3 Dec 1984, Bhopal, India; gas of methyisocyanate (mixture of phosgene and methylamine) over 3 hour period; release caused by the introduction of water into a methylisocyanate storage tank; over 60,000 casualties of which 2500-5000 died, 60,000 seriously injured, 200,000 exposed; follow-up studies indicated that 43% of the pregnant women did not carry a live child to birth.

12. MATSUMOTO, JAPAN: Population 200,000 (Denver, CO.); 27 June, 1994, Last evening; first complaints around 11:00 PM; 7 deaths due to undetermined toxic gas release (less than 20 liters) – later determined to be an evaporated/aerosol Sarin release estimated to have been released 80 meters downwind; 54 admitted to hospital; 028 people went to outpatient clinics; via inquiry of residents it was estimated that 277 people exhibited symptoms but did not consult with physicians; people who opened their windows during the night died and no victims on the ground level died, first responders did not wear any PPE and only the policemen wore gloves, 52 people responded formed into 18 teams from 5 fire departments;

8 first responders, 15%, complained of symptoms with one hospital admission. Sarin identified in air, pond water, tissues and blood samples of deceased casualties.

13. Kamakuishiki, Japan, July, 1994; Toxic fumes on a train in Yokohama; accidental release in an attempt to get the plant (capable of producing THOUSANDS OF KILO'S of Sarin and other agents) up and running; this was a dedicated Sarin production plant

14. TOKYO, JAPAN, March 20, 1995, 7:50 AM, Victims came to the hospital by taxi, ambulance, car, walked, etc.; widespread panic; Sarin identified 3 hours post attack and later determined to have been diluted; 5510 casualties; 12 deaths, 17 critical casualties, 37 severe casualties, 984 moderate casualties; roughly 4,000+ casualties showed no signs of intoxication – psychological 278 hospitals and clinics received casualties

15. Ref. JAMA 278(5): 362368; Aug 6, 1997; Tokyo fire department sent 1364 personnel to the 16 incident sites and other locations; 135 first responders (about 10%) were themselves injured by direct or indirect exposure to the Sarin.

16. Ann Emerg Med. 1996, 28:129-135; "One of the difficulties in the Sarin attack was undressing patients and disposing of their clothing."

17. ARRESTED CULT MEMBERS ACKNOWLEDGED MAKING VX, TABUN (GB), MUSTARD, AND CLOSTRIDIUM BOTULINUM

18. Sarin degradation products found in sheep carcasses in Australia

19. JAMA 278 (5): 362368; Aug 6, 1997; CBIRF – 1996 OLYMPICS – casualties would be medically stabilized, deconned with warm water, sponged off with 0.5% bleach solution, and then rinsed under showers. Decontaminated patients would be dried off, clothed in hospital garb and blankets, and evacuated in buses along with a sufficient supply of antidotes to ensure continued medical stabilization.

APPENDIX A

APPENDIX A
ACRONYMS

BALTEX	Baltimore Exercise
DoD	Department of Defense
EDCS	Emergency Decontamination Corridor System
FY	Fiscal year
HAZMAT	Hazardous materials
IRP	Improved Response Program
LDS	Ladder Pipe Decontamination System
MCDRT	Mass Casualty Decontamination Research Team
OSHA	Occupational Safety & Health Administration
PPE	Personal protective equipment
PSI	Pounds per square inch
SBCCOM	Soldier and Biological Chemical Command
TEU	Technical Escort Unit
USAMRICD	U.S. Army Medical Research Institute of Chemical Defense
WMD	Weapons of mass destruction

APPENDIX B

APPENDIX B
NAAK Mark 1 – Nerve Agent Antidote Kit

The NAAK Mark 1 contains the AtroPen auto-injector (2mg of atropine) and the Pralidoxime Chloride auto-injector (600mg of pralidoxime chloride) in a compact package which facilitates emergency use. Atropine is in one of the injectors contained in the NAAK and is used as a treatment for nerve agent poisoning. The other injector contains 2-Pam Chloride. These drugs are fully approved for chemical agent treatment by the U.S. Food and Drug Administration (USFDA). NAAK must be stored in a controlled room temperature of 59-86 degrees Fahrenheit with limited access. The shelf life is five years. Side effects of inadvertent use of Atropine includes inhibition of sweating, dilation of pupils, dry mouth, decreased secretions, mild sedation, and increased heart rate. The side effects of the inadvertent use of 2-PAM Cl include dizziness, blurred vision, nausea, and vomiting. These effects are insignificant in a nerve agent casualty.

APPENDIX C