FIRE SERVICE PLANNING IN MONTGOMERY COUNTY TO MANAGE THE CONSEQUENCES OF TERRORISM INVOLVING CHEMICAL WARFARE AGENTS

EXECUTIVE PLANNING

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ABSTRACT

The problem identified for this applied research project was that Montgomery County's fire service had not been evaluated to determine its capability to manage the life-threatening consequences of terrorism involving a chemical warfare agent (CWA). It was the purpose of this project to evaluate the state of preparedness of the County's fire service and also to identify and recommend measures to improve the fire services's capability. The historical research method was used for data collection and analysis.

The procedures used to collect specific data included literature review and a 35-item survey. References were obtained from the National Fire Academy's Learning Resource Center and from attendance at meetings, conferences, and training seminars (programs).

Five research questions were identified: How prepared was Montgomery County's fire service to manage the life-threatening consequences of terrorism involving chemical warfare agents (CWAs)? How did Montgomery County's fire service state of readiness compare with similar fire departments in the United States? What lessons were learned by fire departments that had conducted CWA-related training exercises? What were the views of fire departments on the future threat of terrorism in the United States? What methods were found to remove or neutralize a liquid contamination caused by a CWA contacting the clothes, skin, or both of a victim?

The author constructed a 35-item survey that was used to gather information from 94 fire departments that served populations of more than 200,000 people. Forty-nine of these fire departments completed and returned surveys. Although several limitations were identified with the survey, interesting and useful information was obtained.

More information was obtained by the author as part of an evaluation of the County's fire service. Specifically, the County's Hazardous Incident Response Team's (HIRT) equipment inventory and standard operating procedures (SOPs) were examined. The level of preparedness of first responders was also evaluated.

The results of this applied research project indicated that Montgomery County's fire service was, at best, marginally prepared to manage a CWA incident. The HIRT had some detection and protection capabilities and also had CWA MSDS. Survey results indicated that about 70 percent of the 49 fire departments which completed the survey, like Montgomery County, did not have a general plan to mitigate CWA incidents.

Based on the survey results, a number of recommendations were identified, including awareness programs for the fire service and Emergency Communications Center; using a pumper's tank water to mix a decontamination solution; using car brush assembly and sprayers to apply decontamination solution; conducting a "SMART" exercise; updating haz mat procedures; exploring ways to reduce response time of Federal assets; purchasing more detection equipment; obtaining antidote kits; exploring feasibility of using chemical protective masks and suits; exploring use of FEMA's MD (US&R) Task Force; developing a quick reference on mitigation action tips; organizing a group to develop a County plan; improving security and safety in

government buildings; visiting Washington Metropolitan Area Transit Authority (WMATA) train stations and conducting training; and exploring feasibility of county officials obtaining chemical protective masks for self-protection. Two of the appendixes include lessons learned from chemical-related exercises in the United States, and from the Tokyo chemical attack. Others appendixes include acronyms, definitions, properties of chemical agents, mitigation action tips, and other topics.

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INTRODUCTION

Terrorism is a growing concern in the United States. In 1995, Hayes wrote "Terrorism is not new to America. Since 1964, more than 10,000 terrorist acts have been committed throughout the world" (p. 8).

The bombings of the World Trade Center in New York City on February 26, 1993, and of the Alfred P. Murrah Building in Oklahoma City on April 19, 1995, significantly increased both public and fire service awareness of the tragic and devastating consequences of terrorism. These two acts of violence claimed 6 and 168 lives, respectively. They also sent a message that the United States is no longer "safe" from acts of carnage and devastation.

"One of the most chilling terrorist activity [ies] of the year [1995] was the gas attack on the Tokyo subway by the Aum Shinrikyo cult, indicating that terrorism involving material of mass destruction is now a reality" (United States Department of State, 1996, April, p. iii). These attacks injured approximately 5,500 people including, 135 members of the Tokyo Fire Department. Twelve civilians also died of exposure to the lethal nerve agent (Komiyi, 1995, November). "The Tokyo sarin attack showed just how susceptible modern society is to terrorist actions that were once too horrific to even image" (Daniels, 1996, September, p. 46).

Moreover, in April of 1995, a sarin attack threatened Disneyland (Cox, 1995, November). Had the attack occurred, casualties could have numbered in tens of thousands (Cox, 1995, November). Just the threat of a terrorist releasing a chemical warfare agent (CWA) can create fear, terror, and chaos (U.S. Army Chemical School, 1996, October).

It was little known that the World Trade Center bomb also contained hydrogen cyanide (HCN) (Eifried and Smoak, 1996, May). Fortunately, the resulting explosion destroyed the HCN and posed no threat to occupants in the building.

The reality of the threat and consequences of terrorism in the United States continued to intensify with the July 27, 1996, explosion of a pipe bomb at Centennial Park, Atlanta, Georgia. Two people were killed and more than 100 were injured.

These recent attacks on United States territory served as warnings that similar attacks with even greater casualties may loom in the future. "The genie is out of the bottle. The next time it will be worse" (W. Bradford "Chip" Chase, III, personal communication, July 17, 1996). Chase also commented that "Terrorists have freedom and mobility in the United States. Resources are readily available and media plays into their hands. A major nuclear/biological/ chemical (NBC) attack in the United States is inevitable."

Dunbar (1996, September, p. 34) wrote that:

> All fire chiefs should examine their response capabilities and the readiness of their line personnel with the thought that such a horrific scene, even on a lesser scale, could find itself positioned squarely in the middle of their jurisdiction. We must realize that no city or jurisdiction is immune to these attacks, but do we thoroughly see just what's happening in our country?

"The need to plan for terrorist activities involving chemical agents is a growing concern of the fire service. But, an equal concern is how soon will fire chiefs commit to developing a plan to manage these activities?" (Robert D. Stephan, personal communication, October 20, 1996).

Scope of Research

The scope of this applied research project is limited to discussion of Montgomery County's fire service planning for terrorism involving CWAs only. To expand the research to include nuclear and/or biological warfare agents would have been too ambitious an undertaking. However, the threat of the use of nuclear and biological warfare weapons dispersed with or without explosives must also be considered and must be a part of fire service planning. Moreover, lethal industrial chemicals such as chlorine (Cl) and hydrogen cyanide (HCN) may be on a terrorist's list of weapons of mass destruction (WMD) (see Appendix A for a list of acronyms). Although they lack the notoriety of the highly publicized sarin nerve agent, they could be just as effective as weapons of terror (Robert D. Stephan, personal communication, October 20, 1996).

Problem

The problem is that Montgomery County's fire service has not been evaluated to determine its capability to manage the life-threatening consequences of terrorist incidents involving CWAs. There are four common categories of CWAs: nerve, blister, blood, and choking (Staten, 1991, March). Properties of these CWAs are listed in Appendixes B, C, D, and E, respectively.

Purpose

The purpose of this research is to evaluate Montgomery County's fire service capability to respond and to manage acts of terrorism involving CWAs and to identify measures needed to improve that capability.

Research Method

The historical research method was used. This research consisted of literature review, and a 35-item survey.

Many articles were obtained from a literature search at the National Fire Academy's Learning Resource Center. Other printed materials were downloaded from the Internet. During these searches, several NBC-related web sites were found (see Appendix F). Additional printed documents were gathered from several training seminars and conferences that the author had

attended since July 1995. More information was obtained through "networking" or interacting with people who had expertise in CWAs.

Research Questions

1. How prepared is Montgomery County's fire service to manage the life-threatening consequences of terrorism involving a chemical warfare agent (CWA)?

2. How does Montgomery County's fire service state of readiness compare with similar fire departments in the United States?

3. What lessons were learned by fire departments that have conducted CWA-related training exercises?

4. What are the views of fire departments on the future threat of terrorism in the United States?

5. What methods are available to the fire service to remove or neutralize a liquid contamination caused by a CWA contacting a victim's clothes, skin, or both?

BACKGROUND AND SIGNIFICANCE

Montgomery County Fire Service

Montgomery County is one of 23 counties in the State of Maryland. With a population of more than 800,000, Montgomery County is the most populous county in the State and has an area of nearly 500 square miles.

Montgomery County's fire service is a combination service. Both career and volunteer personnel provide fire, rescue, and EMS services. Approximately 850 career and 750 volunteer personnel are assigned to 31 fire stations and two rescue stations. During the calendar year of 1995, the fire service responded to approximately 79,000 fire, rescue, and EMS incidents.

Montgomery County has four specialty teams. They are the Hazardous Incident Response Team (HIRT), Special Evacuation and Tactics Team (SETT), Collapse Rescue Team (CRT), and Underwater Rescue Team (URT). The County is also the host of the Federal Emergency Management Agency's (FEMA) Urban Search and Rescue (US&R), Maryland Task Force One.

Hazardous Incident Response Team (HIRT)

In 1981, the County organized its Hazardous Incident Response Team (HIRT). Like other hazardous materials teams across the United States, the HIRT is trained to handle

hazardous materials spills and leaks, ranging from petroleum-based products to corrosives and radioactive materials. The HIRT is recognized as a highly trained and competent hazardous materials response team.

Potential Targets of Terrorism (in and near Montgomery County)

Because of its proximity to Washington, DC, the fire service of Montgomery County could be part of a mutual-aid response to the District of Columbia should a terrorist incident occur involving a CWA. Federal buildings such as the Pentagon, White House, Capitol, and the Washington Monument are examples of possible targets of terrorism. The large number of tourists who visit Washington annually could become targets of terrorists. Visiting dignitaries meeting with the President of the United States could attract terrorists. Our President, Vice-President, and other high-profile government officials could also be on a terrorist's "hit list."

Another target could be the Washington Metropolitan Area Transit Authority's (WMATA) surface/underground subway system that runs through the County. Twelve passenger train stations are on the **A** and **B** lines of WMATA's "Red Line." More than half of these two lines are underground (Eric Jacobs, personal communication, October 16, 1996). These 12 stations are Silver Spring, Forest Glen, Wheaton, Glenmont, Shady Grove, Rockville, Twinbrook, White Flint, Grosvenor, Medical Center, Bethesda, and Friendship Heights. (Most of the Friendship Heights station is in the District of Columbia.) This Red Line terminates in the WMATA maintenance yard in Shady Grove.

One of the passenger train stations is approximately 200 feet deep. Access to the tunnel and from the tunnel to the surface is by six high-speed passenger elevators. Another station has an escalator that is 211 feet long. This is the longest escalator in the free world (Eric Jacobs, personal communication, October 16, 1996). The unusual tunnel depth and escalator length at two stations could be targets for terrorists. Consequences of a CWA attack at these two stations could pose extraordinary rescue and evacuation challenges to fire and rescue personnel.

Some of these passenger train stations are near Federal buildings such as the National Institutes of Health (NIH), National Naval Medical Center (NNMC), and the Nuclear Regulatory Commission (NRC). These buildings could be terrorist targets because of their proximity to the WMATA lines and the nature of the organizations.

Several jurisdictions next to Montgomery County also have WMATA passenger train stations. Like the sarin attacks in Tokyo, Montgomery County could be part of simultaneous incidents involving multiple passenger train stations in several jurisdictions.

The high governmental profile and affluence of Montgomery County in the State of Maryland could attract terrorists. The County has many governmental buildings including Maryland District Court. Montgomery County could be a terrorist target because of the embassies found within or near its boundaries.

Executive Planning Course

The *Executive Planning* course offered as part of the National Fire Academy's Executive Fire Officer Program has provided guidance on the development of this applied research paper. Points covered in Module 4 of the Student Manual provided a general approach to the planning process. Fire service planning as a response to the threat of terrorism is a form of executive planning.

LITERATURE REVIEW

Most of the literature review involved resources obtained through the National Fire Academy's Learning Resource Center (LRC). While the author found substantial written material on CWAs from other sources, specific information directly related to fire department operations was obtained mostly from the literature available in the LRC.

In 1996, DeGeneste, Silverstein , and Sullivan wrote that as we approach the twenty-first century, "the time has come to reassess the nature of the terrorist threat" (p. 70). They also wrote, in 1996, that a wide new range of chemical and biological agents could soon become commonplace among the arsenals of terrorists.

Martin, in 1995, wrote, "Right now is none too soon to prepare for a terrorist attack. The clock is ticking" (page 25). Martin supported his statement by repeating that any community is subject to terrorism and that it is not a new reality. In 1994, Walter wrote similar words when he said "emergency service departments and leaders" must realize that terrorism can occur in their community. Campbell and Evancoe, in 1996 emphasized this concern when they wrote, "The use of chemical agents by terrorists has not yet made its debut [in the United States] but there is growing concern among many analysts that it is only a matter of time" (p. 24).

In 1988, Sullivan wrote about fire and rescue operations at a terrorist incident:

> Detailed contingency plans are necessary to ensure smooth operations during the critical situations produced by terrorism. Plans for incident response should be multilevel, deriving input from all segments of government that might be called into action. Plans should be reviewed frequently, tested through drills and updated as required (p. 24).

Sullivan also noted the need for joint training (local police, fire, rescue, and EMS) and exercises to ensure an effective collective service response. In 1996, Forgy and Walter similarly wrote, "A recurrent theme was the need for better relationship between fire and emergency departments and their law enforcement counterparts, both in preparation for terrorism and during the actual response" (p. 38). Milmore and McHale, in 1996, provided more support when they wrote about the importance of coordination among the emergency services personnel (fire, EMS, and police) to deal successfully with terrorist attacks involving chemical agents.

The deadly sarin attack on Tokyo, Japan, occurred on the morning of March 20, 1995. The following is a brief summary of what took place on that Monday morning. This information is cited from a handout provided by Tokyo Fire Chief Takiji Komiyi at the First Worldwide Conference on Strengthening Fire and Emergency Response to Terrorism, held at Mt. Weather (Berryville, Virginia), November 6 to 9, 1995:

> Just after 8:00 a.m. [March 20, 1995], several persons put vinyl bags, containing substances which produce poison gas, on the trains of three subway lines, and at some stations. Many commuters and station staff collapsed, vomited, or felt pain in their eyes. Calls for requesting ambulances were made to the [Tokyo] Fire Department.

Milmore and McHale, in 1996, wrote that none of the emergency services responders initially knew that a terrorist incident was in progress, nor did they realized that they were being exposed to a deadly nerve agent. Moreover, Milmore and McHale wrote that it was not until later that doctors recognized a nerve agent as the cause of the victims' symptoms.

Milmore and McHale's observation supported the need for, and importance of, identifying the nerve agent when possible. In 1996, Downey underscored the seriousness of Milmore and McHale's comment when he wrote that the major problem at the Tokyo chemical attack was attempting to identify the poison used.

In the Tokyo incident, the Fire Department responded with a total of 340 pieces of fire apparatus and 1,364 personnel (see Table 1). With these resources, the Tokyo Fire Department treated 692 victims and transported 688 of them to hospitals (Komiyi, 1995, November).

Table 1
Responding Fire Apparatus (340 Units)

Apparatus	Number	Apparatus	Number
haz mat units	16	command units	19
pump companies	68	command support	5
EMS units	131	equipment transport	10
special rescue teams	10	lighting units	5
ladder companies	6	covering units	70

Source: Komiyi (1995, November)

In October 1996, the author and another chief officer from Montgomery County attended a three and one-half day conference at the National Fire Academy. The title of this conference was "Response to Terrorism." Approximately 30 people were in attendance.

Through facsimile (fax), dated October 9, 1996, Battalion Chief Akira Tada, Tokyo Fire Department (TFD) responded to several questions posed by conference participants. These questions focused on the Tokyo sarin incident. They related to personal protection of members of the TFD, detection equipment, state of readiness, and future concerns (see Appendix G).

In 1996, Milmore and McHale wrote that on September 23, 1995, the City of New York's fire department "participated in a large-scale exercise with the city's Transit Authority, police department and EMS involving a Tokyo-type chemical attack" (p. 58). In 1996, Fialka wrote that following the exercise and one year after the sarin attacks in Tokyo (March 1995), New York officials agreed, "... no major U.S. city is prepared to deal with such an event" (p. A16).

Fialka, in 1996, also wrote that Gar[r]y L. Briese, executive director of the International Association of Fire Chiefs, feels that incidents involving biological and chemical agents are not in the plans of most fire departments. In 1996, Hayes wrote about the preparations needed to respond to the threats of chemical and biological agents. He also wrote, in 1996, "All of the preparations are important, but without the training and exercising of personnel, response personnel could become casualties" (p. 23).

In 1996, Milmore and McHale wrote that attendees at a conference "were warned by federal agents that they [emergency service and police representatives] had to anticipate terrorist action using chemical weapons and that they needed to assess their capabilities for handling such eventualities" (p. A14). Milmore and McHale also wrote about some lessons of the Tokyo sarin attacks. In essence, they wrote about the importance of first responders being aware of the potential use of CWAs.

In view of these comments, Fialka (1996) wrote that "... the first rescuers at any incident likely would serve--to use their term--as 'canaries.' They would collapse like the caged birds once carried by miners, signaling the presence of something exceptionally dangerous" (p. A14). Forgy and Walter, in 1996, supported this concern when they wrote that "The safety of emergency responders is at stake and must be an early consideration" [at a terrorist incident] (p. 36).

In 1996, Forgy and Walter wrote that it is the responsibility of the emergency services to respond to and understand the implications of a terrorist incident. They also wrote that this type of incident is different from "traditional large-scale emergencies" (p. 36).

Bruno, in 1995, wrote that the firefighters will be the ones who must handle the destruction, injuries, and death caused by the work of a few terrorists. Bruno also wrote that it does not matter what the motivation is of terrorists when they attack, the first responders of the local fire department will be on the scene. In 1996, Zeigler wrote that "Emergency response teams are struggling to prepare for the casualties and exposure they might face because of terrorism or an accidental release [of chemicals]" (p. 182).

Martin, in 1995, wrote about the types of functions and activities associated with fire service operations at the scene of a terrorist incident. These included, among other things, fire suppression; search, rescue, and extrication; triage and medical treatment; hazardous materials control; crowd control; logistical support; and incident scene command and management. Besides these typical functions and activities performed by fire service personnel, Martin wrote that these operations may be conducted in unusually hazardous environments. He wrote that arriving fire service personnel could be targets of the terrorists.

In 1995, Martin further wrote that personnel could be met by armed terrorists, secondary explosive devices, other forms of booby traps, or unanticipated toxic chemicals. Walter, in 1994, also wrote about terrorists using secondary devices. He noted that they should include this consideration in planning. In 1995, Briese wrote that in most cases of terrorism involving explosives or incendiary devices, there will be another explosive device. However, Briese also wrote that the device may not be "set for the rescue personnel, but it may be there just the same" (p. 1). In 1991, Staten visited the issue of secondary devices. He wrote that, on at least three occasions worldwide, explosive devices had detonated about the same time fire service and police personnel arrived.

Besides the need for fire service personnel to conduct training on many topics related to managing a terrorist incident, Martin, in 1995, wrote that "periodic exercises should be conducted to practice multi-company/agency coordination at the scene of a terrorist incident" (p. 24).

Hume, in 1994, wrote that the fire service has the responsibility to improve its capability to manage acts of terrorism. Hume also wrote that while terrorist targets remain abundant and the media continues to provide widespread coverage of events, terrorists will continue to promote their cause through the random application of violence against both people and property.

In 1994, Hume wrote that fire departments at the scene need additional research in developing standard procedures for response and operations of terrorist incidents. Moreover, Hume wrote that fire departments must develop ways to manage and "battle" terrorist incidents, with a focus on incident management, personnel safety, and cooperation and coordination among agencies.

Medici and Patrick (1995) wrote that to operate both safely and effectively at the scene of an incident, it is crucial for emergency responders to expand their knowledge of chemical and biological agents. They also wrote that managing a chemical/biological incident can be handled in a similar way as a conventional haz mat incident. However, Medici and Patrick (1995) wrote, "Unique challenges may present themselves in many forms including: lack of specific information, mass casualties, multiple fatalities, large scale crime scene, direct attack on public safety facilities or personnel" (p. 26).

An emerging specialized resource is the Metropolitan Medical Strike Team (MMST). This "team was developed to provide support for and assistance to local jurisdictions' first responders in NBC [nuclear, biological, and chemical] terrorist events" (Moultrie, 1996,

September, p. 49). Moultrie also wrote that the MMST has a deployment window of 60 to 90 minutes. In 1996, Moultrie wrote that the MMST is "a federal asset under the umbrella of the U.S. Public Health Service and...will most probably be the first federal agency on the scene" (p. 49).

As noted earlier, the survey did not address the subject of decontamination. However, the author did find information from other resources. The following highlights pertinent aspects of decontamination, that is, the types of materials (substances) used to decontaminate both clothes and victims exposed to a chemical warfare agent in liquid form.

In 1996, Eifried and Smoak wrote that a 0.5-percent solution of sodium hypochlorite is sufficient to decontaminate victims exposed to a chemical agent. They also wrote that a 5-percent solution is suitable for decontaminating equipment. However, Henry J. Siegelson, MD, is one authority who recommends the use of a 5-percent solution to decontaminate victims exposed to a CWA liquid (personal communication, December 4, 1996).

Ordinary bleach (chlorox) contains about a 5-percent solution of sodium hypochlorite (actually 5.25 percent solution). A 0.5-percent solution can be made by diluting the 5-percent chlorox solution with 10 parts water (see Appendix H).

In summary, the literature review emphasized the importance of the fire service to plan for and train to manage the consequences of a terrorist incident involving chemical weapons. The planning and training should involve joint participation by members of the fire service and police departments.

The literature review also emphasized the importance of first responders to identify the chemical agent, when possible, after arriving on the scene, and being aware of potential secondary explosive or chemical devices. Another point noted in the literature review was that incidents involving CWAs are hazardous materials incidents, but they are different in some ways from "ordinary" haz mat incidents.

Through the literature review, the author also found information about decontamination methods. These methods included both dry and wet decontamination. These substances or solutions can be used to remove, or neutralize contaminated clothes or skin.

PROCEDURES

A survey was developed to determine how prepared fire departments were, including Montgomery County's fire service, to handle terrorist-related incidents involving CWAs (see Appendix J). The survey was mailed in August 1996 to 94 fire departments in the United States, each of which served a population of 200,000 or more. This population criterion was selected because it is the minimum population served by the fire departments included in the list of Metro Chiefs maintained by the International Association of Fire Chiefs (IAFC), which gave the author the list. This population size was selected because major terrorist activities in the United States

had occurred in cities with populations greater than 200,000 (e.g., New York City and Oklahoma City).

To encourage responses to the survey, the author addressed each fire department chief with a signed, "original" letter (not a photocopy), in which the purpose of the survey was explained (see Appendix K). Although preparing both the letter requesting response and the survey was time-consuming, the author credits this for the high number of responses (49). This number represented 52 percent of the 94 fire departments that received a survey.

After receiving the completed surveys, the author created a database in which data were entered for 25 of the 35 items. These questions required a response of either YES or NO, or check mark(s). Items 9, 11 and 28 were excluded from data entry because they required explanations. The remaining seven items (12, 13, 14, 15, 16, 34, and 35) were deleted completely from further consideration because the author later determined that the language in these items was ambiguous, or the data were not substantive to the research. Items 9 and 28 were excluded because the information was not completed by all respondents, consisted of common knowledge, or was not deemed important to the survey.

The literature review was another source of information. This information was obtained from the National Fire Academy's LRC and from written material gathered from meetings, conferences, and training programs. Nearly 50 articles and manuals related to terrorism were read or scanned by the author. Twenty-nine of these are listed in the references.

Besides the survey, an evaluation of Montgomery County's fire service was conducted by the author and other fire service personnel. This evaluation required a visit to the County's HIRT home station and a review of its equipment inventory. It also required a review of the fire service's operational policies and procedures, and the personal protective equipment (PPE) worn by first responders.

Limitations

The 35-item survey had several limitations. One limitation was that the respondents who completed the surveys were of different ranks and assignments. Some were chief-level officers and others were station-level officers. Some were assigned to their department's haz mat team and still others were administrative staff. If two representatives from the same fire department were to complete the survey separately, their responses may not be the same, possibly because of differences in their backgrounds related to the subject matter, or simply because they were or were not interested in completing the survey.

Another limitation of the survey was that the author did not request other fire service personnel to "exercise" the survey (i.e., complete it) before he sent it to the selected fire departments. Had this been done, content errors which may have existed in some survey items might have been identified, corrected, eliminated, or replaced with other items. Having developed the survey, the author was too close to its content and format to spot "flaws."

Most of the 49 completed surveys had items that remained unanswered (left blank). These unanswered items were recorded in this applied research paper either as "no response" or "n/a" (not applicable). Except those responses which elicited no response (i.e., not applicable), the author was uncertain whether the items were overlooked or were intentionally left blank. Time constraints did not permit the author to follow up with the respondents to determine why these items were unanswered.

Another shortcoming was that the survey did not request the name of a contact person. As a result, the author was unable to identify some fire departments which had returned completed surveys and therefore could not follow up.

In retrospect, this survey clearly should have addressed the issue of contamination. As a result, information was obtained through literature review and from material obtained from attendance at meetings, conferences, and training programs.

Acknowledged flaws aside, a well-constructed survey is a valuable tool for collecting data and it should be carefully reviewed to maximize its usefulness in an applied research project.

The nature of the topic ("chemical warfare agents") made it rather difficult to obtain certain information. Because of selected CWA-related materials being classified for security reasons or for military use only, the author spent many hours gathering information as part of the literature review and for use elsewhere in this paper.

Selected Terms

This list is provided to help readers better to understand uncommon terms and expressions noted in the body of this applied research project (see Appendix L for extensive list of definitions).

Weapons of Mass Destruction (WMD): Weapons that can cause mass casualties.

Integrated Emergency Command Structure (IECS): A system that allows for the integration of both career and volunteer fire/rescue personnel by equal rank for purposes of on scene incident command.

Haz mat: An acronym for hazardous material (s).

Chemical Warfare Agent (CWA): A substance designed to kill or incapacitate people.

RESULTS

1. How prepared is Montgomery County's fire service to manage the life-threatening consequences of terrorism involving a chemical warfare agent (CWA)?

To answer this question required the author and other chief officers of Montgomery County's fire service to review the equipment inventory of the County's HIRT; to review the PPE issued to fire, rescue, and EMS personnel; and to research what CWA-related training and exercises have been presented to members of the County's fire service.

HIRT Equipment Inventory

During the past six months the HIRT has obtained several items to improve its response capabilities to manage an incident involving a CWA. For example, in July 1996, HIRT purchased a chemical agent detector known as a "Saw Minicad." This hand-held instrument is designed to detect nerve and blister agents. The team also purchased detector tubes to test for the presence of both nerve and blister agents (see Appendix M).

Material Safety Data Sheets (MSDS) of selected CWAs are part of the team's reference library carried on the hazardous materials response vehicle. Other sets of MSDS are kept in the HIRT home station's reference library. Downloading from the Internet obtained several of these data sheets. The Edgewood Research, Development, and Engineering Center (ERDEC) in Edgewood, Maryland, was the source of these particular MSDS.

Six of the County's EMT-Ps serve as paramedics with HIRT. The paramedic kit carried on the HIRT vehicle has 12, 2-milligram (mg) vials of atropine sulfate. Currently, however, the other common drug to treat exposure to a chemical nerve agent, 2-pam chloride, is not carried.

In October 1996, the County's Department of Fire and Rescue Services (DFRS) purchased an Ambu® Mark III resuscitator with butyl rubber outer cover. It has a gas filter adapter which can be used to protect against chemical nerve agents. DFRS may purchase more of these resuscitators.

The County's fire service is considering the feasibility and fiscal impact of purchasing large quantities of specialized PPE for first responders who are assigned to fire/rescue stations near WMATA train stations (see Table 2). A major problem associated with this proposal is the lack of a "vehicle" by which some items can be obtained from Federal government vendors. The author has seen several displays or demonstrations of various chemical detection kits and protective clothing. However, most of these items were manufactured expressly for military use and, therefore, are not readily available to first responders.

Table 2
Proposed Equipment Purchase

Equipment	Number	Equipment	Number
chemical charcoal suits	300	MCU-2P chemical mask	300
military Tyvek F suits	300	duffle bags for vehicles	200
butyl gloves	600	Tyvek suits	1,000
nerve agent antidote kits	200		

First Responders

For the purposes of this research project, fire, rescue, EMS, and police personnel, except members of the County's HIRT are called "first responders." "The capabilities of Montgomery County's first responders are crucial to the successful handling of mass casualties associated with a CWA incident. Yet they are the least prepared and the most vulnerable to harm" (Robert D. Stephan, personal communication, November 20, 1996). Stephan also wrote:

> In the early moments of a CWA event, the actions or inactions of the first responders will heavily influence the outcome. Upon arriving at the scene, first responders are likely to find that panic is rampant, casualties are many, they are overwhelmed, and the outcome is uncertain. The ultimate goal of first responders must be to prevent the CWA release from harming themselves and others (Robert D. Stephan, personal communication, November 20, 1996).

Montgomery County's fire/rescue personnel wear personal protective clothing and self-contained breathing apparatus (SCBA) that is compliant with applicable National Fire Protection Association (NFPA) standards. Positive-pressure SCBA is the respiratory protection used by the County's fire service. Currently, the fire service is changing from the use of 30-minute and 1-hour air cylinders to 45-minute cylinders. This SCBA provides excellent **respiratory** protection for fire/rescue personnel exposed to respiratory hazards including CWAs. However, the SCBA alone is not sufficient to protect fire/rescue personnel exposed to chemical agents which can injure or be absorbed through the skin.

Some fire service leaders believe that first responders will simply become "canaries" and be the first to succumb to the physiological effects of exposure to a CWA (LeRoy R. Oettinger, personal communication, September 19, 1996). However, this assumption can be averted.

Training Opportunities

During the past 18 months, one or more of four Montgomery County's chief officers (including the author) have attended NBC-related training programs, conferences, and meetings. Through these interactive gatherings, these officers have established contacts with many experts in various aspects of NBC warfare incident management.

United States Army Chemical School

During the week of October 21, 1996, the author and the three other chief officers were among a group of 14 students who attended the four-day Chemical/Biological Counter Measures course which was held at the United States Army Chemical School, Fort McClellan, Alabama. Each student had the opportunity to use different chemical agent detection equipment and to wear chemical-agent protective mask and clothing.

After gaining confidence in the use of both the detection and protection equipment, the students entered and worked in the "live agent chamber" located at the Chemical Defense Training Facility (CDTF). "It is the only live agent training facility of this nature in the world" (Emerson, 1996, July, p. 42). While inside the chamber, small quantities of two nerve agents were released. Exercises were conducted involving nerve agent detection and decontamination. Teamwork and personal safety were emphasized throughout the course.

Collectively, these meetings, conferences, and training opportunities allowed the chiefs to expand their knowledge of NBC warfare agents including the following topics:

1. Properties of NBC warfare agents.
2. Decontamination of mass casualties.
3. CWA detection equipment.
4. PPE.
5. Triage and medical treatment of victims exposed to a CWA.
6. Acquisition and use of antidotes (i.e., atropine, 2-pam chloride).
7. Unified incident management (with police and State/Federal agencies).
8. Factors influencing the spread of NBC agents.
9. Methods of NBC dissemination (dispersal).
10. Managing an NBC incident.

11. Community planning for NBC incidents.

12. Resources available from the military and Federal organizations.

13. Fire service planning for acts of terrorism.

14. Threat/Vulnerability analyses.

In summary, the County's fires service has already begun the process of developing a comprehensive response plan to manage a chemical incident. The detection equipment, MSDS, training received, and related research conducted by members of the fire service supports the position that Montgomery County's fire service capability to mitigate a CWA incident is borderline.

2. How does Montgomery County's fire service state of readiness compare with other fire departments in the United States?

Data provided by the 49 respondents were used in answering this question. These 49 fire departments represented a wide range of populations and number of uniformed emergency service personnel (see Table 3). The department size and populations served ranged from about 200 to more than 14,200, and from 225,000 to 8,000,000, respectively.

Fourteen of the 49 fire departments responded that they had a general plan to manage terrorist incidents involving CWAs (survey items 2 and 3). The earliest plan was adopted in 1983 and the most recent plans were adopted in 1996. These plans were prompted by one or more acts of terrorism in the United States and for other reasons (see Table 4).

It was interesting that one fire department serving a population of 227,000 had a general plan. Yet, 17 fire departments, including Montgomery County, each serving a population of 500,000 or more, did not have a general plan (see Table 5).

Table 3
Number of Personnel and Populations Served by the 49 Fire Departments

Respondent Number	Population Served	Number of Personnel	Respondent Number	Population Served	Number of Personnel
1	350,000	2,700	26	500,000	878
2	470,650	674	27	750,000	1,000
3	750,000	1,000	28	325,000	750
4	1,200,000	843	29	no response	375
5	1,000,000	1,700	30	400,000	222
6	700,00	1,100	31	380,000	721
7	225,000	315	32	230,000	325
8	3,500,000	2,800	33	554,000	1,600
9	404,000	440	34	350,000	290
10	360,000	530	35	1,600,000	2,300
11	700,000	610	36	281,000	231
12	700,000	600	37	2,782,000	4,800
13	950,000	1,032	38	3,034,848	2,498
14	227,000	426	39	400,000	896
15	1,000,000	1,635	40	550,000	480
16	230,000	450	41	497,000	741
17	500,000	365	42	800,000	1,500
18	206,000	474	43	450,000	1,000
19	520,000	1,130	44	1,300,000	1,500
20	500,000	480	45	400,000	470
21	900,000	1,200	46	225,000	525
22	360,000	785	47	1,100,000	1,541
23	700,000	1,600	48	8,000,000	14,275
24	453,000	618	49	500,000	1,035
25	1,200,000	1,200			

Table 4
General Plan--Year Adopted and What Prompted It

Plan Adopted (Year)	Prompted by
1983	General need for haz mat unit
1985	Part of multihazard functional emergency plan
1994	Part of city's comprehensive emergency response plan
1994	Reorganization of the Emergency Operations Center (EOC)
1994	World Trade Center bombing
1995	Oklahoma City bombing
1995	Oklahoma City bombing
1995	Oklahoma City/World Trade Center bombings, Tokyo sarin attack
1996	Republican National Convention
1996	Oklahoma City/World Trade Center bombings, Tokyo sarin attack
1996	Oklahoma City/World Trade Center bombings, Tokyo sarin attack
1996	Oklahoma City/World Trade Center bombings, Tokyo sarin attack Mt. Weather Conference
1996	Tokyo sarin attack
no response	A need for a multihazard plan (including EMS and mass casualties).

Table 5
Departments With and Without General Plans Listed by Populations Served

Population Served	General Plan		Total	(% YES	% NO)
200,000 - 499,000	YES 3	NO 17	20	(17.6	82.4)
500,000 - 999,000	YES 5	NO 11	16	(31.2	68.8)
1,000,000 - 1,000,000+	YES 6	NO 6	12	(50.0	50.0)
No Population listed	YES 0	NO 1	1	(0.0	100.0)
Totals	**YES 14**	**NO 35**	**49**	**(28.6**	**71.4)**

Thirty-five of the 49 respondents noted that their department did not have a general plan (survey item 3). Eleven of the 35 departments presently were developing a general plan (survey item 6). Five of these 11 fire departments, including Montgomery County, noted that their plans should be completed within 12 months (survey item 7). However, the other six departments left the survey item blank (i.e., in effect, "no response").

Sixteen of the 24 fire departments that noted that they were not now developing a general plan, and did not plan to develop one within the next 12 months. Six of the other 8 respondents suggested that they would have a general plan within the next 12 months. One of the remaining two respondents noted "did not know," and the other one left the survey item unanswered (see Table 6).

Table 6
Status of Fire Departments That do not Have a General Plan

Status of Plan	Number	Yes	No	No Response	Did Not Know
Developing Plan Now	11				
Within 12 Months		5	---	6	---
Not Developing Plan Now	24				
Within 12 months		6	16	1	1

The survey revealed that 16 of the fire departments, including Montgomery County, had instruments (or other means) to detect the presence of chemical agents (survey item 8). The remaining 33 departments did not have detection instruments.

About four percent of the respondents noted that their first responders had personal protective clothing to protect them from exposure to chemical agents (e.g., sarin and mustard). Nearly 86 percent of the respondents indicated that their haz mat team had personal protective clothing to protect against chemical agents (see Table 7).

Eight of the respondents suggested that their first responders were trained to respond to incidents involving chemical agents of mass destruction (survey item 17). Only two of the respondents suggested that members of their emergency communications center (ECC) had received special training in determining from callers that an incident may be related to a chemical nerve agent (survey item 18). One respondent did not know if the ECC personnel had received special training.

Montgomery County was among the 41 respondents who indicated that the first responders were not trained to mitigate incidents involving chemical agents (survey item 17). Moreover, Montgomery County and 39 other fire departments' personnel assigned to the ECC had not received special training in determining from callers that an incident may be related to a chemical nerve agent (survey item 18).

Table 7
Personal Protective Clothing for First Responders and Haz Mat Team

Response	First Responders	(%)	Haz Mat Team	(%)
Yes	2	(4.1)	42	(85.7)
No	44	(89.8)	6	(12.2)
No response	3	(6.1)	2	(2.0)
Total	**49**	**(100.0)**	**49**	**(99.0)***

*Percent total is less than 100 due to rounding.

Thirty-two of the 49 respondents indicated that they had MSDS on the chemical agents including sarin and mustard. Fifteen of the respondents indicated that they had access to antidotes (i.e., atropine and 2-pam chloride) to treat mass casualties (see Table 8).

Table 8
Fire Departments With CWA-related MSDS and Access to Antidotes

Response	MSDS	(%)	Antidotes	(%)
Yes	32	(65.3)	15	(30.6)
No	12	(24.5)	24	(49.0)
Did not know	5	(10.2)	7	(14.3)
None	--		1	(2.0)
Incorrectly marked	--		2	(4.0)
Total	**49**		**49**	(99.9)

Note: Percent is less than 100 due to rounding.

The respondents were also asked to "check" one or more agencies who they believed will have the most impact on reducing life loss from a chemical attack (survey item 23). First responders and haz mat team were "checked" the most (see Table 9).

Survey item 25 relates to the state of readiness of fire departments to mitigate an incident involving a CWA. Eight of the 13 respondents whose fire departments participated in an exercise indicated that their fire departments were "well-prepared to mitigate these types of incidents (see Table 9).

Table 9
Agencies Likely to Minimize Life Loss from a Chemical Attack

Agency (Organization)	Number	Percent (%)
First Responders	36	37.5
Haz mat Teams	32	33.3
Military Chemical Specialists	16	16.7
Other	12	12.5
Total Responses	**96**	**100.0**

Table 10
State of Readiness of 13 Fire Departments that Participated in Chemical Agent Exercises

Type of Response	Number	Percent (%)
Prepared	3	23.1
Marginally Prepared	8	61.5
Well-prepared	2	15.4
Total	**13**	**100.0**

In summary, the survey results show that Montgomery County's fire service is among 71 percent of the fire departments that were without a general plan to manage chemical agent incidents. However, the survey also suggests that the County's fire service has already taken steps to develop a plan. Measured against the state of readiness noted by 13 fire departments in Table 10, Montgomery County's fire service would "qualify" as "marginally prepared."

The survey also indicated that the respondents believe that both first responders and haz mat personnel will play a major role in minimizing life loss from a CWA-related incident.

3. What lessons were learned by fire departments that had conducted CWA-related exercises?

Exercises related to chemical agents were conducted by 13 of the fire departments which responded to the survey. Several of these departments provided comments regarding lessons they learned from their exercises. Thirty-five comments were noted. For brevity and clarity, the author edited some of these comments (see Appendix N).

These comments covered topics including hospital state of preparedness, need for joint training between the fire service and military groups, concerns about decontamination, and safety of first responders.

Other fire departments can benefit from these observations when developing their own response plan. Information acquired before an incident can improve safety, efficiency, and effectiveness of both first responders and haz mat personnel should a CWA-related activity occur.

4. What are the views of the fire service on the future threat of terrorism in the United States?

The respondents were asked to select one place from the list of buildings and structures provided in the survey (survey item 19) which they felt was a likely target for a chemical attack. Shopping mall was selected the most, followed by the subway and government building (see Table 11).

Table 11
"Predicted" Targets of Terrorism in the United States

Location	Number	Percent (%)
Shopping mall	15	30.6
Subway	12	24.5
Government building	9	18.4
Airport	7	14.3
Theme park	1	2.0
Other	2	4.1
No response	2	4.1
Did not know	1	2.0
Total	**49**	**100.0**

Forty-four of the respondents indicated that "... a chemical attack similar to what happened in Tokyo, Japan, will probably occur somewhere in the United States." The remaining five respondents checked **no** (survey item 20).

Of the 44 respondents who suggested that the United States is likely to experience a chemical attack similar to what occurred in Tokyo (survey item 21), 26 checked the period of 1 to 3 years; 10 respondents noted 3 to 5 years; one respondent included a response that was not on the survey (an invalid response) and one respondent marked "greater than five years." Six respondents checked "no opinion" (see Table 12).

Table 12
"Future Attack" Time Frames

Time Frames (Years)	Number	Percent (%)
1-3	26	53.1
3-5	10	20.4
Greater than 5	1	2.0
Invalid response	1	2.0
No opinion	6	12.2
Answered **No** to question	5	10.2
Total	**49**	**99.9**

Note: Percent is less than 100 due to rounding.

Survey item 22 requested the respondents to indicate what they think will be the weapon of choice when the United States experiences another terrorist attack. About 75 percent of the respondents selected conventional explosives (see Table 13).

Table 13
"Predicted" Weapon of Choice

Weapon Type	Number	Percent (%)
Conventional explosives	37	75.5
Biological agent	3	6.1
Sarin gas	3	6.1
Nuclear device	1	2.0
Other	1	2.0
Other chemical agent	1	2.0
No response	3	6.1
Total	**49**	**99.8**

Note: Percent is less than 100 due to rounding.

In summary, most of the respondents feel that there will be another terrorist attack in the United States within the next three years. The "predicted" weapon of choice was conventional explosives. Nearly 88 percent of the respondents "checked" that the location would be a shopping mall, subway, or government building.

5. What methods are available to the fire service to remove or neutralize a liquid contamination caused by a CWA contacting the clothes, skin, or both of a victim?

From literature review and personal communications, the author found information on ways to decontaminate chemical agents. These included both dry and wet decontamination methods. For dry decontamination of casualties, one method available is the M291 Skin Decontamination Kit (U.S. Army Chemical School, 1996, October). The kit "consists of six identical packets each containing a mixture of activated resins that both absorbs liquid chemical agents present on a person's skin and neutralizes agents" (Defense Protective Service, 10-90 Gold, DPS NBC Response Plan, 1996, June, p. 84).

Other dry decontamination materials available are cornstarch and fuller's earth (John Medici, personal communication, November 3, 1996). These materials can absorb chemical agents. However, they do not neutralize them.

Soap and water, sodium hypochlorite solutions, and calcium hypochlorite solutions are wet-type decontaminants (Defense Protective Service, 1996, June). However, soap and water just removes chemical agents, it does not neutralize them.

Two common "strengths" of hypochlorite solutions are used in decontamination, 0.5 percent and 5.0 percent (U.S. Army Chemical School). Some references recommend the 0.5-percent and 5.0-percent solution of the hypochlorites for individual and equipment decontamination, respectively. However, other authorities suggested the use of 5.0-percent hypochlorite solution for both individual and equipment decontamination (Henry J. Siegelson and Charles M. Jones, personal communications, December 4, and 12, 1996, respectively). Properties of sodium and calcium hypochlorites are listed in Appendix H.

The author obtained information about the mixing ratios of hypochlorite-to-water to obtain 0.5-percent and 5.0-percent solutions. Although it appeared that the ratios differed from source-to-source, the resulting percent of solutions were within the range of 0.5 percent to 5.0 percent. Appendix I is an abbreviated chart of mixing quantities for calcium hypochlorite (Olin Corporation-Charleston, Texas, representative, personal communication, November 22, 1996).

Removing the contaminated clothes of victims is an effective way to remove the chemical agent (Henry J. Siegelson, personal communication, December 4, 1996). However, people may be reluctant to remove their clothing because of modesty and concern for their valuables (Robert D. Stephan, personal communication, October 20, 1996).

In summary, the M291 kit, cornstarch, and fuller's earth are materials which can be used as dry decontaminants. Calcium and sodium hypochlorite solutions are commonly noted for use in wet decontamination. Removing the victim's contaminated clothes is effective in decontamination. But the victim may not agree to disrobe unless privacy and security are ensured.

DISCUSSION

Relationship Between the Study Results and Findings of Others

The literature review supported the survey result in many ways. About one-third of the respondents indicated that their fire department had a general plan for managing terrorist incidents involving chemical agents such as sarin. This is somewhat consistent with Fialka (1996) who wrote that New York officials agreed that no major city in the United States is prepared to manage an incident similar to what had occurred in Tokyo a year earlier (1995).

In 1996, Milmore and McHale wrote about the training exercise conducted by the New York City Fire Department which was held in 1995. Although the exercise had positive results,

they did identify areas where the fire department needed improvement. One participant shared some of those experiences as a respondent of the survey.

Author's Interpretation of the Study Results

The author's analysis of the survey results supported his intuition about the relatively low number of fire departments which had a general plan against a terrorist's chemical attack. After reviewing the data collected from the survey and inspecting the survey items, it is the author's opinion that the number of fire departments that actually have a general plan may be less than the number reported (14), because survey item 3 simply required a YES or NO answer. Some respondents may have answered this survey item based on assumption without verification.

The author contacted one respondent who had answered YES to the general plan question. However, after the author explained the substance of the question in greater detail, the respondent concluded that his fire department did not have a general plan.

The literature review suggested that a chemical attack in the United States is inevitable. Yet, more than 75 percent of the survey respondents indicated that the "weapon of choice" in a future act of terrorism in the United States will be conventional explosives. No matter whether explosives, chemicals, or other deadly substances are used, the author believes that the next terrorist event will likely cause the Tokyo chemical attacks and the bombings in New York City and Oklahoma City to pale in the wake of its destruction.

Because of the exhaustive, worldwide coverage of these tragic events by the media, and the almost limitless release of information detail, would-be-terrorists get an "armchair report" of what to do and not to do when planning an act of terrorism. This suggests that our country's generosity may be its undoing.

The survey reflected that about one-third of the 49 respondents had equipment to detect the presence of CWAs (e.g., sarin and blister). These instruments are expensive and require maintenance and retraining. From both safety and practical viewpoints, knowing and identifying the signs and symptoms displayed by victims exposed to a CWA is probably the best way to "detect" its presence. Therefore, learning the signs and symptoms of these agents is an important part of chemical agent recognition (Charles M. Jones, personal communication, December 12, 1996).

If a CWA is suspected, first responders and hazmat personnel should assume a "worst-case" scenario until its identify is known and verified. After verification, the protective measures could be evaluated to determine if the level A protection should be maintained or modified.

The role of first responders should include, among other things, doing rescue/triage/ treatment of victims found outside the building or structure in which the chemical release occurred, gathering information about the incident, cordoning the area, setting up for gross decontamination, and providing information to the responding haz mat team officer. Circumstances should dictate actions. First responders and haz mat personnel must remember to

keep the mission and risk in an acceptable balance. The wearing of personal protective clothing and using SCBA is essential and must be worn throughout an incident, unless the Incident Commander (IC) later lowers the protection based on verified information.

It is important to emphasize here that a CWA incident is a hazardous material incident. Strategic and tactical operations should be built upon this basic premise and around the precautions attendant to managing the extraordinary challenges and consequences posed by this type of incident. Add to this the threat of an explosive device or another chemical release, and the awareness that the incident will also be a crime scene. Where safe to do so, evidence should be preserved.

First responders will be obligated to set up and do decontamination of other first responders and civilians who have been contaminated, exposed, or both. Setting up another decontamination area for haz mat members themselves is equally important for the HIRT personnel and for the first responders engaged in rescue, patient care, and decontamination activities. Besides decontamination, HIRT personnel should focus on conducting RECON, identifying the chemical agent(s), and providing safety and technical guidance to the IC (and other first responders). Some of these actions must be executed simultaneously.

If faced with an incident involving a CWA, first responders must decide whether to mount an offensive or defensive operation. That is, will the mission be one of rescuing "savable" victims or to establish a "safe" perimeter from which to aid victims? The stated purpose of the mission should be part of the response plan.

To help make this decision, four factors should be considered: personnel, equipment, protection, and time. The author calls these factors the "GO or NO GO" factors. Questions related to these factors include Are there enough **trained** personnel to help mitigate the CWA incident? Is the **equipment** available to do crucial tasks (detection equipment, references, tools, materials, etc.)? Do they have the proper level of personal **protection** for the chemical hazard? Is there sufficient **time** to effect rescues? Conduct RECON? Do other critical tasks? If the answer to any of the questions is NO, then the leaders should consider a defensive posture until the needed resources are available.

This research determined that fire departments must develop and exercise practical procedures for the decontamination of mass casualties. One known resource designed to decontaminate mass casualties is the CBIRF. This is an acronym for Chemical Biological Incident Response Force. This specialized group was recently formed by the United States Marine Corps.

In October 1996, the author had the opportunity to observe the CBIRF at an exercise in Quantico, Virginia. Through simulation, the CBIRF displayed its capability to set up for and decontaminate victims exposed to a CWA. The author was impressed with the efficiency and effectiveness of CBIRF. However, there was one "downside" to the response of the CBIRF--the predicted response time of about six to eight hours (U.S. Marine, personal communication, October 25, 1996).

The CBIRF should have a rapid deployment advance group (RDAG) designed to get a "few" members en route to a chemical-related incident within an hour or so. The RDAG could at least provide medical and technical guidance to the IC reasonably early into the incident. The RDAG could then determine if the full complement of the CBIRF is needed.

It was clear from the literature review and personal communications that several methods or ways exist for decontaminating victims. Medici (personal communication, November 3, 1996) believes there is merit in the use of dry decontamination under certain circumstances to remove a liquid chemical agent from a victim's clothing or skin. The author finds this approach interesting and worthy of further review. In particular, Medici recommends the use of cornstarch or "fuller's earth." Fuller's earth (attapulgite clay) is a fibrous claylike material that gets its name "from its ability to remove dirt and grease from wool," a process called "fulling" (Etherington and Roberts, 1982).

However, some authorities believe that using a 0.5 percent solution of Chlorox (sodium hypochlorite) is sufficient to decontaminate liquid chemical agent contacting a person's clothes or skin. Yet, surprisingly to the author, other authorities recommend using a higher percent of solution (5.0 percent) for the same purpose. So, it appears from the research that either strength is sufficient if the skin contact time is not too long.

Implication of Study Results on Montgomery County's Fire Service

The survey results suggest that the County's fire service and government are lacking sufficient planning and equipment to manage a terrorist activity involving a CWA. Although steps have already been taken by some members of the fire service to gain more knowledge on CWA-related issues and to obtain chemical detection and personal protective equipment, this is just the beginning.

The author believes that the time he devoted to this applied research project has served greatly to enhance his appreciation and understanding of the issues which must be addressed to develop a meaningful and practical response plan for Montgomery County. The literature review and personal communications support the observation that first responders will face the uncertainty of a chemical attack long before other resources arrive (W. Bradford "Chip" Chase III, personal communication, July 17, 1996).

In Montgomery County (and elsewhere), an act of terrorism involving the release of a CWA will create an enormous challenge to first responders and haz mat personnel. As the hours pass, this challenge will likely begin to shift from managing the incident itself to managing the extraordinary "outpour" of assistance from the State and Federal governments.

As noted by Captain "Chip" Chase, "the genie is out of the bottle." Who knows whether terrorists may strike Montgomery County or nearby District of Columbia. Having a sound response plan could greatly reduce the risk of injury to first responders.

This applied research paper will be available to the leaders of Montgomery County's fire service and members of County government. It is intended to serve as a resource for use in the development of a plan to manage the consequences of terrorism involving CWAs. Providing awareness training to both telecommunicators and first responders **must** be high on the fire service's list of priorities, lest first responders will be among the casualties.

The readers of this applied research project, especially those representing fire departments that participated in the survey should find these results beneficial. At the least, it should give them an opportunity to compare the results with their own department's efforts to prepare for terrorism. At best, the survey results, information contained in the appendixes, and the recommendations may serve to "ignite" interest in other fire service leaders to develop a general plan.

RECOMMENDATIONS

While these recommendations are directed toward the fire service of Montgomery County, they may be of value to fire chiefs who have yet to develop a plan to manage an incident involving a CWA.

1. Develop and deliver an awareness training program for career and volunteer fire, rescue, and EMS personnel, and members of the County's Emergency Management Group.

This program would benefit fire service personnel and police and members of other County agencies. In the interest of time and efficiency, the information should be videotaped and distributed to the 33 fire/rescue stations and other worksites. Using this communication medium will ensure that all personnel receive the same information. Moreover, the videotape format will allow personnel an opportunity to review the awareness program more than once.

The County's fire service has both the personnel and equipment to prepare and produce the entire awareness training tape. Several members have received sufficient training in CWA-related subjects to provide the technical support needed to prepare this awareness videotape.

Awareness training for the Emergency Management Group (EMG) could be delivered at one of the monthly EMG meetings. Approximately 25 to 30 people typically attend these meetings. Excerpts from the first responder videotape could be used as part of this presentation.

2. Develop and deliver an interim awareness training program for members of the Emergency Communications Center (ECC).

Only 2 of the 49 survey respondents indicated that their ECC personnel had received CWA-related training. Montgomery County's ECC was 1 of 47 fire departments that had not provided training for their ECC personnel.

While the awareness training program videotape is being developed, training should be provided to the telecommunicators because their relatively small number and their consolidated location help the delivery process. Fire service instructors can prepare and deliver the needed training. This recommendation should be given high priority.

The role of the telecommunicators is crucial in warning first responders that an incident may be related to terrorist activities involving the release of a CWA. The questions they ask and the information they elicit from 911 callers could substantially reduce the risk of first responders becoming "canaries" (casualties). A prepared set of questions on circumstances regarding a potential terrorist activity could facilitate recognition by telecommunicators.

For illustration, the author offers a simple acronym, "PEST," to trigger the capturing of key information from a caller about a possible CWA release. PEST represents **P**eople, **E**nvironment, **S**ymptoms, and **T**ime.

People

How many people are injured or sick? Are they children or elderly? Are there any suspicious people in the area?

Environment

What caused the situation? An explosion? People with "packages"? Is there an unusual mist or fog present?
Are the victims inside a building? At a Metro station? What location? Is there another device? (See Appendix P for other signs of a chemical incident.)

Signs/Symptoms

Are the victims walking around or lying down? Unconscious? Do they have runny noses? Are they complaining that they cannot see? (See Appendix O for list of signs/symptoms related to exposure to nerve, blister, blood, and choking agents.) This information should be displayed in a convenient checklist format.

Time

When did you first see the victims? When did you hear the explosion?

As noted earlier "PEST" is just an example of a simple way to help the telecommunicators capture information that may be related to terrorist activities. No matter what system is used, it should be in a convenient format for EMS-reported incidents. The important thing to remember here is that the procedure or method is in a simple format, easy to record the information, and easy to interpret the results. The Defense Protective Service (DPS) developed a comprehensive "NBC Indicator Matrix" which is designed for use by ECC personnel. This eight-page "Matrix" is published in the DPS's *10-90 Gold NBC Response Plan*.

Training for the telecommunicators should include, but not be limited to, potential targets of terrorism in Montgomery County, properties of common CWAs, signs and symptoms of victim exposure to a CWA, victim self-survival actions, use of MSDS, and capabilities of first responders to protect themselves.

3. Prepare and deliver a CWA-incident operations course for the HIRT personnel, members of the Office of Emergency Management, and command-level officers.

This course should be developed as an extension of the awareness training program. Topics should include, but not be limited to, CWA recognition, chemical detection equipment, chemical PPE, decontamination procedures, scene management, personnel accountability, and other safety concerns.

Participants should have the opportunity to work with the M8 paper, M256 detection kit, M291 decontamination kit, and other methods of decontamination. A "mini" exercise should be part of the course to reinforce the objectives.

The County's Office of Emergency Management (OEM) is a key element in the search for and coordination of resources requested by the IC at the scene of a terrorist activity involving a CWA. The OEM supports, helps, and is an essential part, of the Montgomery County's EMG. Whenever the County is faced with the threat of a disaster, the EMG is fully or partly activated. The EMG is a valuable asset to the onscene IC.

A six-hour course should be developed for the command-level officers. This course could be presented as part of the fire service's Command Officers Professional Development and Improvement (COPDI) program. Points to cover should include, but not be limited to, review of the information provided in the awareness program, preservation of evidence, coordination and interaction with members of the Maryland Emergency Management Agency (MEMA), FEMA, and other Federal resources, mass casualty management, and unified incident command.

4. Consider preparing an NBC community awareness brochure.

The County should prepare an NBC awareness brochure for the citizens of the community. This brochure should inform the citizens of potential signs of a terrorist "device" or "package," safety precautions when using public transportation including the subway, trains, and buses, and other pertinent information. The brochure should also contain information about the fire service's capability to mitigate incidents involving chemical agents. Furthermore, the brochure should emphasize the importance of the community and the public safety agencies working together to protect the citizens.

The brochure should be a joint venture of the County's Public Information Office, fire service, police department, and WMATA. Informing the public serves a twofold purpose: first, it helps to increase awareness, and secondly, it elicits cooperation from the public should a CWA incident occur in or near Montgomery County. Because of the nature of the CWAs, it may be necessary for people to disrobe as part of decontamination. If the citizens have an appreciation ahead of time why this must be done, they are likely to be more understanding and cooperative.

5. Explore the feasibility of using a pumper's tank of water to mix a decontamination solution (calcium hypochlorite and water) for use in decontaminating mass casualties exposed to a CWA.

The tank water-calcium hypochlorite solution could be used conveniently to fill garden sprayers and other containers for decontaminating victims and equipment. In mass casualties situation where it is uncertain how many victims' clothes may have contacted liquid chemical agent, one or more small-diameter hoselines could be used to "gently" apply the solution directly onto the victims' clothes. Calcium hypochlorite was selected because it is less corrosive to a metal tank than sodium hypochlorite (Olin Corporation-Charleston, Texas, representative, personal communication, November 22, 1996). (Before using the solution it should be tested to verify the desired percent of solution.)

Before spraying the clothing, the victim's face and eyes must be protected. The victims should be instructed to close their eyes, cover their eyes, nose, and mouth with both hands, and tilt their heads forward.

After spraying the victims, they should be directed to tents or other suitable enclosures where they can disrobe, dry off, and then don a Tyvek suit (or other suitable attire). Contaminated clothing and personal items should be placed in plastic bags, sealed, and labeled.

6. Explore the feasibility of using a hand-held car-washing brush assembly with a garden hose attached to decontaminate victims.

This procedure may be easier than a hoseline to control the flow of the decontamination solution. A 2-½-inch-to-garden hose adaptor is needed to obtain water supply from a pumper's tank. The flow rate from the garden hose would be much less and easier to handle than a hoseline designed for fire extinguishment.

7. Determine approximately how many victims can be decontaminated per gallon of decontamination solution or sprayer.

These sprayers can be used to apply decontamination solution to the clothing of victims who were contaminated by a chemical agent liquid. Sprayers are carried on the HIRT unit. One way to determine how many victims could be decontaminated per gallon of solution involves using a mannequin. After putting clothes on the mannequin, water could be sprayed onto the clothes. After removing the clothes, drying the mannequin, another set of dry clothes could be put on the mannequin, and the procedure repeated enough times to determine about how many victims could be decontaminated per gallon of solution. The number of "victims/gallon" could be marked on the sprayer.

8. Conduct a "SMART" exercise to determine the effectiveness of decontamination procedures and mass casualty handling.

A "SMART" exercise is one in which the participants know the scenario ahead of time and prepare to mitigate the "incident" using their best effort. (SMART is an acronym for Special

Management Advanced Readiness Training.) The participants will have an opportunity to develop a SMART action plan. In this way, the participants will evaluate the exercise outcome against what they believe to be an effective approach to managing anticipated challenges. Sufficient stressors should be included in the exercise to ensure a sense of realism and to require the participants to make decisions within a small "window of time." The scene should contain some signs of a chemical incident for purposes of realism, "evidence" collection, and exercise evaluation (see Appendix P).

This exercise should have at least 50 "casualties": 25 "dead" (on paper) and another 25 treatable "victims." Personnel could evaluate the effectiveness of triage, decontamination, and other components of their incident management procedures.

9. Integrate specific aspects of CWA-incident management into the County's HIRT standard procedures for mitigation of haz mat incidents.

An incident involving a CWA is a hazardous material incident. Planning for a terrorist incident involving a CWA must be built upon the HIRT's existing haz mat management procedures. The modified plan should address the use of specialized chemical detection and PPE, concern for mass casualties, risk of exposure to CWA vapor or liquid by first responders and HIRT personnel, preservation of evidence, mass decontamination operations, and protection of civilians (i.e., evacuate or "protect in place"). The threat of a secondary chemical agent release or explosive device should also be considered.

10. Request that the County Executive explore ways to reduce the response time of specialized State and Federal assets if there is a terrorist incident in Montgomery County.

In case of terrorist activity involving a CWA in Montgomery County, the incident will likely overwhelm fire service resources. As a result, State and Federal assets most probably will be requested to help mitigate the incident. Unfortunately, the time between request and arrival will likely be at least two hours or more (W. Bradford "Chip" Chase, III, personal communication, July 16, 199).

The County Executive should pursue ways to cut the "red tape" so the response time will be substantially reduced. Of what value are lifesaving State and Federal assets if they arrive too late?

11. Pursue the purchase (or acquisition) of more chemical detection equipment, and rapid access to large quantities of nerve agent antidote kits ("NAAK-1").

Although the HIRT has some means of detecting the presence of nerve and blister agents (i.e., Saw Minicad and Draeger chemical tubes), more equipment is needed to monitor victims during decontamination operations and other aspects of scene management.

The County does not have any NAAK-1 kits. While the fire service is willing to purchase these kits, large supplies cannot be found. It appears that these kits are produced in large quantities for use by only the military, Veterans Administration, and United States Public

Health Service. This does not seem reasonable when one considers that first responders and haz mat personnel will be on the scene long before Federal assets arrive. The County Executive should be requested to help the fire service obtain these NAAK-1 kits. These kits are needed on the scene at the outset of operations effectively to treat victims of a CWA exposure. Time is extremely crucial to their survival.

12. Explore the feasibility of first responders and HIRT personnel using chemical-protective masks and suits.

Of course HIRT personnel would wear fully-encapsulated suits with SCBA (level A protection) when entering and working inside a confined space suspected of containing a released chemical agent. This is standard practice for any incident involving an "unknown substance" or one that poses a serious health threat.

However, when working in open air away from the contaminated structure or building, a lower level of personal protection may be acceptable. Still, chemical monitors must be used to check the air to ensure that the environment is safe for personnel to work at a lower level of protection.

Typically, the protection worn by first responders would be SCBA, firefighter's turnout coat, pants, gloves, hood, and helmet. HIRT personnel would also wear SCBA but may wear a different type of protective clothing.

However, if the activity is extended over a long period, the SCBA may become cumbersome and weighty. Examples of activities include patient triage, decontamination, treatment, and transport. During these activities, chemical protective masks and clothing may be suitable for use by first responders and HIRT personnel (see Appendixes Q for examples of protective clothing).

A QuickMask-type of respiratory protection may prove suitable for police officers assigned to maintain security, protect evidence, control traffic, control crowds, coordinate evacuation, and other related duties performed outside and away from the contaminated structure or building. Ambulance attendants may also benefit from wearing this type of respiratory protection.

13. Explore ways to use the FEMA Maryland US&R Task Force to help first responders, HIRT, and the EMG during a CWA incident.

The US&R task force represents diversified resources and expertise related to disaster management. Consideration should be given to developing a small "rapid deployment group" (RDG) from among members of the US&R task force. This RDG could help with logistics, communications, decontamination, and other functions as requested by the on-scene incident commander, EMG, or both. The RDG could substantially reduce the response time of other specialized resources that are part of the US&R Task Force's equipment cache maintained in the County.

14. Develop mitigation action tips (MAT) quick reference for use by first responders and HIRT personnel.

Hopefully, Montgomery County (or any other jurisdiction) will not experience an act of terrorism involving a chemical agent. But, if it should happen, the County must be prepared. As time passes and unless procedures are reviewed, practiced, or both, people are apt to forget some planning details.

Therefore, MAT quick references could serve as memory joggers (see Appendix R). Different versions could be prepared for first responders, HIRT, and members of the EMG. For convenience, these quick references should be printed on three by five or four by six-inch cards, color-coded, and laminated. They could be carried in a shirt pocket or purse. Larger versions could be carried on fire/rescue apparatus, command vehicles, and police cars. Others could be displayed or available in the County's emergency operations center (EOC).

15. Organize a group of people from the fire service, police department, other county agencies and organizations to develop a county response plan to acts of terrorism.

The author coined the acronym CPRAT--County Planning and Response to Acts of Terrorism--to serve as the name of this proposed group. Although the scope of this applied research project was limited to fire service planning, it is important to expand the plan to include other agencies and organizations throughout Montgomery County. Members of the County's EMG, Office of Emergency Management, and other police departments, including WMATA, should be among the participants.

Many issues and concerns associated with mitigating a terrorist incident involving a CWA transcend various organizations and agencies. Examples include evacuation, shelter, transportation, decontamination, coordination with State and Federal agencies, declaration of a public emergency (legal matters), media relations, welfare of citizens, equipment and materials acquisition, logistics, safety and welfare, and so forth.

16. Suggest that the Division of Fire Investigation, County Police and Sheriff's Departments, conduct a vulnerability study of the County's government buildings and identify ways to improve security and safety.

It appears that some buildings do not have enough security cameras and other monitoring initiatives, especially in the enclosed parking garages of the Executive Office Building (EOB) and Judicial Center. The nature of County government elicits a high flow of people to and from various buildings. Terrorists could have easy access to these buildings.

Fire and police stations should be considered for evaluation. It is common to enter fire stations while the units are on an alarm and find them unlocked. In addition, the police departments should consider providing counterterrorism suggestions to owners of shopping centers, theaters, etc.

17. Suggest that fire service personnel visit the WMATA's train stations to become more familiar with their layout, and to develop strategic plans and tactical procedures.

Points to consider include public and personnel access (i.e., stairs, escalators, elevators), ventilation system, evacuation (or protect-in-place) procedures, refuge areas, incident operating guidelines, etc. A list of MATs could be developed for use at both the company and command-officer levels. (See recommendation 14.)

18. Include a terrorist-related exercise involving a chemical agent in a future "Metro" training exercise.

This exercise should be conducted besides the proposed "SMART exercise. It should be added to the fire service's periodic training involving one of the in-county WMATA train stations.

19. Suggest that County Officials (e.g., County Executive, Council Members, etc.) consider the purchase of a chemical protective mask (e.g., QuickMask) for personal use in the unlikely event of a chemical attack (see Appendix Q).

These masks are relatively inexpensive, easy to don, and compact. Montgomery County's HIRT has begun evaluating the feasibility of using this mask under specific conditions and circumstances.

Closing Comments

Readers who have interest in conducting research on the subject of chemical and biological agents should carefully consider the scope and purpose of the applied research project. Based on the purpose of the research, an inordinate amount of research and preparation time may be required.

If a survey is used, give ample time to its development. It should be checked and tested thoroughly before sending it to the target audience.

Prepare a timeline for completing different phases of the project. If the projected timeline exceeds the time the researcher has available for the project, consider changing the topic or narrowing its scope.

REFERENCES

Argonne National Laboratory (1994, August). Personal protective equipment for civilian emergency workers following a chemical weapons agent release. Decision and Information Sciences Division, 9700 South Cass Avenue, Argonne, IL 60439-4832. pp. 1-20.

Briese, Garry (1995, November). Fire and emergency service considerations when responding to a terrorist incident. *First worldwide conference on strengthening fire and emergency response to terrorism.*

Bruno, Hal. (1995, July). Anti-government movement a menace to fire service. *Firehouse,* p. 10.

Campbell, Knight, & Evancoe, Paul. (January, 1995). Chemical weapons lurk as terrorists' 'surprise.' *National Defense*, pp. 24-25.

Cox, Jim. (1995, November). The Harbor incident. *Presentations and Summaries, Strengthening the fire and emergency response to terrorism*. First worldwide conference, November 6-9, 1995, pp. 36-37.

Daniels, Kevin. (1996, September). The terrorist's cookbook. *Fire Chief,* pp. 44, 46, 48.

DeGeneste, Henry I., Silverstein, E. Martin, Herbert, F. Edward, & Sullivan, John P. (1996, October). Chemical and biological terrorism: Upping the ante? *The Police Chief*, pp. 70-72, 74-75, 77-78, 80, 83.

Defense Protective Service (1996, June). 10-90 gold NBC response plan. (No publication information included with this book.)

Downey, Ray (1996, June). Terrorism and the fire service: analyzing the problems. *Fire Engineering*, pp. 101-105.

Dunbar, Jan R. (1996, September). Brace yourself for biological and chemical terrorism. *Fire Chief*, pp. 34-36, 38, 40, 42-43.

Eifried, Gary, & Smoak, Pat. (1996, June). *Chemical and biological counterterrorism training for executives*. Abingdon, Maryland: EAI Corporation.

Emerson, James J. (1996, July). Live agent chemical defense training. *CML*, pp. 40-43.

Etherington, Don, & Roberts, Matt J. (1982*). Book binding and the conservation of books: A dictionary of descriptive terminology*. Library of Congress. (Obtained from the Internet.)

Fialka, John J. (1996, June 3). U.S. cities prepare to deal with terror attacks, but drills point to weakness in rescue plans. *The Wall Street Journal*.

Forgy, Michael, &. Walter, Andrea A. (1996, January). Terrorism - conference spotlights global menace to fire and emergency services. *Firehouse*, pp. 36-38.

Harris, Jef L. (1996, July). *Chemical warfare agents or chemical surety material properties*. Gaithersburg, MD: Geomet Technologies, Inc.

Hayes, Steven E. (1995, October). Beating the clock on terror. *Public Risk*, pp. 8-10.

Hume, G. Brett. (1994, August). *Terrorism and the fire services role*. (Executive Fire Officer Program) Emmitsburg, MD: National Fire Academy.

Komiyi, Takiji (1995, November). *Outline of the nerve gas attack in the Tokyo subway system*. (Handout, The First Worldwide Conference on Strengthening Fire and Emergency Response to Terrorism) Mount Weather, Berryville, VA.

Martin, William M. (1995, June). Terrorism and the fire service. *American Fire Journal*, pp. 19-25.

Medici, John, & Patrick, Steve. (1996, August). Emergency response to incidents involving chemical & biological warfare agents. Richmond, VA: Virginia Department of Emergency Service, Technological Hazards Division, pp. 1-40.

Milmore, Robert J., & McHale, Thomas A. (1996, May). Sarin - The unspoken threat. *Firehouse*, pp. 54-59.

Moultrie, Mike. (1996, September). A new kind of calvary. *Fire Chief*, pp. 49-51.

Staten, Clark. (1991, March). Target: Terrorism. *Emergency Medical Services*, *20*, (3), pp. 31-33, 34-35.

Sullivan, John P. (1988, September). Fire and rescue operations at the terrorism incident. *American Fire Journal*, pp. 22-25.

United States Army Chemical School (1996, October). Chemical/biological countermeasures course. Fort McClellan, Alabama. (Student manual used in 4-day course held October 21-24, 1996.)

United States Department of State (1996, April). Patterns of global terrorism 1995. 1-440. *Department of State Publication 10321*.

Walter, Andrea A. (1994, November). Terrorism - Are you prepared? *IEMS News*.

Zeigler, James P. (1996, October). The dangers of chemical weapons. *Occupational Health & Safety*, pp. 182-184, and 186.

Appendix A
Acronyms

AC	hydrogen cyanide (blood agent)
ACT FAST	agent characteristics & toxicity first aid & special treatment (program)
AED	automatic external defibrillator
AEL	airborne exposure limit
APR	air purified respirator
BATF	Bureau of Alcohol, Tobacco and Firearms
BIDS	biological integrated detection systems
BDO	battle dress outergarment
B-NICE	biological, nuclear, incendiary, chemical, and explosives
BW	biological warfare
BWA	biological warfare agent
CA	tear agent
CAM	chemical alarm monitor
CB	chemical/biological
CBDCOM	Chemical Biological Defense Command (U.S. Army)
CBIRF	Chemical Biological Incident Response Forces (USMC)
CBRDT	Chemical/Biological Rapid Deployment Team
CDC	Centers for Disease Control
CDTF	Chemical Defense Training Facility (U.S. Army)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
$C^{O}M$	consequence management
CG	phosgene (choking agent)
CK	cyanogen chloride (blood agent)
Cl	chlorine
CN	tear agent
CNB	tear agent
CNC	tear agent
CNS	tear agent
COG	Council of Governments
COOP	continuity of operations
CR	tear agent
$C^{R}M$	crisis management
CSEPP	Chemical Stockpile Emergency Preparedness Program
CW	chemical warfare
CWA	chemical warfare agent
CX	phosgene oxime (urticant)
DA	vomiting agent
DC	vomiting agent
DM	vomiting agent
DEST	Domestic Emergency Support Team
DFO	Defense Coordinating Officer
DECON	decontamination

DFO	disaster field office
DMAT	Disaster Medical Assistance Team
DMORT	Disaster Mortuary Team
DOD	Department of Defense
DOE	Department of Energy
DOMS	Director of Military Support
DP	diphosgene (choking agent)
DPS	Defense Protective Service
DSWA	Defense Special Weapons Agency
EMG	Emergency Management Group
EOC	emergency operations center
ERDEC	Edgewood Research Development, and Engineering Center
EOD	Emergency Ordnance Disposal
ERT	Emergency Response Team
ESF	emergency support function
EST	Emergency Support Team
FAsT	Field Assessment Team
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FORSCOM	Forces Command (U.S. Army)
FRP	Federal Response Plan
GA	tabun (nerve agent)
GB	sarin (nerve agent)
GD	soman (nerve agent)
GF	unnamed chemical nerve agent
GIS	geographic information system
HAZMAT	hazardous material(s)
HD	distilled mustard (blister agent)
HL	mustard and lewisite mix (blister agent)
HN	nitrogen mustard (blister agent)
HT	mustard mixed with a thickener (blister agent)
IC	Incident Commander
ICAD	improved chemical agent detector
ICS	Incident Command System
ID	incapacitating dose
ID50	incapacitating dose to 50 percent of exposed individuals
IECS	integrated emergency command structure
IEMS	Integrated Emergency Management System
L	lewisite (blister agent)
LEPC	Local Emergency Planning Committee
M8/M9	chemical detector paper
M40	military chemical protective mask
M17A2	military chemical protective mask
M256	chemical warfare agent detection kit
M291	kit for self-decontamination of skin
MACC	multi-agency coordination center

MATTS	Mobile Air Transportable Telecommunications System
MCU2P	military chemical protective mask
MEMA	Maryland Emergency Management Agency
MINICAMS	miniature continuous air monitoring system
MK1 NAAK	mark 1 nerve agent antidote kit
MMART	Mobile Medical Augmentation Readiness Team
MMST	Metropolitan Medical Strike Team
MOPP	mission-oriented protective posture
MOSH	Maryland Occupational Safety and Health
NRC	national response center
NBC	nuclear, biological, and chemical
NEST	Nuclear Emergency Search Team
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PAPR	powered air-purifying respirator
PHOSGENE	choking agent
PDD	Presidential Decision Directive
PHS	Public Health Service
PPV	positive pressure ventilation
PS	tear agent
ROC	regional operations center
SA	arsine (blood agent)
SAW MINICAD	surface acoustic wave miniature chemical agent detector
SCBA	self-contained breathing apparatus
STEPO	self-contained toxic protective outfit
TAP	toxicological agent protective
TEU	Technical Escort Unit
USAMRIID	United States Army Medical Research Institute of Infectious Diseases
VX	persistent nerve agent
USAMRICD	U.S. Army Medical Research Institute of Chemical Defense
WMD	weapons of mass destruction
2 PAM CHLORIDE	pralidoxime chloride

Appendix B

Chemical Warfare Agents

Nerve Agents

Tabun (GA)

CAS Registry Number: 71-81-6
UN: 2810
Formula: $C_2H_5OPO(CN)N(CH_3)_2$
Symbol: GA
Molecular weight: 162.3
State at 20 degrees C: colorless to brown liquid
Odor: faintly fruity; none when pure
Vapor density: 5.63
Liquid density (g/cc): 1.073 at 25 degrees C
Freezing/Melting Point (degree C): -5
Boiling point: (degree C): 240
Vapor pressure (mm Hg): 0.037 at 20 degrees C
Volatility: (mg/m^3): 610 at 25 degrees C
Flashpoint: 78 degrees C
Decomposition temperature (degrees C): 150
Median lethal dose ($mg\text{-}min/m^3$): 400 for a resting person
Median incapacitating dose ($mg\text{-}min/m^3$): 300 for a resting person
Eye and skin toxicity: very high
Rate of action: very rapid
Physiological Action: cessation of breath - death may follow
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Sarin (GB)

CAS Registry Number: 107-44-8
UN: 2810
Formula: $CH_3PO(F)OCH(CH_3)_2$
Symbol: GB
Molecular weight: 140.1
State at 20 degrees C: colorless liquid
Odor: almost none when clear
Vapor density: 4.86
Liquid density (g/cc): 1.0887 at 25 degrees C; 1.102 at 20 degrees C
Freezing/Melting Point (degree C): -56
Boiling point: (degree C): 158
Vapor pressure (mm Hg): 2.9 at 25 degrees C; 2.10 at 20 degrees C
Volatility: (mg/m^3): 22,000 at 25 degrees C; 16,090 at 20 degrees C
Flashpoint: nonflammable
Decomposition temperature (degrees C): 150
Median lethal dose ($mg\text{-}min/m^3$): 100 for a resting person
Median incapacitating dose ($mg\text{-}min/m^3$): 75 for a resting person
Eye and skin toxicity: very high
Rate of action: very rapid
Physiological Action: cessation of breath - death may follow
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Soman (GD)

CAS Registry Number: 96-64-0
UN: 2810
Formula: $CH_3PO(F)OCH(CH_3)C(CH_3)_3$
Symbol: GD
Molecular weight: 182.173
State at 20 degrees C: colorless liquid
Odor: fruity; camphor when impure
Vapor density: 6.33
Liquid density (g/cc): [10222 at degrees C]
Freezing/Melting Point (degree C): -42
Boiling point: (degree C): 198
Vapor pressure (mm Hg): 0.4 at 25 degrees C;
Volatility: (mg/m^3): 3,900 at 25 degrees C
Flashpoint: high enough not to interfere with military use
Decomposition temperature (degrees C): 130
Median lethal dose ($mg\text{-}min/m^3$): GB, GA range
Median incapacitating dose ($mg\text{-}min/m^3$): [not found by author]
Eye and skin toxicity: very high
Rate of action: very rapid
Physiological Action: cessation of breath - death may follow
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

GF

CAS Registry Number: [not found by the author]
UN: 2810
Formula: $CH_3PO(F)OC_6H_{11}$
Molecular weight: 180.2
Symbol: GF
State at 20 degrees C: liquid
Odor: sweet; musty; peaches; shellac
Vapor density: 6.2
Liquid density (g/cc): 1.1327 at 20 degrees C
Freezing/Melting Point (degree C): -30
Boiling point: (degree C): 239
Vapor pressure (mm Hg): 0.044 at 20 degrees C
Volatility: (mg/m^3): 438 at 20 degrees C
Flashpoint: 94 degrees C
Decomposition temperature (degrees C): not listed
Median lethal dose ($mg\text{-}min/m^3$): not listed
Median incapacitating dose ($mg\text{-}min/m^3$): not listed
Eye and skin toxicity very high
Rate of action: very rapid
Physiological Action: cessation of breath - death may follow
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

VX

CAS Registry Number: 50782-69-9
UN: 2810
Formula: $(C_2H_5O)(CH_3O)P(O)S(C_2H_4)N[C_2H_2(CH_3)_2]_2$
Molecular weight: 267.38
Symbol: VX
State at 20 degrees C: colorless to amber liquid
Odor: none
Vapor density: 9.2
Liquid density (g/cc): 1.0083 at 20 degrees C
Freezing/Melting Point (degree C): below -51
Boiling point: (degree C): 298
Vapor pressure (mm Hg): 0.0007 at 20 degrees C
Volatility: (mg/m^3): 10.5 at 25 degrees C
Flashpoint: 159 degrees C
Decomposition temperature (degrees C): half life 36 hours at 150
Median lethal dose ($mg\text{-}min/m^3$): 100
Median incapacitating dose ($mg\text{-}min/m^3$): 50
Eye and skin toxicity: very high
Rate of action: very rapid
Physiological Action: cessation of breath - death may follow
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Appendix C

Chemical Warfare Agents

Blister Agents

Sulfur Mustard (HD)

CAS Registry Number: 505-60-2
UN: 2810
Formula: $(ClH_2CH_2)_2S$
Symbol: HD
Molecular weight: 159.08
State at 20 degrees C: colorless to pale yellow liquid
Odor: garlic or horseradish
Vapor density: 5.4
Liquid density (g/cc): 1.268 at 25 degrees C, 1.27 at 20 degrees C
Freezing/Melting Point (degree C): 14.45
Boiling point: (degree C): 217
Vapor pressure (mm Hg): 0.072 at 20 degrees C
Volatility: (mg/m^3): 610 at 20 degrees C
Flashpoint: 105 degrees C; ignited by large explosive charges
Decomposition temperature (degrees C) 149 to 177
Median lethal dose ($mg\text{-}min/m^3$): 1,500 by inhalation; 10,000 by skin exposure
Median incapacitating dose ($mg\text{-}min/m^3$): 200 by eye; 2,000 by skin; 150 inhaled
Eye and skin toxicity: eyes very susceptible; skin less so
Rate of action: delayed - hours to days
Physiological Action: blisters; destroys tissue; injures blood cells
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Nitrogen Mustard (HN)

CAS Registry Number: 538-07-8
UN: 2810
Formula: $(ClCH_2CH_2)_2NC_2H_5$
Symbol: HN-1
Molecular weight: 170.08
State at 20 degrees C: dark liquid
Odor: fishy or musty
Vapor density: 5.9
Liquid density (g/cc): 1.09 at 25 degrees C
Freezing/Melting Point (degree C): -34
Boiling point: (degree C): 194
Vapor pressure (mm Hg): 0.24 at 25 degrees C
Volatility: (mg/m^3): 1,520 at 20 degrees C
Flashpoint: [not found by the author]
Decomposition temperature (degrees C) decomposes before boiling point is reached
Median lethal dose ($mg\text{-}min/m^3$): 1,500 by inhalation; 20,000 by skin exposure
Median incapacitating dose ($mg\text{-}min/m^3$): 200 by eye; 9,000 by skin;
Eye and skin toxicity: eyes susceptible to low concentration; less toxic to skin
Rate of action: delayed - delayed - 12 hours or longer
Physiological Action: blisters; affects respiratory tract; destroys tissue; injures blood cells
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Nitrogen Mustard (HN-2)

CAS Registry Number: 51-75-2
UN: 2810
Formula: $(ClCH_2CH_2)_2NCH_3$
Symbol: HN-2
Molecular weight: 156.07
State at 20 degrees C: dark liquid
Odor: soapy in low concentrations; fruity in high concentrations
Vapor density: 5.4
Liquid density (g/cc): 1.15 at 20 degrees C
Freezing/Melting Point (degree C): -65 to -60
Boiling point: (degree C): 75 at 15 mm Hg
Vapor pressure (mm Hg): 0.29 at 20 degrees C
Volatility: (mg/m^3): 3,580 at 25 degrees C
Flashpoint: [not found by the author]
Decomposition temperature (degrees C) below boiling point; polymerizes with heat generation
Median lethal dose ($mg\text{-}min/m^3$): 3,000 by inhalation
Median incapacitating dose ($mg\text{-}min/m^3$): less than HN-1; greater than HN-3; 100 by eye
Eye and skin toxicity: toxic to eyes; blisters skin
Rate of action: delayed - skin- delayed 12 hours or more; eyes - faster than HD
Physiological Action: similar to HD; Bronchopneumonia possible after 24 hours
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Nitrogen Mustard (HN-3)

CAS Registry Number: 555-77-1
UN: 2810
Formula: $N(CH_2CH_2Cl)_3$
Symbol: HN-3
Molecular weight: 204.54
State at 20 degrees C: dark liquid
Odor: none if pure
Vapor density: 7.1
Liquid density (g/cc): 1.24 at 25 degrees C
Freezing/Melting Point (degree C): -3.7
Boiling point: (degree C): 256
Vapor pressure (mm Hg): 0.0109 at 25 degrees C
Volatility: (mg/m^3): 121 at 25 degrees C
Flashpoint: [not found by author]
Decomposition temperature (degrees C) Below boiling point
Median lethal dose ($mg\text{-}min/m^3$): 1,500 by inhalation; 10,000 by skin exposure (estimate)
Median incapacitating dose ($mg\text{-}min/m^3$): 200 by eye; 2,500 by skin; (estimate)
Eye and skin toxicity: eyes very susceptible; skin less so
Rate of action: serious effects same as for HD; minor effects sooner
Physiological Action: similar to HN-2
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Lewisite (L)

CAS Registry Number: 541-25-3
UN: 2810
Formula: $ClCHCAsCl_2$
Symbol: L
Molecular weight: 207.35
State at 20 degrees C: colorless to brownish
Odor: variable; may resemble geraniums
Vapor density: 7.1
Liquid density (g/cc): 1.89 at 20 degrees C
Freezing/Melting Point (degree C): -18
Boiling point: (degree C): 190
Vapor pressure (mm Hg): 0.394 at 20 degrees C
Volatility: (mg/m^3): 4,480 at 20 degrees C
Flashpoint: none
Decomposition temperature (degrees C) Greater than 100
Median lethal dose ($mg\text{-}min/m^3$): 1,200 to 1,500 by inhalation; 100,000 by skin exposure
Median incapacitating dose ($mg\text{-}min/m^3$): less than 300 by eye; greater than 1,500 by skin;
Eye and skin toxicity: 1,500 mg min/m^3 severely damages eyes; skin less so
Rate of action: rapid
Physiological Action: similar to HD, plus may cause systemic poisoning
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Mustard-Lewisite Mixture (HL)

CAS Registry Number: [no number assigned]
UN: 2810
Symbol: HL
Molecular weight: 186.4
State at 20 degrees C: dark, oily liquid
Odor: garlic
Vapor density: 6.5
Liquid density (g/cc): 1.66 at 20 degrees C
Freezing/Melting Point (degree C): -25.4 (pure); -42 (plant purity)
Boiling point: (degree C): less than 190
Vapor pressure (mm Hg): 0.248 at 20 degrees C
Volatility: (mg/m^3): 2,730 at 20 degrees C
Flashpoint: [not found by the author]
Decomposition temperature (degrees C) Greater than 100
Median lethal dose (mg-min/m^3): 1,500 by inhalation; over 10,000 by skin exposure
Median incapacitating dose (mg-min/m^3): 200 by eye; 1,500-2,000 by skin;
Eye and skin toxicity: very high
Rate of action: prompt stinging; blistering delayed about 13 hours
Physiological Action: similar to HD, plus may cause systemic poisoning
Protection required: protective mask and clothing

Source: Army Field Manual FM 3-9 (1990, December 12)

Appendix D

Chemical Warfare Agents

Blood Agents

Hydrogen Cyanide (AC)

CAS Registry Number: 74-90-8
UN: 1051
Formula: HCN
Symbol: AC
Molecular weight: 27.02
State at 20 degrees C: colorless gas or liquid
Odor: bitter almonds
Vapor density: 0.990 at 20 degrees C
Liquid density (g/cc): 0.687 at 20 degrees C
Freezing/Melting Point (degree C): -13.3
Boiling point: (degree C): 25.7
Vapor pressure (mm Hg): 742 at 25 degrees C; 612 at 20 degrees C
Volatility: (mg/m^3): 1,080,000 at 25 degrees C
Flashpoint: 0 degrees C
Decomposition temperature (degrees C) greater than 65.5
Median lethal dose (mg-min/m^3): varies widely with concentration
Median incapacitating dose (mg-min/m^3): varies with concentration
Eye and skin toxicity: moderate
Rate of action: very rapid
Physiological Action: interferes with body tissues' oxygen use; accelerates rate of breathing
Protection required: protective mask; protective clothing in unusual situations

Source: Army Field Manual FM 3-9 (1990, December 12)

Cyanogen Chloride (CK)

CAS Registry Number: 506-77-4
UN: 1051
Formula: CNCl
Symbol: CK
Molecular weight: 61.48
State at 20 degrees C: colorless liquid or gas
Odor: pungent, biting; can go unnoticed
Vapor density: 2.1 at 20 degrees C
Liquid density (g/cc): 1.18 at 20 degrees C
Freezing/Melting Point (degree C): -6.9
Boiling point: (degree C): 12.8
Vapor pressure (mm Hg): 1,000 at 25 degrees C;
Volatility: (mg/m^3): 2,600,000 at 12.8 degrees C; 6,132,000 at 25 degrees C
Flashpoint: none
Decomposition temperature (degrees C) greater than 100
Median lethal dose (mg-min/m^3): 11,000
Median incapacitating dose (mg-min/m^3): 7,000
Eye and skin toxicity: low; lacrimatory and irritating
Rate of action: very rapid
Physiological Action: chokes, irritates, causes slow breathing rate
Protection required: protective mask

Source: Army Field Manual FM 3-9 (1990, December 12)

Appendix E

Chemical Warfare Agents

Choking Agents

Phosgene (CG)

CAS Registry Number: 75-44-5
UN: 1076
Formula: $COCl_2$
Symbol: CG
Molecular weight: 98.92
State at 20 degrees C: colorless gas
Odor: new-mown hay, green corn
Vapor density: 3.4
Liquid density (g/cc): 1.37 at 20 degrees C
Freezing/Melting Point (degree C): -128
Boiling point: (degree C): 7.6
Vapor pressure (mm Hg): 1.173 at 20 degrees C
Volatility: (mg/m^3): 4,300,000 at 7.6 degrees C
Flashpoint: none
Decomposition temperature (degrees C): 800
Median lethal dose (mg-min/m): 3,200
Median incapacitating dose ($mg\text{-}min/m^3$): 1,600
Eye and skin toxicity: none
Rate of action: immediate to 3 hours depending on concentration
Physiological Action: damages and floods lungs
Protection required: protective mask

Source: Army Field Manual FM 3-9 (1990, December 12)

Diphosgene (DP)

CAS Registry Number: 503-38-8
UN: [not found by author]
Formula: $ClCOOCCl_3$
Symbol: DP
Molecular weight: 197.85
State at 20 degrees C: colorless liquid
Odor: new-mown hay, green corn
Vapor density: 6.8
Liquid density (g/cc): 1.65 at 20 degrees C
Freezing/Melting Point (degree C): -57
Boiling point: (degree C): 127 to 128
Vapor pressure (mm Hg): 4.2 at 20 degrees C
Volatility: (mg/m^3): 45,000 at 20 degrees C
Flashpoint: none
Decomposition temperature (degrees C): 300 to 350
Median lethal dose (mg-min/m^3): 3,200
Median incapacitating dose (mg-min/m^3): 1,600
Eye and skin toxicity: slightly lacrimatory
Rate of action: immediate to 3 hours depending on concentration
Physiological Action: damages and floods lungs
Protection required: protective mask

Source: Army Field Manual FM 3-9 (1990, December 12)

Chlorine (Cl)

CAS Registry Number: 7782-50-5
UN: 1017
Formula: Cl_2
Symbol: Cl
Molecular weight: [35.453]
State: greenish liquid or gas
Vapor density: [2.4]
Boiling point: (degree C): - 34
Vapor pressure (mm Hg):
Flashpoint: not applicable
Decomposition temperature (degrees C): unknown

Source: MSDS, Olin Corporation

Appendix F

NBC-related Internet Web Sites

1. http://www.camberava.com/surgeon/
2. http://www.members.aol//hbpub2/index.htm
3. http://www.opcw.nl/chemhaz/cwagents.htm
4. http://www.nbc-med.org
5. http://www.apgea.army.mil/rda/index.html

Source: Internet

Appendix G

Summary of Selected Comments Related to the Sarin Attacks in Tokyo, Japan March 20, 1995

Tokyo Fire Department

Below is a partial list of questions and answers related to the March 20, 1995 sarin attacks in Tokyo, Japan. The responses were provided by Battalion Chief Akira Tada, International Relations, Administration Section. (These comments were faxed to the National Fire Academy in response to questions posed by participants of a conference on terrorism.)
Question l: What were the three top problems in responding to the sarin incident?

A. Answer: "Heavy casualties among Fire Service Personnel."

One hundred thirty-five fire service personnel were injured directly or indirectly from exposure to the poisonous gas during the incident. This number of fire service injuries is very high compared with the average number of about 100 injuries per year. Both EMS and command officers were also injured. Usually, the number of EMS and command officers injured at disaster scenes is small compared with firefighters.

B. Answer: "No preparedness to cope with phosgene cases."

Before the sarin incident all emergency response activities such as "handling of accidents in our daily life, quelling industrial disasters, etc.," have been successful. No unusual incidents like the sarin incident had been expected to happen because deadly substances like sarin is of military use. These substances "are not usually found in industrial activities in today's Japan." We have learned from the sarin incident and now "see the absolute necessity for the preparedness for phosgene cases."

C. "No operational procedures to cope with sarin."

"Aside from our current fire department operational procedures to handle the leakage of gases in industrial use (ex. chlorine gas), we had no standards for extraordinary substances including sarin."

Question 2: What actions have the Tokyo Fire Department taken to correct problems since the sarin incident? The response is summarized below:

A. Responders were provided specialized respiratory protection equipment designed to protect against deadly gases such as sarin were provided to responders.

B. Haz mat units were provided with detection tubes for organic phosphates and similar substances. During the early moments of an incident, haz mat personnel could take "swift and effective action." In addition, chemical agents for neutralization of poisonous gases were prepared together with portable sprayers, and decontaminating showers were placed in actual use for personnel exposed to poisonous gases.

C. The fire department's operational procedures were amended to reflect lessons learned from the sarin incident. Personnel will receive operational training on the new procedures. Additionally, the fire department will put in service another kind of gas chromatograph-type analyzer in service this year (1996). "The analyzer should be a high-efficiency device capable of detecting 70,000 gases including sarin.

Question 3. Related to the 135 personnel who were injured:

A. Their Personal Protective Clothing

Responders were not heavily equipped. As a matter of fact, the emergency calls from disaster-stricken stations were about sick passengers. (The calls were like "Ambulance, please. We've got a passenger sickened and fallen.")

EMS responders were clad with usual clothes (a work wear for an ambulance member), an anti-contagion white gown for medical use, and a helmet. Personnel other than EMS responders wore work wear, a helmet, Kevlar gloves, and laced work shoes.

B. Respiratory Protection in Use.

Air masks and haz mat suits were worn by responders (except EMS members) after a deadly gas was suspected. Personnel with no air masks and haz mat suits on were not allowed to gain access to disaster scenes.

C. Correlation between equipment and injuries.

At the early stage of the sarin incident, some of our members responded to the scene as ordinary EMS/rescue teams, not knowing of the actual state caused by sarin. As a result, they were attacked by the gas soon after they arrived on the affected scenes. During this early stage responders were injured, regardless of their level of technical equipment. Acetonitrile, a solvent for sarin, was detected one hour later, and at that point, many personnel were found sick from exposure to sarin.

D. Injuries to Responders Wearing SCBA (see 3 above.)

Responders who wore SCBA were not among the casualties. SCBAs began to be used after the seriousness of the incident was revealed.

E. Injuries to Responders with Their Skin Exposed to Sarin.

There was no serious injury to emergency responders whose skin was exposed to sarin. They were actually in turnout coats or work wear.

Injuries to Medical Responders in Ambulances. (See 3 above). The number of injured EMS members was 30.

Source: Battalion Chief Akida Tada, Tokyo Fire Department

Appendix H

Common Decontamination Solutions

Regular Chlorox Bleach
(Sodium Hypochlorite Solution)

CAS Registry Number: 7681-52-9
UN: 11791
Formula: NaOCl
Ingredients: Hydrochlorous acid, sodium salt; (sodium hypochlorite)
Percent: 5.25
Appearance and Odor: None specified by manufacturer.
Boiling Point: 100 degrees C.
Specific Gravity: 1.085
Solubility in Water. Complete

Calcium Hypochlorite

CAS Registry Number: 7778-54-3
UN: 2880
Formula: $Ca(OCl)_2$
Percent: 65.0
Specific Gravity: 0.8
Flashpoint: none
Decomposition temperature (degrees C): 177 (350 degrees F)
Solubility in Water: Appreciable

Source: MSDS, Olin Corporation

Appendix I

Weight of CCH Dry Chlorinator* Required to Prepare Various Strength Solutions

		Volume of Water in Gallons				
Ave Cl ppm	**Conc %**	**1**	**3**	**5**	**10**	**100**
		Weight of CCH (ounces)				
1000	0.1	0.2	0.6	1.0	2.1	20.6
5000	0.5	1.0	3.0	5.1	10.3	102.8
------	1.0	2.06	6.2	10.3	20.6	205.5
------	5.0	10.3	30.9	51.4	102.8	1028.0
------	10.0	20.5	61.6	102.8	205.5	2055.0

*contains 65 or 70% available chlorine (granular or tablet form of calcium hypochlorite)

Source: Olin Corporation

Note: This is a partial listing of the chart. For convenience the author added the three and five-gallon columns and rounded the value of ounces to the nearest tenth.

Appendix J

National Fire Academy
Executive Fire Officer Development Program
Applied Research Project

SURVEY

Please provide responses to all of the items. This survey was also sent to other fire departments throughout the United States that serve a population of 200,000 or greater. This applied research project will include the results of the survey. Thank you.

1. What is the approximate population served by your department? _____

2. What is the total number of uniformed emergency service personnel in your department fire, rescue, and EMS)? **_____**

3. Does your department have a general plan for handling terrorist incidents involving the release of chemical agents such as nerve gas (sarin) and blister agent (mustard gas)? **YES____ NO____**

   If the answer is **YES**, please answer items 4 and 5. If **NO**, go to item 6.

4. In what year was the plan adopted? _____

5. What event or initiative prompted the development of the plan? (**check all that apply**)

   Tokyo sarin attack ___ Oklahoma City bombing ___ World Trade Center bombing ___

   Other event or reason (please note) _____

6. Is your department presently developing a general plan to handle terrorist incidents involving chemical agents? **YES____ NO____**

7. If the answer to item 6 is **NO**, does your department intend to develop a plan within the next 12 months? **YES____ NO____**

8. Does your department have instruments (or other means) to detect the presence of chemical agents (such as sarin and mustard gas)? **YES____ NO____**

9. If the answer to item 8 is **YES**, please list the types and models of each instrument (or other item).

_____

_____

_____

_____

_____

10. Does your department have personal protective equipment that you know can protect emergency response personnel against exposure to chemical agents such as sarin and mustard gas? First Responders **YES____NO____** Hazardous Materials Team **YES____NO____**

11. If the answer to 10 is **YES**, list the type and model of clothing:

suits: Level A:_____ Level B:_____

Level C:_____ **gloves:** _____

other: _____

12. Does your department have filter masks with chemical warfare (CW) capability?

Fire personnel **YES____ NO____** EMS personnel **YES____ NO____**

Haz mat personnel **YES____ NO____**

13. Has your hazardous materials response team received training in ways to detect, protect, and decontaminate against exposure to chemical agents? **YES ____ NO ____**

If the answer is **YES**, please answer items 14 Through 16. If **NO**, go to item 17.

14. What is the minimum number of training hours required for members of the team?

_____

15. Approximately how many hours did each member receive on the following subjects?

properties of chemical agents ____ personal protection ____ EMS operations ____

detection ____ decontamination ____ incident handling ____

16. Was the training provided by: (**check all that apply**)

member(s) of the department ____ military personnel ____ private contractor ____

other organization (please list) _____

17. Are first responders trained to respond to incidents involving chemical agents of mass destruction? **YES____ NO____**

18. Have members of your jurisdiction's emergency communications center received special training in determining from callers that an incident may be related to a chemical nerve agent? **YES____ NO____**

19. If a community has all of the following, where do you think is the most likely place for a chemical attack involving sarin or other deadly chemical agent? (**check only one**)

underground train station (subway) ____ shopping mall ____ theme park ____

government building ____ airport ____ other location) _____

20. Do you believe that a chemical attack similar to what happened in Tokyo, Japan will probably occur somewhere in the United States? **YES____ NO____**

21. If the answer to item 20 is **YES**, when? (**check only one**)

1-3 year ____ 3-5 years ____ more than 5 years ____ no opinion ____

22. When the United States experiences another terrorist attack, what do you think the "weapon" of choice will be? (**check only one**)

conventional explosives ____ sarin gas ____ biological agent ____ nuclear device ____

other chemical agent (name) _____ other agent (name)_____

23. What agencies do you believe will have the most impact on minimizing the loss of life from a chemical attack involving a nerve agent such as sarin, soman, or VX? (**check all that apply**)

first responders(fire/rescue/ems) ____ military chemical specialists____

fire dept. hazardous materials response team ____ other _____

24. Has your department had any exercise(s) to evaluate the capabilities of your fire department to handle an incident involving chemical agents? **YES ____ NO ____**

If the answer to item 24 is **YES**, please answer items 25 through 28. If **NO**, go to item 29.

25. How would you rate your fire department's capability to handle such an incident?

not prepared ____ marginally prepared ____ prepared ____ well-prepared ____

26. Did the community hospitals participate in the exercise(s)? **YES ____ NO ____**

27. In your opinion, are the community hospitals prepared to handle mass casualties from exposure to a chemical agent? **YES ____ NO ____**

28. Please list lessons learned from your training exercise(s). Also, list any sources/references that may be helpful to fire departments that have yet to develop a response plan to a terrorist attack involving a chemical agent such as sarin, VX, mustard gas or dual-use hydrogen cyanide (i.e., industrial and chemical).

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

29. Are you aware that the United States Public Health Service is developing a **M**etropolitan **M**edical **S**trike **T**eam for deployment in the Washington, D.C. metropolitan area to a nuclear, chemical or biological incident within 90 minutes of the event?
YES ____ NO ____

30. Does your community have immediate access to large quantities of antidotes (e.g., atropine, 2-pam chloride) necessary to treat mass casualties exposed to the nerve agent sarin? **YES ____ NO ____**

31. Has your department's first responders been trained to do their job without destroying all evidence needed to convict the terrorist? **YES____ NO____**

32. Are personnel trained to look for secondary incidents set to take out first responders? **YES____ NO____**

33. Does your department have **M**aterial **S**afety **D**ata **S**heets (MSDS) for chemical agents such as sarin, soman, VX, and mustard gas? **YES____ NO____** don't know____

34. During an incident, who would the fire department likely call to obtain information about a particular chemical agent such as sarin or soman? (**check all that apply**)

    CHEMTREC ____ National Response Center____ FBI____ National Guard____

    other (name)_____

35. Has your state taken official action to prepare for a terrorist incident involving chemical agents such as sarin and mustard gas? **YES____ NO____** don't know____

    If the answer is **YES**, please summarize the action(s) below:

_____

_____

_____

_____

_____

Thank you again for completing this survey. Hopefully, the applied research project will help the fire service to better prepare for a terrorist attack involving chemical agents.

If you would like to have a copy of the survey results please check here _____.
(Please include your business card.)

Appendix K

SURVEY LETTER
(SAMPLE)

Dear Chief:

I am a third year graduate of the National Fire Academy Executive Fire Officer Development Program. I recently completed the Executive Planning course. It is for this reason that I am writing for your help. I am requesting that you (or your designee) help me by completing the enclosed survey. The data collected will be used in preparation of an applied research paper. The tentative title of the project is Preparing a Fire Department Response Plan to Acts of Terrorism Involving Chemical Agents of Mass Destruction. [Fire Service Planning in Montgomery County to manage the consequences of Terrorism Involving Chemical Warfare Agents.]

As you are aware, terrorism is a growing concern in the United States. The recent bombings of the World Trade Center in New York City and the Alfred P. Murrah Building in Oklahoma City drew attention to the tragic and devastating consequences of terrorism. The earlier sarin attacks in Tokyo provided a warning of the disastrous effect of chemical nerve agents on the human population. In April of 1995, one of the national theme parks was under a threat of a sarin attack.

Because of these attacks and threats, the fire service and other public safety organizations have begun to develop comprehensive response plans. Your completed survey will be very helpful not only to my applied research project but also to the fire departments that do not have a general plan.

In closing, if your department has a response plan to terrorism, I would like to obtain a copy. Your prompt response in completing the enclosed survey will be appreciated.

Thank you.

Sincerely,

Theodore L. Jarboe
Deputy Chief

enclosure:

[final title of applied research paper]

Appendix L

Definitions*

ABSORPTION: The process of an agent being taken in by a surface (clothing, fabrics, wood, etc.), much like a sponge and water.

ACTUAL BREAKTHROUGH TIME: The average time elapsed between initial contact of the chemical with the outside surface of the fabric and the detection time.

ACETYLCHOLINE: A chemical compound formed from an acid and an alcohol which causes muscles to contract (neurotransmitter). It is found in various organs and tissues of the body. It is rapidly broken down by an enzyme, cholinesterase.

ACETYLCHOLINESTERASE: An enzyme (a protein produced in the cells) which stops (inactivates) the action of acetylcholine by separating the acetylcholine into its components of acetic and choline. This occurs as soon as acetylcholine has produced a muscle contraction. Nerve agents combine with acetylcholinesterase to prevent it from performing its inactivation of acetylcholine.

ADSORPTION: The process of an agent sticking to or becoming chemically attached to a surface.

AEROSOLS: A suspension or dispersion of small particles (solids or liquids) in a gaseous medium.

AGENT DOSAGE: The concentration of a toxic vapor in the air multiplied by the time that the concentration is present or the time that an individual is exposed (mg-min/m^3).

ANTICHOLINERGIC: An agent or chemical that blocks or impedes the action of acetylcholine, such as the (also cholinolytic) antidote atropine.

ANTICHOLINESTERASE: A substance which blocks the action of cholinesterase (acetylcholinesterase) such as nerve agents.

ANTIDOTE: A substance which neutralizes toxic agents or their effects.

ARSENICAL: Pertaining to or containing arsenic; a reference to the vesicant lewisite.

ATROPINE: An anticholinergic used as an antidote for nerve agents to counteract excessive amounts of acetylcholine. It also has other medicinal uses.

BLISTER AGENT: A chemical warfare agent which produces local irritation and damage to the skin (vesicant) and mucous membranes, pain and injury to the eyes, reddening and blistering of the skin, and when inhaled, damage to the respiratory tract.

BLOOD AGENT: A chemical warfare agent which is inhaled and absorbed into the blood. The blood (cyanogen) carries the agent to all body tissues where it interferes with the tissue oxygenation process.

CAS REGISTRY NUMBER: A number assigned to a material by the Chemical Abstract Service to provide a single unique identifier.

CEILING EXPOSURE VALUE: The maximum airborne concentration of a biological or chemical agent to which a worker may be exposed at any time.

CHEMICAL AGENT: Any chemical substance which is intended for use in military operations to kill, seriously injure, or incapacitate humans because of its physiological effects.

CHEMICAL AGENT SYMBOL: A code usually consisting of two letters that are used as a designation to identify chemical agents, e.g., GB for the chemical agent sarin.

CHEMICAL CONTAMINATION: The presence of a chemical agent on a person, object, or area.

CHEMICAL WARFARE AGENT: A chemical substance which, because of its physiological, psychological, or pharmacological effects, is intended for use in military operations to kill, seriously injure, or incapacitate humans (or animals) through its toxicological effects. Excluded are riot control agents, chemical herbicides, and smoke and flame agents.

CHOKING AGENTS: These agents exert their effects solely on the lungs and result in the irritation of the alveoli of the lungs. Agents cause the alveoli to constantly secrete watery fluid into the air sacs, which is called pulmonary edema. When a lethal amount of a choking agent is received, the air sacs become so flooded that the air cannot enter and the victim dies of anoxia (oxygen deficiency); also known as a dry land drowning.

CLASSIFICATION OF CHEMICAL AGENTS: Chemical agents are classified according to their physical state, use and physical action.

CONCENTRATION: The amount of a chemical agent present in a unit volume of air, usually expressed in milligrams per cubic meter (mg/m^3).

CONCENTRATION TIME: The amount of a chemical agent present in a unit volume of air multiplied by the time an individual is exposed to that concentration.

CONJUNCTIVITIS: Redness in the eyes.

CONSEQUENCE MANAGEMENT: Measures to alleviate the damage, loss, hardship, or suffering caused by emergencies. It includes measures to restore essential government service, protect public health and safety, and provide emergency relief to affected governments, businesses, and individuals.

CONTAINMENT: The attempt to prevent the spreading of contamination by holding it in, enclosing, encapsulating, or by controlling it.

CRISIS MANAGEMENT: Measures to resolve the hostile situation, investigate, and prepare a criminal case for persecution under Federal law.

CRYOGENICS: Materials which exist at extremely low temperatures, such as nitrogen.

CUMULATIVE: Additional exposure rather than repeated exposure. For example, a one hour exposure of HD followed within a few hours by another exposure of one hour, had the same effect as a single exposure lasting for two hours.

DECONTAMINATION: The process of neutralizing or removing contaminants that have accumulated on personnel, clothing, and equipment.

DESORPTION: The reverse process of absorption. The agent will be "removed" from the surface (out gassing).

DILUTION FACTOR: Dilution of contaminated air with uncontaminated air in a general area, room or building for the purposes of health hazard or nuisance control, and/or for heating and cooling.

DOSAGE: The concentration of a chemical agent in the atmosphere (C) multiplied by the time (t) the concentration remains, expressed as mg-min/m^3. The dosage (Ct) received by a person depends upon how long he is exposed to the concentration. That is, the respiratory dosage in mg-min/m^3 is equal to the time in minutes as individual is unmasked in an agent cloud multiplied by the concentration of the cloud. The dosage is equal to the time of exposure in minutes of an individual's unprotected skin multiplied by the concentration of the agent cloud.

DOWNWIND DISTANCE: The distance a toxic agent vapor cloud will travel from its point of origin, with the wind.

EVAPORATION RATE: The rate at which a liquid changes to vapor at normal room temperature.

HYDRATION: The combining of a substance with water.

HYDROLYSIS: The reaction of any chemical substance with water by which decomposition of the substance occurs and one or more new substances are produced.

HYDROLYSIS PRODUCTS: Those new substances formed when a chemical agent or compound reacts with or is decomposed by water.

IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH): An atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere.

IMPERMEABLE PROTECTIVE CLOTHING: Protective clothing that does not allow penetration of gas and liquid, or evaporation of perspiration. Designed primarily for protection of personnel engaged in extremely hazardous decontamination or other special operations involving life threatening danger from liquid or high concentrations of vapor from chemical warfare agents.

IMPROVISED EXPLOSIVE DEVICES (IED): Devices placed or fabricated improvisational incorporating destructive, lethal, noxious, pyrotechnic, or incendiary chemicals, designed to destroy, disfigure, distract, or harass. They may incorporate military stores, but are normally devised from nonmilitary or commercial components.

INCAPACITATING AGENT: An agent that produces physiological or mental effects, or both, that may persist for hours or days after exposure, rendering an individual incapable of performing his or her assigned duties.

INITIAL DOWNWIND VAPOR HAZARD AREA: Areas initially establish to evacuate all unprotected personnel and to prevent other unprotected personnel from entering and thus encountering agent vapors or any other type of contamination.

INTEGRATED EMERGENCY COMMAND STRUCTURE (IECS): A system that allows for the integration of both career and volunteer fire/rescue personnel by equal rank for purposes of on scene incident command. (Montgomery County fire service definition.)

LATENT PERIOD: Specifically, in the case of mustard, the period between exposure and onset of signs and symptoms; otherwise, an incubation period.

LETHAL CHEMICAL AGENT: An agent that may be used effectively in a field concentration to produce death.

LIQUID DOSAGE: The weight of a liquid agent received by a person on his skin is usually expressed as dosage in milligrams of contaminant per kilogram of body weight (mg/kg). This is equivalent to parts per million (ppm).

MEDIAN INCAPACITATING DOSAGE (ICT50): The volume of a chemical agent vapor or aerosol inhaled that is sufficient to disable 50% of exposed, unprotected people (expressed as mg-min/m^3).

MEDIAN LETHAL DOSAGE (LCT50): The dosage of a chemical agent vapor or aerosol inhaled that is lethal to 50% of exposed, unprotected people (expressed as mg-min/m^3).

MEDIAN LETHAL DOSAGE (LD50): The amount of liquid chemical agent expected to kill 50 percent of a group of exposed, unprotected individuals.

MEDIAN INCAPACITATING DOSAGE (ID50): The volume of a liquid chemical agent expected to incapacitate 50% of a group of exposed, unprotected individuals.

METHOD OF DISSEMINATION: The way a chemical agent or compound is finally released into the atmosphere.

MIOSIS: A condition where the pupil of the eye becomes contracted (pinpointed) which impairs night-vision.

M8 CHEMICAL AGENT DETECTOR PAPER: A paper used to detect and identify liquid V- and G-type nerve agents and H-type blister agents. It does not detect chemical agent vapors.

M256 KIT: A kit that detects and identifies vapor concentrations of nerve, blister, and blood agents.

NERVE AGENTS: Agents which effect the transmission of nerve impulses by reacting with the enzyme cholinesterase, permitting an accumulation of acetylcholine and continuous muscle stimulation. The muscles tire due to over-stimulation and begin to contract.

NON-PERSISTENT AGENT: An agent that remains in the target area(s) for a relatively short period of time. The hazard, predominantly vapor, will exist for minutes or, in exceptional cases, hours after dissemination of the agent. As a general rule, a non-persistent agent duration will be less than 12 hours.

ORGANOPHOSPHATE: A compound with a specific phosphate group which inhibits acetylcholinesterase. Used in chemical warfare and as an insecticide.

PERMEABLE PROTECTIVE CLOTHING: Protective clothing made of materials that absorb or neutralize vapors, aerosols, and small liquid droplets of chemical warfare agents, but allow a degree of evaporation of perspiration.

PERMEATION: The process by which a chemical moves through a protective clothing.

PERMEATION RATE: The rate at which the challenge chemical permeates the fabric.

PERSISTENCY: An expression of the duration of effectiveness of a chemical agent, dependent on physical and chemical properties of the agent, weather, method of dissemination, and terrain conditions.

PERSISTENT AGENT: An agent that remains in the target area for longer periods of time. Hazards from both vapor and liquid may exist for hours, days, or in exceptional cases, weeks or months after dissemination of the agent. As a general rule, persistent agents duration will be greater than 12 hours.

PHYSIOLOGICAL ACTION: Most toxic chemical agents are used for their toxic effects that is to produce a harmful physiological reaction when applied to the human body externally, or when breathed, or taken internally. This reaction of chemical agents, within the body or on the body, is the physiological action.

QUICK MASK^{TM}: An emergency respiratory protective device which can reduce the health risks and mortality rates associated with inhalation of toxic air.

RATE OF ACTION: The rate at which the body reacts to or is affected by a chemical substance or material.

RATE OF DETOXIFICATION: The rate at which the body can counteract the effects of a poisonous chemical substance.

RATE OF HYDROLYSIS: The rate at which the various chemical agents or compounds are decomposed by water.

RECONNAISSANCE (RECON): A primary survey to gather information).

RESPIRATORY DOSAGE: This is equal to the time in minutes an individual is unmasked in an agent cloud multiplied by the concentration of the cloud.

RHINORRHEA: A runny nose.

SAW MINICAD: A pocket sized instrument that monitors for trace levels of chemical agents. It can detect both nerve and blister agents simultaneously.

SENSITIZE: To become highly responsive or easily receptive to the effects of toxic chemical agents after the initial exposure.

SHORT TERM EXPOSURE LIMIT (**STEL**): A 15-minute time-weighted average exposure which should not be exceeded at any time during a work day even if the 8-hour time-weighted average (TWA) is within the threshold limit value (TLV). Exposures at the STEL should not be repeated more than four times a day and there should be at least 60 minutes between successive exposures at the STEL.

SKIN DOSAGE: This is equal to the time of exposure in minutes of an individual's unprotected skin multiplied by the concentration of the agent cloud.

SOLUBILITY: The ability of a material to dissolve in water or another liquid.

SOLVENT: A material which is capable of dissolving another chemical.

SOURCE STRENGTH: The weight of a chemical agent that is at the chemical accident/incident site and may be released into the environment.

SPECIFIC GRAVITY: The weight of a liquid compared to the weight of an equal volume of water.

TEAR AGENTS: Compounds which cause a large flow of tears and intense eye pain and irritation of the skin.

TIME-WEIGHTED AVERAGE (TWA): The average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed without adverse effect.

TOXICITY: The property a material possesses which enables it to injure the physiological mechanism of an organism by chemical means, with the maximum effect being incapacitation or death.

UPWIND: In or toward the direction from which the wind blows. To be upwind of an item, the wind would be blowing from your position to the item.

URTICANT: A chemical agent that produces irritation at the point of contact, resembling a stinging sensation, such as a bee sting. For example, the initial physiological effects of phosgene oxime (CX) upon contact with a person's skin.

URTICARIA: A skin condition characterized by intensely itching red, raised patches.

VAPOR DENSITY: A comparison of any gas or vapor to the weight of an equal amount of air.

VAPOR PRESSURE: The motion of the escaping molecules of a liquid in an enclosed container is confined to the vapor space above the surface of the liquid. As an increasing number of molecules strike and reenter the liquid, a point of equilibrium is eventually reached when the rate of escape of molecules from the liquid equals the rate of return to the liquid. The pressure exerted by the escaping vapor at the point of equilibrium is called vapor pressure.

VESICANT AGENT: An agent that acts on the eyes and lungs and blisters the skin.

VESICLES: Blisters on the skin.

VISCOSITY: The degree to which a fluid resists flow.

VOLATILITY: With chemical agents, it refers to their ability to change from a liquid state into a gaseous state. (The ability of a material to evaporate.)

VOMITING AGENT: Compounds which cause irritation of the upper respiratory tract and involuntary vomiting.

WHEAL: An acute swelling of the skin. This condition is common to a bee sting.

Source: Harris (1996, July), and others

*Most of these definitions were taken from a booklet prepared by Jef L. Harris, Geomet Technologies, Inc., titled Chemical warfare agents or chemical surety material properties. Other definitions were from several other resources including the course book provided by the U.S. Army Chemical School, titled Chemical/biological countermeasures course. Some definitions are for regional or local application and were listed by the author.

Appendix M

Gas Warfare Agents
Draeger Gas Detection Tubes

Agents	Draeger Tube	Part Number
Lewisite (L)	Organic Arsenic Compounds	CH26303
Sulfur Mustard (HD)	Thioether	CH25803
Nitrogen Mustard (HN)	Organic Basic Nitrogen Compounds	CH25903
Sarin (GB), Soman (GD) Tabun (GA)	Phosphoric Acid Esters	6728461
Cyanogen Chloride (CK)	Cyanogen Chloride 0.25/a	CH19801
Phosgene (CG)	Phosgene 0.25/b	CH28301
Hydrogen Cyanide (AC)	Hydrocyanic Acid 2/a	CH25701

Source: Gas Detection Unit - Northeast Division
National Draeger, Inc.

Appendix N

Lessons Learned from Chemical Agent-related Training Exercises (reported by 13 respondents)

1. Hospitals will not initially recognize the scope of the incident.

2. Law enforcement agencies and others are not trained and therefore are not held to an Incident Command System. This can cause confusion and lack of coordination.

3. When hospitals finally do recognize the scope of the incident they do not notify the fire departments.

4. Detection equipment is of little value in the initial assessment. The best indicators are signs/symptoms presented by victims.

5. For decontamination to be provided in a timely manner, it must be "down and dirty." Use water deluge, with little time/manpower committed to runoff. (Life saving actions must take precedence over environmental considerations). Complete stripping of victims' clothing is essential to maximum decontamination. With most contaminated victims presenting a vapor hazard to responders, decon personnel must be adequately protected by SCBA and full turnout protective clothing with chemical gloves. (Exceptions would include blast victims with liquid agent contamination, i.e., those closest to the point of release.)

6. Equipment will be needed to adequately mitigate a terrorist attack.

7. Department training and drill will be necessary.

8. Interagency drills will be needed.

9. Metro area drills will be necessary.

10. FBI and other Federal agencies will be involved.

11. Local SOPs must anticipate EMS/hospital involvement. Police bomb technicians are not haz mat technicians. Explosives may be employed to disperse contaminants.

12. Emergency room and hospital staff must be trained for NBC countermeasures and be aware of NBC signs and symptoms for walk-ins. EMS must also have awareness of and protect against exposure to NBC.

13. "Clean rooms" are not available in most hospitals. Separate HVAC and isolation will eliminate risk of exposure to other patients and personnel.

14. Sarin-type incidents permit only a 10-minute window to respond, decontaminate, and transport victims.

15. Most communities do not have access to response by trained military personnel who have equipment and medications.

16. **All** terrorist acts are crimes that fall under the exclusive authority of the FBI. Preservation of evidence is extremely important.

17. Suppression and EMS must prevail at incidents with mass casualties that are also crime scenes.

18. Communities should be prepared for all contingencies and stockpile countermeasures or seek State and Federal support for these resources.

19. Resources to address needs beyond the local level should be obtained through emergency management officials at some early level.

20. First responders need more training.

21. EMS providers are not aware of the dangers of NBC environments.

22. No national, State, or local government agency is a clearing house for (NBC) resource material.

23. Fire/Rescue personnel should train with military units, since they have the most experience in nerve and biological agents.

24. We are not adequately prepared for any first responder role to a terrorist act that has secondary emissions or explosions specifically designed to neutralize or kill these responders.

25. Do not limit your focus to nerve agents. Blood and choking agents along with other toxins (ricin) are easy to obtain and can be equally threatening. Military resources and Department of Defense (DOD) are excellent trainers regarding technical information. Fire department planners need to invest time identifying local, State, and Federal capabilities.

26. We were able to point out and emphasize to other city agencies the limitations of our haz mat team in dealing with a terrorist attack. We had a problem identifying the chemical agent with our current equipment.

27. Law enforcement agencies, both Federal and local, are less than forthright concerning terrorist threats and intelligence.

28. Agencies that profess proficiency in haz mat response are often inadequately trained in incident command, site access control, and decontamination.

29. Local fire departments and haz mat teams lack the necessary equipment to detect chemical/biological agents effectively.

30. Fire departments and haz mat teams lack equipment to treat chemical/biological agent patient exposures.

31. Fire departments and haz mat teams lack decontamination resources to mitigate mass casualty exposures.

32. The military has detection, rapid entry, and treatment resources.

33. Military resources will not be readily available.

34. Fire departments and haz mat teams can work effectively with the military.

35. Fire departments and haz mat teams need resources the military uses to act in a timely fashion at these incidents.

Appendix O
Chemical Warfare Agents
Poisoning/Exposure
Signs and Symptoms

Nerve Agents

Initial Symptoms

Dimness of vision (Miosis)

Runny nose

Advanced Symptoms

Difficulty breathing

Twitching

Jerking and staggering

Tightness in chest

Nausea/Vomiting/Cramps

Involuntary defecation and urination

Frontal headaches

Confusion/Drowsiness

Convulsions/Coma

Source: Ron Lauck and Tom Schmidt (NBC awareness training presentation) (Atlanta, Georgia, Cobb County Fire Grounds, August 1996)

Blister Agent (Mustard)

Symptoms

Early phase - reddening of the skin; severe itching

Vesication phase - blisters form between 12-24 hours (average 24 hours)

Necrosis - affected tissues begin to decay and die

Blister Agent (Urticant)

Vapor - eyes and nose with strong irritation of mucous membranes

Solid/liquid - skin effects are strong stinging sensation similar to bee stings are immediate

Note: Blanching of skin (surrounded by reddening) within 30 seconds, welt forms in 30 minutes; blanched area turns brown in 24 hours

Source: Ron Lauck and Tom Schmidt (NBC awareness training presentation) (Atlanta, Georgia, Cobb County Fire Grounds, August 1996)

Blood Agent Symptoms

Initial Symptoms

Changes in breathing rates

AC - strong stimulated breathing

CK - strong, irritating, choking effects, slows breathing

Headaches

Happy-go-lucky feeling (giddiness)

Advanced Symptoms

Violent convulsions, unconsciousness with occasional shallow gasps

AC - lips and skin will turn red

CK - lips and skin will turn blue tinge

Note: Death will occur within 4-6 minutes
Either death occurs rapidly or recovery takes place after removal from toxic area.

Source: Ron Lauck and Tom Schmidt (NBC awareness training presentation)
(Atlanta, Georgia, Cobb County Fire Grounds, August 1996)

Choking Agents

Initial Symptoms

Dry/sore throat

Tearing of eyes

Tightness in the chest

Coughing

Nausea/vomiting

Headache

Advanced Symptoms

Severe coughing-up of frothy phlegm

Convulsions

Pulmonary edema

Note 1: Irritation quickly disappears when exposure is ended, and a symptomless period of 2-6 hours elapses before pulmonary edema sets in.

Note 2: The onset of pulmonary edema is indicated by uneasiness, fear and productive cough with white or yellow phlegm, often bloody.

Note 3: Nausea, vomiting, and gastric pain is common. Breathing is rapid, pulse is fast and faint. Shock develops and the patient may die from heart failure or lack of oxygen.

Source: Ron Lauck and Tom Schmidt (NBC awareness training presentation) (Atlanta, Georgia, Cobb County Fire Grounds, August 1996)

Appendix P
Indicators of a Possible Chemical Incident

Dead animals/birds/fish

Not just an occasional roadkill, but numerous animals (wild and domestic, small and large), birds, and fish in the same area.

Lack of insect life

If normal insect activity (ground, air, and/or water) is missing, then check the ground/water surface/shore line for dead insects. If near water, check for dead fish/aquatic birds.

Blisters/Rashes

Numerous individuals experiencing unexplained water-like blisters, wheals (like bee stings), and/or rashes.

Mass casualties

Numerous individuals exhibiting unexplained serious health problems ranging from nausea to disorientation to difficulty in breathing to convulsions to death.

Definite pattern of casualties

Casualties distributed in a pattern that may be associated with possible agent dissemination methods.

Illness associated with confined geographic area

Lower attack rates for people working indoors versus outdoors, or outdoors versus indoors.

Unusual liquid droplets

Numerous surfaces exhibit oily droplets/film; numerous water surfaces have an oily film. (No recent rain).

Areas that look different in appearance

Not just a patch of dead weeds, but trees, shrubs, bushes, food crops, and/or lawns are dead, discolored, or withered. (No current drought.)

Unexplained odors

Smells may range from fruity to flowery to sharp/pungent to garlic/horseradish-like to bitter almonds/peach kernels to new mown hay. It is important to note that the particular odor is completely out of character with its surroundings.

Low-lying clouds

Low-lying cloud/fog-like condition that is not explained by its surroundings.

Unusual metal debris

Unexplained bomb/munitions-like material, especially if it contains a liquid. (No recent rain.)

Unusual numbers of sick or dying people or animals

Any number of symptoms may occur. As a first responder, strong consideration should be given to calling local hospitals to see if additional casualties with similar symptoms have been observed. Casualties may occur minutes or hours to days or weeks after an incident has occurred. The time required before symptoms are observed is dependent on the agent used.

Unscheduled and unusual spray being disseminated

Especially if outdoors during periods of darkness.

Abandoned spray devices

Devices will have no distinct odor.

Source: Interagency Intelligence Committee on Terrorism
Chemical/Biological Incident Handbook (1995, June)

Appendix Q

Personnel Protective Clothing

DuPont Tychem Line of Chemical Barrier Fabrics
Chemical Warfare Permeation Data

Fabric	Agent	Protocol	Breakthru Time	Minimum Detectable Permeation ($\mu g/cm^2$)	Average Observed Permeation ($\mu g/cm^2$)
					nd
					0.121@ 8 hrs.
Tychem 7500	L	DN4	>12 hours	<0.0120	1.484@12 hrs
" "	HD	DN4	>12 hours	<0.2000	nd
" "	GA	DN6	>12 hours	<0.0002	"
" "	GB	DN6	>12 hours	<0.0002	"
" "	GD	DN6	>12 hours	<0.0002	"
" "	VX	DN6	>12 hours	<0.0002	"
Tychem 9400	L	DN3	>12 hours	<0.0060	"
" "	HD	DN3	>12 hours	<0.1000	"
" "	GA	DN5	>12 hours	<0.0001	"
" "	GB	DN5	>12 hours	<0.0001	"
" "	GD	DN5	>12 hours	<0.0001	"
" "	VX	DN5	>12 hours	<0.0001	"
Tychem 10,000	L	DN4	>12 hours	<0.0120	"
" "	HD	DN4	>12 hours	<0.2000	"
" "	GA	DN6	>12 hours	<0.0002	"
" "	GB	DN6	>12 hours	<0.0002	"
" "	GD	DN6	>12 hours	<0.0002	"
" "	VX	DN6	>12 hours	<0.0002	"

L - Lewisite HD - Distilled Sulfur Mustard GB - Sarin
GA - Tabun GD - Soman VX - no alias
Tests ran in triplicate.

Protocol DN3 - MIL-STD-282, Method T-209 (HD) or modified for Lewisite, for 12 hours. 10 cm^2 sample smeared with HD or L, to 10 g/m^2 concentration.

Protocol DN4 - MIL-STD-282, Method T-209 (HD) or modified for Lewisite, for 12 hours. 10 cm^2 sample smeared with HD or L, to 100 g/m^2 concentration.

Protocol DN5 - MIL-STD-282, Method T-208 (GB) or modified for GA, GD, and VX, for 12 hours. 10 cm^2 sample smeared with GA, GB, GD, or VX, to 10 g/m^2 concentration.

Protocol DN6 - MIL-STD-282, Method T-208 (GB) or modified for GA, GD, and VX, for 12 hours. 10 cm^2 sample smeared with GA, GB, GD, or VX, to 100 g/m^2 concentration.

Source: DuPont Advanced Fiber Systems

Military Tyvek "F"
Barrier Against Chemical Warfare Agents

Detected Agent	Breakthrough Time (Hours)	Temperature	Remarks
Mustard	> 48	37°C	Enclosed
Lewisite	1.25 - 1.75	37°C	Enclosed
Lewisite	2 - 6	37°C	Open
Lewisite	> 24	30°C	Open
Lewisite	> 24	26°C	Open
Mustard (Lewisite/ Mustard 2:1 Mixture)	> 24 > 24	37°C 26°C	Open Open
Sarin	> 24	30°C	Enclosed

Source: DuPont, Inc.

U.S. Military Chemical Protective Suit
MOPP (Mission Oriented Protective Posture)

Levels of Protection

Equipment	MOPP 0	MOPP 1	MOPP 2	MOPP 3	MOPP 4
Mask (MCU-2P)	carried	carried	carried	carried	worn
BDO	readily available	worn	worn	worn	worn
OBP	carried	carried	worn	worn	worn
Gloves (butyl)	carried	carried	carried	worn	worn

BDO - Battle Dress Outergarment
OBP - Over boot protection

Source: Captain W. Bradford "Chip" Chase, personal communication, December 11, 1996.

QUICKMASK
(Respiratory Protective Escape Mask)

INFOPACK

Charcoal Cloth Filter Performance

Test Gas	IDLH Concentration (ppm)	Test Concentration (ppm)	Time Before Breakthrough (minutes)
Acrolein	5.0	100.0	16.5
Ammonia	500.0	500.0	15.0
Ammonia	500.0	500.0	8.0
Chlorine	25.0	1000.0	> 60.0
Chlorine	25.0	100.0	27.0
Chlorine	25.0	500.0	17.0
Hydrogen sulphide	300.0	200.0	46.0
Hydrogen sulphide	300.0	500.0	18.0
Hydrogen cyanide	50.0	400.0	19.5
DMMP*	13.0	276.0	> 60.0
Sulfur dioxide	100.0	100.0	54.0
Sulfur dioxide	100.0	500.0	13.0
Tear gas	16.0	16.0>	75.0

* DMMP possesses chemical properties common to the organophosphorus nerve agents, including Sarin, Tabun and Soman, and is used by the U.S. Army as a stimulant in these types of penetration tests.

Notice: This device does not filter carbon monoxide - a lethal gas associated with fire.

The performance data listed above is a summary of lab tests conducted by Miller-Nelson Research, Inc., Monterey, CA.

IDLH is the concentration of gas which can cause Immediate Danger to life or Health. Gas concentration are expressed in terms of "ppm" or parts per million.

The QuickMask particulate filter is rated at 99% efficient for solid particles 0.3 of a micron and larger.

QuickMask has been extensively field tested against all types of police chemical weapons including CS, CN and OC.

QuickMask is manufactured in Israel under ISO 9002 Quality Control Standards

The above chart is a summary of the test gases and is not complete.

Source: Fume Free, Inc.

Minimum Chemical Agent Breakthrough Times for Gloves

Glove Thickness (mil)	Minimum Breakthrough Times (min)	
	Mustard (HD)	Nerve (GB)
25	360	450
14	240	450
7	75	360

The chemical protective cloth set consists of an outer glove for chemical protection and an inner cotton liner for perspiration absorption. When engaged in heavy work, or when in cold weather, leather work gloves should be worn over the chemical protective gloves.

The outer gloves are made of an impermeable black butyl rubber. The thickness of glove required varies with the type of duty to be performed. The 7-mil glove provides extreme tactility, sensitivity, or both, while the 14-mil glove provide normal tactility and sensitivity. The 7-mil and 14-mil gloves should not be exposed to harsh treatment. The 25-mil glove is more durable and may be used for heavy labor. The permeable liners for all gloves are made of either 100% cotton or 50% cotton/50% acrylic, and can be worn on either hand.

Source: Argonne National Laboratory (1994, August)

Appendix R

Chemical Warfare Agent Incident Mitigation Action Tips (MATs)

1. Consider use of positive pressure ventilation (PPV) to dilute, disperse, or otherwise move chemical vapors away from endangered people and responding personnel.

2. Use the GO or NO GO factors in decisionmaking (i.e., personnel, equipment, protection, and time). If there are not enough trained personnel, suitable equipment, appropriate PPE, or enough time to mount an offensive operation, consider a defensive posture.

3. Be sure personnel have donned their PPE before committing them to action.

4. Remember most CWAs are heavier than air.

5. Limit the number of personnel exposed to the CWA and limit the duration of exposure. Rotate crews.

6. Expect to find chaos during the early moments of a CWA incident. Don't become a victim of it, but rather work to gain control of the scene.

7. Beware that individuals exposed to CWA could be contaminated. "Off-gassing" ("out-gassing") of the CWA could occur later.

8. Implement the Incident Command (management) System.

9 Use a unified incident command when multi-agencies are involved and the incident involves many casualties.

10. Consider sending haz mat teams to hospitals to assist with decontamination of "walk-in" victims. Decontamination should occur outside the hospital. The local haz mat team should report directly to the scene to help identify the chemical agent, set up decontamination area, and conduct RECON.

11. Decontaminate victims as soon as possible. Time is crucial to the health and safety of the victims and the rescuers.

12. Establish the three operating zones: hot, warm, and cold. Restrict entry into the hot zone to personnel wearing level "A" protection; and the warm zone to personnel wearing level "B" or "C" protection.

13. Implement an accountability system for both personnel and victims.

14. Beware of a secondary explosive device and/or CWA release.

15. Take note of the surroundings upon approaching the scene. Don't get overly occupied with the uniqueness of the incident. If explosives were used, be alert for common hazards such as downed power lines, weakened walls, escaping gas, etc.

16. Consider using buses to transport large numbers of casualties.

17. Consider spraying clothed victims with decontamination solution if liquid contact with a CWA is suspected. Then allow them to disrobe with privacy at a designated location.

18. Be careful not to apply (spray) decon solution on the victim's eyes and face.

19. Consider the use of 0.5 or 5.0 percent bleach solution (sodium hypochlorite) or HTH (calcium hypochlorite solution) to decontaminate victims.

20. Consider the feasibility of using an inert cryogenic (e.g., liquid nitrogen) to "freeze" liquid agent to stop vapor formation and for safe removal.

21. Remember to locate staged personnel and apparatus upwind and upgrade.

22. Consider the feasibility of using fans to blow bleach "vapors" into area containing released chemical nerve agent in an attempt to neutralize it

23. Consider the feasibility of adding granular calcium hypochlorite to a pumper's tank water to create a 0.5 or 5.0 percent calcium hypochlorite solution. Using a hoseline, this solution could be used to spray the clothing of mass casualties exposed to a chemical warfare.

24. Consider benefit of using foam (AFFF) to cover "pool" of CWA liquid to help suppress vapors.

25. Consider the benefit of using megaphones (bull horns) when giving instructions to a large crowd, including the "walking" casualties.

Source: Random thoughts compiled by the author