SUPPLEMENT 14

Emergency Response to Incidents Involving Chemical and Biological Warfare Agents

Lt. Col. John Medici, U.S. Army Chemical Corps, retired, Hazardous Materials Officer for Prince William County, Virginia; and Steve Patrick, Hazardous Materials Officer, Virginia Department of Emergency Services.

This supplement, Emergency Response to Incidents Involving Chemical and Biological Warfare Agents, was originally published as part of the *Hazardous Materials Response Handbook* (third edition). As with all the materials in the handbook, use of this material is subject to the following Notices:

Notice Concerning Code Interpretations: This third edition of *Hazardous Materials Response Handbook* is based on the 1997 editions of NFPA 471, *Recommended Practice for Responders to Hazardous Materials Incidents*; NFPA 472, *Standard for Professional Competence for Responders to Hazardous Materials Incidents*; and NFPA 473, *Standard for Competencies for EMS Personnel Responding to Hazardous Materials Incidents*. All NFPA codes, standards, recommended practices, and guides are developed in accordance with the published procedures of the NFPA technical committees comprised of volunteers drawn from a broad array of relevant interests. The handbook contains the complete text of NFPA 471, NFPA 472, and NFPA 473 and any applicable Formal Interpretations issued by the Association. These documents are accompanied by explanatory commentary and other supplementary materials.

The commentary and supplementary materials in this handbook are not a part of NFPA 471, NFPA 472, and NFPA 473 and do not constitute Formal Interpretations of the NFPA (which can be obtained only through requests processed by the responsible technical committees in accordance with the published procedures of the NFPA). The commentary and supplementary materials, therefore, solely reflect the personal opinions of the editor or other contributors and do not necessarily represent the official position of the NFPA or its technical committees.

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Lt. Col. John Medici, U.S. Army Chemical Corps, retired, Hazardous Materials Officer for Prince William County, Virginia; and Steve Patrick, Hazardous Materials Officer, Virginia Department of Emergency Services.

Editor's Note: *There are many similarities between handling a hazardous materials incident and an incident involving chemical and biological agents. The real difference occurs during the identification phase. Keep in mind as you read this supplement that the person(s) responsible for creating the hazard through criminal or terrorist activity has aimed at injury or destruction and does not want you or the public to detect or identify the chemical or biological agent at the scene. This is truly a worst-case scenario.*

Introduction

International terrorism has been a global issue and threat for many years. These events, for the most part, have

occurred in other countries. Recently, two terrorist acts in the United States—the World Trade Center and Oklahoma City Federal Building bombings—have heightened awareness of this threat within our borders.

Terrorist acts may be carried out by either groups or individuals but the patterns of terrorism are rapidly changing. Emerging alliances of extremist and radical elements transcend the customary national, political, religious, and ethnic boundaries that formerly marked these activities. The frequency of terrorist attacks fluctuates annually, and, for a while, the number of incidents seemed to decrease. However, even as the number of incidents in a year has dwindled, there has been an unsettling trend toward ever increasing viciousness in the nature of the attacks and the resultant loss of human life and property damage. This recent trend has manifested itself terribly in the United States. Had the desired damage been inflicted on the World Trade Center, the carnage would have been horrendous. It is also not easy to forget the pictures of those killed and injured in Oklahoma City.

Along with the increasing trend toward more spectacular and destructive terrorist acts, an even more disturbing element has emerged. The recent terrorist use of a deadly chemical agent by the extremist group in Japan poses a formidable challenge that has far reaching implications for emergency responders. The use of a military chemical agent in Japan signifies the introduction of weapons of mass destruction into the terrorists' arsenals. The March 1995 nerve agent release in the Tokyo subway resulted in over 5000 casualties. There are reports that many of the most seriously injured were emergency responders who were unaware of the dangers they were facing.

The use of weapons of mass destruction has prompted emergency response agencies worldwide to reevaluate current plans and capabilities. It is essential to expand the scope of knowledge of all emergency responders concerning chemical and biological agents in order to be prepared to operate safely and effectively should the need arise.

In addition to the challenges posed by the possible use of chemical and biological agents by extremists, emergency responders in other countries have found themselves to be targets as part of an individual's or organization's attempt to carry out a terrorist act. Although security issues are beyond the scope of this manual, all emergency responders are advised to consider the ramifications of becoming targets and to exercise extreme caution when reacting to a real or suspected terrorist act.

This supplement is intended as a chemical and biological primer. It integrates technical information regarding chemical and biological agents into existing hazardous materials response incident management, training, operations, and planning principles.

Chemical and Biological Agents: An Overview

Chemical and biological agents are classes of hazardous materials that are unique to military arsenals and are usually classified as secret or top secret. As such, the characteristics of these agents are difficult to recognize, identify, and treat and are unfamiliar to most emergency responders. These agents can be lethal in extraordinarily small concentrations and can be released on a target or into the environment by various surreptitious and relatively unsophisticated methods.

At an incident site, acquiring necessary information about these agents may be much more difficult than it is to obtain data about other hazardous materials. This document is a compilation of the unclassified technical information needed to fill that void. This information, once understood and integrated into local jurisdictions' training programs, will provide a foundation upon which an effective response to such exposures can be planned, organized, and implemented.

History of Chemical Agents

Even though there are more than 100 known types of chemical warfare agents, only a small number of these have actually been used in warfare. In fact, World War I represents the only large-scale use of chemical agents. After that war, development of chemical agents continued but major battlefield use did not. Indeed, significant efforts have been underway to ratify banning the use of chemical weapons.

The first chemical warfare agent used in World War I against the Allies by the Germans was *chlorine,* followed later by *phosgene*. Initially, the chemicals used as agents on the battlefield were common industrial chemicals. Chlorine, especially, is still in widespread use. These first agents were indeed true gases when released. Consequently, the term *poison gas* was used to describe them. However, the continued use of the term *gas* is a misnomer. Most common agents in chemical warfare arsenals are actually liquids.

Later in World War I, the Germans introduced the *mustard agents*. The mustard agents caused the majority of the chemical casualties in the war. Prior to World War II, Germany began development of *nerve agents.* Even today these agents are regarded as the most toxic of the chemical warfare agents.

The German development and use of mustard agents, followed by the development of the nerve agents, demonstrated the military value of programs designed to synthesize, test, produce, and stockpile chemicals expressly to be used as weapons. After the war, both the United States and the Soviet Union, building on captured German agent technology, embarked on extensive research and development programs that resulted in the production and stockpiling of thousands of tons of chemical agents and munitions. Other nations

also continued research and development programs and acquired chemical weapons.

During the 1960s, 1970s, and 1980s, chemical agents once again emerged as a very real threat. Egyptians used mustard agent in Yemen. In Vietnam, the United States used irritating agents and defoliant chemicals. In the Iran–Iraq war the Iraqis used both mustard gas and nerve agents.

Early in the 1990s, the threat of Iraq's chemical and biological weapons was a major concern during the Gulf War. Just recently, admissions by former Iraqi military officials regarding the possession and readiness of nerve and biological weapons have been reported in the media.

However, the 1995 incident in the Tokyo subway system involving the release of nerve agent sarin by an extremist group is the first time a chemical agent has been used for terrorism in a major metropolitan area. In Japan, a small nerve gas release incident reported in June 1994 killed 7 people. In the second, more widely publicized attack in March 1995, 12 deaths and over 5000 casualties were reported.

The Role of the Emergency Responder

Before emergency response personnel can hope to be effective at the scene of a chemical agent incident, they must be aware of the nature and characteristics of chemical agents. This awareness is essential for self-protection; it also provides the capability to render aid and assistance to those affected.

While not generally considered lethal, a few incidents involving military irritating agents happen every year. In 1992 a CS tear canister was discharged inside a high school in Spostylvania County, Virginia, causing injuries to students as well as responding fire fighters. In 1995, CS from a military training exercise in Caroline County, Virginia, traveled to a state roadway injuring motorists as well as responding fire fighters.

In addition to the use of chemical agents in battle and in deliberate terrorist acts, numerous sites have been identified as containing or are suspected to contain buried chemical agents and munitions. Discovery and remediation activities at these sites have resulted in evacuations as well as extensive excavations. In 1994, residents in the Spring Valley development in Washington, D.C., were evacuated when such a site was discovered.

Awareness Equals Readiness

All emergency responders should recognize the proximity of a potential terrorist target within their community (such as military installations, federal and state offices, etc.), but these should not be considered the only threatened locations. Chemical and biological agents must be produced, packaged, and delivered to the intended place of use. Emergency responders should

not be complacent because there are no obvious terrorist targets in their first-due area. The Japanese agent was produced in a chemical plant expressly designed and built to produce agents. The agents were then transported and used first in Masumoto and months later in Tokyo with reported testing along the way in a remote location in Australia. The materials for the bombs that were detonated in New York City and Oklahoma City were collected, stored, and finally fabricated at distant locations and the resulting bombs were transported to the targets along heavily congested roads through densely populated areas.

Consequently, emergency responders should be sensitive to the possibility of discovering a clandestine laboratory that is making something other than designer drugs, a storage locker filled with unusual chemicals, or an unplacarded vehicle containing an unexpected cargo.

Another ominous possibility results from the current availability of chemical agent information from underground publishers, as well as on the computer networks that comprise the growing information superhighway. The potential of a botched experiment with recipes obtained from books or the Internet should not be considered unlikely.

CHEMICAL AGENTS

Today, the most common chemical agents are those chemicals expressly selected and produced because of their ability to cause injury or incapacitation. Chemical warfare agents are generally classified into broad categories based on their intended use.

- Lethal agents
- Incapacitating agents
- Harassing agents

Another more recognizable categorization based on physiologic effects includes nerve agents, blister agents, blood agents, choking agents, and irritating agents.

Nerve Agents

Nerve agents are specific organophosphorus compounds that are considered to be the most dangerous of the chemical warfare agents. Similar physiological effects are produced by carbonates and other organophosphate based pesticides. However, nerve agents are 100–500 times more potent than these other compounds.

There are two major classes of nerve agents. Most chemical agents are commonly designated by one- or two-letter symbols. The first letter represents the type, group, or the developer, and the second letter represents a specific agent within the type or group. Common nerve agents are basically the same compounds originally synthesized in the 1930s by the Germans. Accordingly, the nerve agents are designated GA, GB, GD, and VX.

The G stands for German and the A, B, and D signify the specific chemical. The common names for the G-agents sarin, soman, and tabun are from part of the name of the scientist that developed each type. Another class of nerve agents is represented by the letter V. The most common agent in this group is VX, the V standing for venom and the X originating from a series of chemicals originally synthesized to be used as insecticides. VX has no common name.

The common nerve agents are listed in the Table S14-1. Nerve agents are liquids at ambient conditions. They are clear, colorless, and tasteless. The G-agents are reported to have a slightly fruity odor; the V-agents are said to be odorless.

Table S14-1 *Common Nerve Agents*

Common Name	NFPA 704 Labeling	Military Abbreviation	PEL/TWA mg/m^3	LD_{50} (mg min/m^3)
Sarin	411	GB	0.0001	100
Soman	411	GD	none estab.	100
Tabun	421	GA	0.0001	400
V agent	411	VX	0.00001	1–100

Although GA, GB, and GD are all volatile compounds, GB is the most volatile. All of these agents present a vapor hazard under temperate conditions. VX is oily with little volatility; however, a large surface area or widely dispersed droplets can, especially under high-temperature conditions, present a vapor hazard. All nerve agents penetrate the skin rapidly and well. Inhalation of vapors or aerosols is especially dangerous.

Exposure to these agents causes a disruption of nerve impulse transmissions by reacting with the enzyme acetylcholinesterase. Exposure to even minute quantities may be rapidly fatal.

Symptoms of exposure may occur within minutes or hours, depending on the dose and mode of entry into the body. Symptoms include the following:

- *Eyes.* Pinpoint pupils, blurred and dimming vision, pain in and above the eyes aggravated by bright light
- *Skin.* Excessive sweating and fine tremors of the muscles under the skin
- *Muscles.* Involuntary twitching and contractions of various muscles of the body
- *Respiratory System.* Runny nose and nasal congestion, chest pressure, cough, and difficulty breathing
- *Digestive System.* Excessive salivation, abdominal pain, nausea, vomiting, involuntary urination and defecation
- *Nervous System.* Giddiness, anxiety, difficulty in thinking, difficulty in sleeping, and nightmares

Detection clues for nerve agents are limited because these agents may resemble water or light oil without any characteristic odor.

Large inventories of these materials are usually found only at secure military laboratories or ammunition depots. However, there are a few private laboratories that conduct chemical agent testing for the government in the United States. Awareness of the location of such a facility in the area is essential. Consequently, any incident in or around a known facility should be suspect. Transportation of nerve agents in bulk in the United States has been very limited and such transports are accompanied by members of the U.S. Army Technical Escort Unit. Table S14-2, lists the ID numbers and DOT Hazard classes and other transport information that can alert emergency responders to a potentially dangerous transport-related release in the community.

***Table S14-2**: Nerve Agents*

Chemical Agent	UN ID#	DOT Hazard Class	Pkg. Group	Zone
Tabun (GA)	2810	6.1	I	A
Sarin (GB)	2810	6.1	I	B
Soman (GD)	2810	6.1	I	B
V agent (VX)	2810	6.1	I	A

Clandestine activities that may involve nerve agent production may be evident by the presence of unusual chemicals, laboratory glassware as well as underground "cookbooks," military manuals, or chemical textbooks. Discovery of a clandestine laboratory or storage site containing unusual chemicals in an unexpected or unlikely place may be indicative of an intention to synthesize chemical agents. Chemicals used to synthesize other chemicals are called precursors. The precursors for nerve agents are not generally found in bulk in commercial shipments nor are they usually associated with clandestine drug laboratories. Possible nerve agent precursors are listed in Table S14-3.

Table S14-3 *Chemical Precursors and Resulting Nerve Agents*

Chemical Precursors	Nerve Agent
Ammonium bifluoride	Sarin (GB), soman (GD)
Diethyl ethylphosphonate	Ethyl sarin (GE)
Diethyl N,N-dimethyl phosphoramidate	Tabun (GA)
Diethylphosphite	Sarin, soman
Diisopropylamine	V-agent (VX)
Dimethylamine	Tabun
Dimethyl ethylphosphonate	Ethyl sarin
Dimethyl methylphosphonate	Sarin, soman
Ethylphosphonous dichloride	Ethyl sarin
Ethylphosphonous difluoride	Ethyl sarin, V-agent
Ethylphosphonyl dichloride	Ethyl sarin
Ethylphosphonyl difluoride	Ethyl sarin
Hydrogen fluoride	Sarin, soman
Methylphosphonyl dichloride	Sarin, soman, V-agent
Methylphosphonyl difluoride	Sarin, soman
N,N-Diisopropyl-aminoethanethiol	V-agent
N,N-Diisopropyl-(beta)- aminoethanol	V-agent
N,N-Diisopropyl-(beta)- aminoethyl	V-agent chloride
Phosphorus oxychloride	Tabun
Phosphorus pentachloride	Tabun
Phosphorus trichloride	Tabun, sarin
Pinacolone	Soman
Pinacolyl alcohol	Soman
Potassium bifluoride	Sarin, soman
Potassium cyanide	Tabun
Potassium fluoride	Sarin, soman
Sodium cyanide	Tabun
Sodium fluoride	Sarin, soman
Thionyl chloride	Sarin

Outward Warning Signs. Outward warning signs will generally be the first clue of a release of nerve agent. The most significant sign will be the rapid onset of similar symptoms in a large group of people. Pinpointed pupils (miosis) are the best symptomatic indication of nerve agent use. Because the nerve agents are so lethal, mass fatalities without other signs of trauma may also be present. The following are other outward warning signs of a nerve agent release:

- Explosions that dispense liquids, mists, or gases
- Explosions that seem only to destroy a package or bomb device
- Unscheduled and unusual spray being disseminated
- Abandoned spray devices
- Numerous dead animals, fish, and birds
- Lack of insect life

- Mass casualties without obvious trauma
- Definite pattern of casualties and common symptoms
- Civilian panic in potential target areas (government buildings, public assemblies, subway system, etc.)

Blister Agents

Blister agents were used against the British at Ypres during World War I. The British called it mustard due to its characteristic smell. The French named it Yperite after the locality where it was first used. The terms *blister* and *vesicant agent,* which are also used, refer to the physiologic effect. The term *mustard agent* is the most commonly used.

Blister agents are heavy oily liquids. In the pure state, they are colorless and nearly odorless, but in the impure state they are dark-colored and have an odor strongly suggesting mustard, onion, or garlic. Blister agents cause severe burns to the skin, eyes, and tissue in the respiratory tract. In addition, if a large area of skin is involved, significant amounts of agent can be absorbed into the bloodstream and cause severe systemic poisoning. These agents have a very high propensity for penetration and easily penetrate layers of clothing before being quickly absorbed through the skin. The common blister agents are listed in Table S14-4, and Table S14-5 lists the U.S. Department of Transportation information for each material.

Table S14-4 *Common Blister Agents*

Common Name	NFPA 704 Label Information	Military Abbreviation	PEL/TWA mg/m^3	LD_{50} ($mg\ min/m^3$)
Mustard	411	H, HD	0.003	1,500
Lewisite	411	L	0.003	1,000 - 1,500

Table S14-5 *DOT Information on Blister Agents*

Chemical Agent	Symbol	UN ID#	DOT Hazard Class	Pkg. Group
Mustard	H	2810	6.1	I
Distilled mustard	HD	2810	6.1	I
Nitrogen mustard	HN	2810	6.1	I
Lewisite	L	2810	6.1	I

These agents are extremely toxic, although they are far less lethal than nerve agents. A few drops of mustard on the skin can cause severe injury, and 3 grams absorbed through the skin can be fatal. Symptoms of exposure may not appear for minutes, hours, or days. Symptoms include the following:

- *Eyes.* Exposure time until symptoms appear $^1/_2$ to 12 hours. Reddening, congestion, tears, burning and gritty feeling in the eyes. In more severe cases,

marked swelling of the eyelids, severe pain and spasm of the eyelids.

- *Skin.* Exposure time until symptoms appear 1 to 12 hours. Initially mild itching only followed by redness, tenderness, and burning pain in the affected area. Later, burns appear, some with large fluid-filled blisters. The blisters appear particularly in the groin and armpit where the skin is warm and moist.
- *Respiratory System.* Exposure time until symptoms appear 2 to 12 hours. Burning sensation in the throat and nose, hoarseness, profusely runny nose, severe cough, severe shortness of breath.
- *Digestive System.* Exposure time until symptoms appear 2 to 3 hours. Abdominal pain, nausea, blood-stained vomiting, and bloody diarrhea.

Detection clues for blister agents are limited. These materials usually are found only at secure military installations, and any incident in or around this type of facility may be suspect. Generally, these materials are not transported except in very small amounts. The presence of unusual chemicals, in unlikely places, underground "cookbooks," military or chemical books, and even a clandestine laboratory may also be clues. The chemicals used to prepare blister agents may be discovered in storage, shipment, or in a clandestine laboratory. The chemical precursors for mustard agent are as follows:

- Thiodiglycol
- Thionyl chloride
- 2-Chloroethanol
- Arsenic trichloride
- Trethanolamine
- Sodium sulfide
- Hydrochloric acid

Outward Warning Signs. Outward warning signs will generally be the first clue of a release of blister agents. Signs may not be evident immediately as would be the case for nerve agents. Blisters take hours to days to form. Complaints of eye and respiratory irritation along with the reports of the characteristic garlic-like odor would be the initial signs. Similar symptoms experienced by a large number of people as well as the following may indicate a blister agent release:

- Explosions that dispense liquids, mists, or gases
- Explosions that seem only to destroy a package or bomb device
- Unscheduled and unusual spray being disseminated
- Abandoned spray devices
- Mass casualties without obvious trauma

- Definite pattern of casualties and common symptoms
- Civilian panic in potential target areas (government buildings, public assemblies, subway system, etc.)

Blood Agents

Blood agents produce casualties by interfering with the blood's ability to transfer oxygen to the cells, which can lead to death by asphyxiation. Signs and symptoms of blood agent poisoning include rapid death if exposed to high concentrations. Small concentrations cause respiratory distress, vomiting, diarrhea, vertigo, and headache. Large numbers of casualties displaying these common symptoms and reports of peach blossom or bitter almond odors indicate a possible blood agent release.

Blood agents are liquids under pressure. The discovery of lecture bottles and gas cylinders is a possible clue to their presence. Most blood agents are derivatives of cyanide compounds. The discovery of packages of cyanide salts and acids that are precursors for blood agents may also be considered clues. Table S14-6 shows the DOT information for these agents, which are common industrial chemicals. Information on these agents should be readily available from most technical reference sources.

Table S14-6 *Blood Agents*

Chemical Name	NFPA 704	UN ID #	DOT Hazard Class	DOT ERG
Hydrogen cyanide AC	4 4 2	1051	6.1 PG I	117
Cyanogen chloride CK	4 4 2	1589	2.3	125

Choking Agents

Choking agents produce casualties by severely stressing respiratory system tissues. This distress produces copious fluids, which can result in death by asphyxiation.

Signs and symptoms that choking agents were released include severe irritation of the respiratory tract and eyes, as well as coughing and choking. Reports of a strong, irritating chemical odor would be characteristic. Most people recognize chlorine, and phosgene has an odor like newly cut hay.

These agents are liquid when stored under pressure. The discovery of lecture bottles or gas cylinders are possible clues to their presence. Table S14-7 shows the DOT information for these agents, which are common industrial chemicals. Information on them should be readily available from most technical reference sources.

Table S14-7 Choking Agent DOT Information

Chemical Name	NFPA 704	UN ID #	DOT Hazard Class	DOT ERG
Chlorine	300 ox	1017	2.3	124
Phosgene	400	1076	2.3	125

Irritating Agents

Irritating agents are also known as riot control agents or tear gas. They cause respiratory distress and copious tearing that incapacitates a victim. These agents are generally nonlethal, but under certain conditions they can act as an asphyxiant.

Another common compound that produces effects similar to tear gas is pepper spray. The active ingredient in pepper spray is capsicum, a natural organic compound extracted from hot peppers. The frequency of incidents involving these agents appears to be on the increase in schools and fast-food restaurants, as "keychain" personal defense devices have become available at retail stores almost everywhere.

Several manufacturers market these products as either a single agent or a mixture. Some devices contain dyes to visually mark a sprayed assailant. The common irritating agents are listed in Table S14-8.

Table S14-8 Common Irritating Agents

Name	Military Abbreviation	PEL/TWA	IDLH
Chloropicrin	none	0.1 ppm	4 ppm
MACE™	CN	0.05 ppm	100 mg/m^3
Tear gas	CS	0.05 ppm	2 mg/m^3
Capsicum/pepper spray	none		

Outward Warning Signs. Outward warning signs will generally be the first clue of a release of irritating agents. Signs will include casualties complaining of burning and irritation of the eyes and throat. In severe exposures or when direct contact with the liquid occurs, complaints of burning skin as well as abdominal pain may also be present. Exposure to these agents is accompanied by tearing, coughing, choking, difficulty breathing, nausea, and vomiting. Additional signs and symptoms may include the following:

- A characteristic peppery odor in the area of the event
- A characteristic peppery odor on the clothing of persons exposed
- Reports of tear gas–like odor from those exposed
- Identification of tear gas munitions used by either military or police

- Identification of discharged personal protection devices
- Brownish colored stains on objects near the site of the suspected release
- Dye stains near the site of the suspected release

The effects of these agents are temporary, although casualties must be monitored should the irritant trigger a secondary medical problem such as an asthma attack or other respiratory problem. Infants and the elderly will usually exhibit the most severe symptoms and secondary medical problems.

Detection clues for the irritating agents are usually the characteristic odors reported by those exhibiting symptoms and recognition of the dispensing devices. Irritating agents are dispensed from burning or bursting grenades in the form of micropulverized powders. Personal defense devices are low concentrations of agent dispensed in a carrier solution from a small spray device.

Summary

Many common hazardous materials used in industry pose the same threat to emergency responders as the chemicals used and classified by the military as nerve, blister, blood, and choking agents. Some examples are shown in Table S14-9.

Table S14-9 *Common Hazardous Materials Used in Industry with Toxic Effects Resembling Chemical Weapons*

Common Chemical	Agent Its Effects Resemble
Organophosphate insecticide	Nerve agent
Dimethyl sulfate (DMS)	Blister agent
Methyl isocyanate (MIC)	Blood agent
Anhydrous ammonia	Choking agent

Standard haz mat emergency response equipment and procedures provide adequate protection when dealing with these chemicals. Ample reference materials are readily available from multiple sources regarding these materials, and industrial facility personnel are also a valuable source of information and assistance.

Biological Weapons

To provide a more comprehensive technical reference for dealing with weapons of mass destruction, information concerning biological agents has been included in this supplement. Although the use of biological agents by terrorist groups and national extremists has, thankfully, been limited, the prospect of biological terrorism is chilling.

It makes sense to cover these agents concurrently with chemical agents, as the large-scale effects and emergency response considerations for incidents involving both agents are closely related.

Biological warfare agents are living organisms or the materials derived from them (endotoxins or exotoxins) that cause harm to or disease in humans. A biological agent has a latency period of days to weeks between infection and onset of disease, depending on the microorganism. Toxins are an example of very quick-acting biological agents, with death resulting in minutes or hours. Biological agents that cause disease have a longer period from exposure to onset of symptoms. They typically have no characteristic signature because biological agents are usually odorless and tasteless.

Biological agents have not been used in warfare to any great extent. The United States destroyed its offensive stockpile in the late 1960s. Other countries have not necessarily followed suit. There have been scattered reports of alleged use of biological agents by the Japanese during World War II in Asia as well as a suspected accident in the former Soviet Union involving anthrax.

Biological agents pose a significant threat because their use is even more difficult to recognize than the use of chemical agents. The presence of symptoms may well be confused with a naturally occurring case or outbreak of disease. Many of the initial symptoms may be common to several other types of disease, which further complicates recognition, identification, and treatment.

The ease with which people can travel throughout the world today presents a situation in which an individual can become infected in one part of the world and then carry the infection home before becoming symptomatic. The recent outbreak of the plague in India and the Ebola Virus in Zaire are examples of opportunities for a dangerous disease to spread. Fortunately, the diseases remained confined to the local area. Table S14-10 offers a list of potential biological agents.

Table S14-10 *Possible Biological Agents*

Disease	Days/Latency	Fatal*	Other Possible Toxins
Anthrax	1–5	Yes	Enterotoxin B
Tularemia	1–10	Yes	Alpha toxin
Cholera	2–5	Yes	Ricin
Encephalitis	2–5	Yes	Saxitoxin
Plague	1–3	Yes	Tetrodotoxin
Botulism**	2–3	Yes	Tricothene mycotoxin

*The degree of mortality associated with any of these agents is determined by many factors, such as the health status of the individual before infection, when treatment is started, how appropriate the drugs are for the particular agent as well as the variation in individual response to the treatment. Pulmonary anthrax has a mortality rate as high as 99 percent for untreated persons. To be most effective, treatment must begin early with the most appropriate drugs. To be early enough, treatment may have to begin even before symptoms appear. Selection of the most appropriate drugs may be delayed until the causative agent is positively identified. A further complication results from the potential unavailability of the most appropriate drugs because of the large number of casualties.

**Botulism does not produce a disease. The causative agent is the exotoxin produced by the microorganism. Many other microorganisms produce toxins that poison the body. Toxins are especially quick-acting and are extremely difficult to treat effectively once symptoms appear. Both the toxin itself and the organism that produces it can be used to cause casualties.

The biological agents that produce disease are living microorganisms. Once released into the environment or host, these organisms can mutate and may become even more deadly and resistant to available drugs. Such organisms can be obtained from secretions or tissues from sick or dead individuals and animals, and many of them can be cultured, or grown, relatively easily. Controls on biological materials are not as stringent as those for chemical agents, and small quantities can easily be transported undetected. In 1995 the Federal Bureau of Investigation confiscated samples of plague that had been obtained by a member of the Aryan Army.

Figure S14-1 lists the steps that should be included in an effective preplan for both chemical and biological release incidents.

1. Coordinate efforts in your community addressing deliberate releases. Include all public safety, health, and law enforcement agencies. Involve and educate public information specialists.
2. Assess the likelihood of a deliberate release and potential vulnerable locations (water treatment plants, transportation systems, public buildings, etc.).
3. Ensure that your plan:
   - (a) Requires training on a broad range of incidents, including deliberate releases, discovery of stockpiles, clandestine production facilities, transport vehicles, treatment of contaminated patients, recognition of booby traps and protection of responders against personal attack
   - (b) Identifies and practices "Unified" or "Integrated" command operations including communication with all critical agencies
   - (c) Includes rapid notification procedures to federal, state, and local authorities

     National Response Center: 1-800-424-8802

     State Emergency Operations Center (number varies by state)

     Federal Bureau of Investigation (number varies by state)
   - (d) Includes rapid notification procedures to medical care facilities as well as health care providers in the affected area
   - (e) Addresses rapid public warning without causing undue alarm
   - (f) Addresses personal protection for non-fire service personnel including law enforcement, EMS, and medical facility staff
   - (g) Addresses decontamination and contamination control procedures for mass casualty chemical incidents
   - (h) Provides for special security procedures for access to key facilities
   - (i) Allows for unified public information briefings
   - (j) Highlights personnel and procedures for access control, rumor control, isolation-in-place, and evacuation control
   - (k) Provides for communications with near-by sites and facilities that may also be targets of deliberate releases
   - (l) Identifies access to advice and procedures concerning tactical operations involving chemical and biological warfare agents:

     CHEMTREC: 1-800-424-9300

     U.S. Public Health Service: 1-800-USA-NDMS

     U.S. Army Operations Center: 1-703-697-0218/0219

     Defense Logistics Agency: 1-800-851-8061
   - (m) Provides for securing and treating the incident site as a crime scene

Figure S14-1 *Preplanning for chemical and biological incidents.*

Incident Management

Management of an incident involving chemical and biological warfare agents can be conducted in a manner similar to managing a conventional hazardous materials incident. Unique challenges may be present such as a lack of specific information, mass casualties, multiple fatalities, large-scale crime scene, or a direct attack on public safety facilities or personnel. Incidents of this type will usually necessitate the response of multiple agencies from all levels of government. Aside from the immediate public safety concerns, parallel operations may be underway in the interests of national security and law enforcement. A unified command is necessary to ensure the safety and effectiveness of all response actions.

Under the unified command system, the agency or individual designated as the incident commander should be selected based on preexisting emergency operations plans and specific incident priorities. Agency commanders should work in a unified manner to contribute to the incident plan and integrated operations.

The incident commander should always be guided by the SEE principle.

According to this principle, incident operations should be *safe* (no one gets hurt); *effective* (everyone works towards stated objectives); and *efficient* (all resources are utilized to maximum benefit). Management of the incident is based on three steps.

1. Establishing and updating incident priorities:
   - Life safety
   - Incident stabilization
   - Property and environmental conversation
   - Investigation of cause and origin
2. Continuing to size up the incident:
   - Present situation
   - Predicted behavior
3. Establishing and updating incident action plan:
   - Strategic goals (what needs to be done)
   - Tactical objectives (how will it be done)
   - Task operations (who and when)

Incident Size-Up

Incident size-up is the continual process of determining the types and degree of hazards and the damage that may be caused to life, critical systems, property, and the environment. This process is generally conducted in a rapid fashion early in an incident and is studied in more detail as the incident progresses. The goal is to answer three questions.

1. What is the present situation?
2. What is the predicted behavior?
3. How has this affected the incident priorities?

There are many ways to conduct an incident size-up. The method generally used in a hazardous materials incident is to attempt to answer the following questions:

1. What is causing the problem?

2. What are the physical properties, health hazards, fire hazards, reactivity hazards, and environmental hazards?

3. What are the container type, release, and impingement area?

4. What are the incident conditions (weather, terrain, time)?

5. What has already been damaged?

- Life (injuries, fatalities)

- Systems (utilities, transportation)
- Property
- Environment

6. What are the current exposures to life, systems, property, and the environment?

7. What are the estimated type and degree of harm?

Life	*Systems*
severe	severe
moderate	moderate
minor	minor

Environment	*Property*
severe	severe
moderate	moderate
minor	minor

Incident Action Plan

Developing an incident action plan is based on local, state, and federal response plans in conjunction with available resources. The plan should define goals and objectives to achieve a favorable outcome. Developing and implementing the plan is based on three principles: strategy, tactics, and task operations.

Strategy. Determine the response objectives. Ask, "What needs to be done?" Consider two basic principles when using this approach: that you cannot influence events that have already happened, and that the earlier the event sequence can be interrupted the more acceptable the loss. Estimate exposures that can be saved. Focus on changing the actions of the stressors, container and/or the material.

Tactics. Determine response options. Ask, "How will it be done?" Evaluate potential response options and estimate how each option will affect the outcome. Prioritize the response options based on their effects on the outcome.

Task Operations. Select response options. Ask, "Who will do it and when?" Determine resources required for each option. Inventory available resources and determine how to obtain the resources. Select response options consistent with available resources and the time factor to have them deployed and operational.

As the action plan is developed and deployed, provide unified command and control of all emergency operations. Ensure the incident is run safely, effectively, and efficiently to achieve a favorable outcome. Figure S14-2 offers a list of considerations for the incident commander to keep in mind in case a chemical or biological exposure incident is suspected.

1. Be alert for outward warning signs.
2. Be alert for detection clues.
3. Be alert for booby traps and explosive devices.
4. Resist rushing in; approach incident from upwind; stay clear of all spills, vapors, fumes, and smoke. Be extremely mindful of enclosed or confined spaces.
5. Implement the Incident Command System:
   - Activate your emergency operations plan and call for resources.
   - Notify state and federal agencies.
   - Anticipate unified command operations.
6. Establish clear incident priorities.
7. Conduct incident size-up.
8. Establish incident action plan.
9. Implement protective actions:
   - Isolate the immediate area, 1500 feet in all directions.
   - Establish decontamination operations.
   - Evacuate the immediate area.
   - Protect people downwind.
   - Consider in-place protection.
10. Remember these considerations for nerve and blister agents (see the Guides in this supplement).
11. Establish strict site control.
12. Ensure very early notification of medical agencies and establish triage operations.
13. Monitor the progress of meeting incident priorities.
14. Continuously conduct incident size-up and update your plan as needed.
15. Anticipate the implications of clean-up and disposal of contaminated materials:
    - Expect a mass fatality situation to result from a chemical agent incident. Unique problems will be confronted when planning and conducting mortuary related activities. Postmortem examination, identification, and preparation for burial will be complicated by the presence of contamination.
    - The insidious nature of nerve and blister agents necessitates the consideration of disposing of all contaminated protective equipment used during the response. The difficulty in decontaminating suits, gloves, and footwear is such that residual contamination may result in off-gassing that can cause injury long after the incident is resolved. A decision must be made immediately regarding disposal so that replacement actions can be initiated quickly.
    - The extent and level of decontamination that may be required will be beyond the capabilities of even the most well-equipped haz mat team. Specialized federal teams from EPA, FEMA, Public Health Service, and the Department of Defense with their equipment and materials will most probably be required to assist.

Figure S14-2 *Response considerations for chemical agents.*

Incident Considerations for Chemical Incidents

Nerve Agents. Detection of nerve agents for first responders requires individuals to be acutely alert for signs, symptoms, detection clues, and outward warning signs. This is the most practical means for first responders to identify a potential chemical agent release. Various devices for detection are available, including colorimetric tubes, the "Improved Chemical Agent Monitor-Detector" (ICAM-D), the M18A2 Chemical Agent Detector Kit, U.S. Army M 256A1 Chemical Agent Detector Kit, and various detection papers such as U.S. Army M8 and M9 and enzyme tickets.

Treat any suspicious incident as an unknown. Employ the highest level of personal protection available. The primary objective must be to protect yourself. The following guide should be kept available for quick reference.

Nerve Agent Response Guide

North American ERG Guide #:

153—Physical State: Liquid

UN ID#: 2810— Poisonous Liquid, N.O.S.

GA, GB, GD, VX— Inhalation Hazard Zone A

Personal protection—Hot Zone: SCBA with Level A protection. Compatible materials for chemical-protective clothing, gloves, and overboots include butyl rubber and various trade name materials.

Decontamination: Chemical-protective clothing and equipment should be decontaminated using 5 percent (household) bleach, then washed with soapy water. Plan on using at least one gallon of bleach per suit. Skin can be decontaminated with 0.5 percent bleach solution (a 10:1 dilution).

Blister Agents. Detection of blister agents for first responders requires individuals to be acutely alert for signs, symptoms, detection clues, and outward warning signs. This is the most practical means for first responders to identify a potential chemical agent release.

Various devices for detection are available, including colorimetric tubes, the "Improved Chemical Agent Monitor-Detector" (ICAM-D), the M18A2 Chemical Agent Detector Kit, U.S. Army M256A1 Chemical Agent Detector Kit, and various detection papers such as U.S. Army M8. The following guide should be kept available for quick reference.

Blister Agent Response Guide

North American ERG Guide #:

153—Physical State: Liquid

UN ID#: 2810— Poisonous Liquids, N.O.S.

H, HD, L— Inhalation Hazard Zone A

Personal protection—Hot Zone: SCBA with Level A protection. Compatible materials for chemical-protective clothing, gloves and overboots include butyl rubber and various trade name materials.

*Decontamination**:* Chemical-protective clothing and equipment should be decontaminated using 5 percent (household) bleach, then washed with soapy water. Plan on using at least one gallon of bleach per suit. Skin can be decontaminated with 0.5 percent bleach solution (a 10:1 dilution).

**Decontamination and compatible materials listed are intended only as a guide. Additional research for the specific material and situation will be necessary.

Irritant Agents. Detection of this agent with most commonly used Haz Mat team air monitoring devices is virtually impossible. Identification of irritating agents must be done with a combination of recognition of the presenting outward warning signs and detection clues. The following guide should be kept available for quick reference.

Irritant Agent Response Guide

North American ERG GUIDE #:

159—Physical State: Liquid or powdery solid

UN ID#: 1700

CN, CS, MACE™, Pepper Spray

Personal Protection—Hot Zone: SCBA; cover exposed skin by wearing gloves, rolling down sleeves; coveralls such as Saran Coated Tyvek™ will keep turnout gear from becoming contaminated. Air filtering respirators are effective as long as the material has been identified and an IDLH atmosphere is not present.

Decontamination: Brush powder off clothing and skin. Wash with cool water and soap.

Response Considerations for Biological Incidents

A biological agent release, unless identified as such at the time of release by the person or group involved, will evidence itself only as a large number of people begin to exhibit symptoms of a disease not normally seen in the area. The nature of the biological agent may leave one or more areas contaminated with organisms or toxin. However, the people infected will probably appear across a large geographic area as they disperse and begin to seek treatment at emergency rooms, at urgent care centers, or from private physicians.

The key to dealing with a biological incident is to identify the event. When an event is identified as a biological incident, it is imperative to take steps to limit the spread of the disease by attempting to control the movement of persons that may have been exposed. Both strict site control and quarantine of suspected exposures is essential. Site control will limit the spread of the material and contamination. Quarantine of possible exposures will limit the spread of a disease that may be communicable.

Imposing quarantine requires action by a state health commissioner or designee. Notifying health officials as soon as a biological incident is suspected is critical. Quarantine must be imposed if the disease produced by a biological agent is communicable. Generally, transporting a few exposed persons away from the scene for treatment may be reasonable. The facility to which casualties are transported must be alerted and the facility should be capable of isolating the patients when they arrive. When large numbers of exposures are involved, it may be both more useful as well as necessary to impose quarantine at or near the incident site to begin treatment.

When a biological agent incident is suspected, all exposed persons should be considered to be contagious and treated as such until competent medical authority can evaluate the situation and circumstances and provide specific information and guidance. The medical authority may advise prophylactic treatment for any person, including emergency responders, involved in activities at or near the incident site.

Traditionally, non-disaster haz mat operations have focused on providing a "clean" patient to the medical care provider. An infected person may be contagious. This prospect results in the potential for spreading disease. Be aware of the fact that decontamination as it applies to chemical exposure may not be equally effective for biological agent casualties.

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Definitions

Acetylcholinesterase—An enzyme that hydrolyzes the neurotransmitter acetylcholine. The action of this enzyme is inhibited by nerve agents.

Aerosol—Fine liquid or solid particles suspended in air, for example, fog or smoke.

Antibiotic—A substance that inhibits the growth of or kills microorganisms.

Antisera—The liquid part of blood containing antibodies.

Atropine—A medication used as an antidote for nerve agents.

Bacteria—Single-celled organisms that multiply by cell division and that can cause disease in humans, plants, or animals.

BDO—battle dress overgarment—Multipiece suit used by the military for protection against chemical warfare agents.

Biochemicals—The chemicals that make up or are produced by living things.

Biological warfare—The intentional use of biological agents as weapons to kill or injure humans, animals, or plants, or to damage equipment.

Biological warfare agents—Living organisms or the materials derived from them that cause harm to or disease in humans, animals, or plants, or cause deterioration of material. Biological agents may be used as liquid droplets, aerosols, or dry powders.

Bioregulators—Biochemicals that regulate bodily functions. Bioregulators that are produced by the body are termed "endogenous." Some of these same bioregulators can be chemically synthesized.

Blister agents—Substances that cause blistering of the skin. Exposure is through liquid or vapor contact with any exposed skin (eyes, skin, lungs). For example, mustard gas.

Blood agents—Substances that injure a person by interfering with cell respiration (the exchange of oxygen and carbon dioxide between blood and tissues).

Casualty (toxic) agents—Substances that produce incapacitation, serious injury, or death and include the choking, blister, nerve, and blood agents.

Causative agent—The organism or toxin that is responsible for causing a specific disease or harmful effect.

Chemical agent—A chemical substance that is intended for use in military operations to kill, seriously injure, or incapacitate people through its physiological effects. Excluded from consideration are riot control agents and smoke and flame materials. The agent may appear as a vapor, aerosol, or liquid; it can be either a casualty/toxic agent or an incapacitating agent.

Choking agents—Substances that cause physical injury to the lungs. Exposure is through inhalation. In extreme cases, membranes swell and lungs become filled with liquid. Death results from lack of oxygen; hence the victim is "choked."

CNS—Pertaining to the central nervous system.

CNS depressants—Compounds that have the predominant effect of depressing or blocking the activity of the central nervous system. The primary mental effects include the disruption of the ability to think, sedation, and lack of motivation.

CNS stimulants—Compounds that have the predominant effect of flooding the brain with too much information. The primary mental effect is loss of concentration, causing indecisiveness and an inability to act in a sustained, purposeful manner.

Contagious—Capable of being transmitted from one person to another.

Culture—A population of microorganisms grown in a medium.

Cutaneous—Pertaining to the skin.

CWA—chemical warfare agents—One of three types of nonconventional warfare (see N.B.C).

Decontamination—The process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing the hazardous material.

Fungi—Any group of plants mainly characterized by the absence of chlorophyll, the green-colored compound found in other plants. Fungi range from microscopic single-celled plants (such as mold and mildews) to large plants (such as mushrooms).

G-series nerve agents—Chemical agents of moderate to high toxicity developed in the 1930s. Examples are tabun (GA), sarin (GB), and soman (GD).

Host—An animal or plant that harbors or nourishes another organism.

IDLH—Concentrations immediately dangerous to life and health.

Incapacitating agents—Substances that produce temporary physiological and/or mental effects via action on the central nervous system. Effects may persist for

hours or days, but victims usually do not require medical treatment. However, such treatment does speed recovery.

Industrial agents—Chemicals developed or manufactured for use in industrial operations or research by industry, government, or academia. These chemicals are not primarily manufactured for the specific purpose of producing human casualties or rendering equipment, facilities, or areas dangerous for use by man. Hydrogen cyanide, cyanogen chloride, phosgene, chloropicrin and many herbicides and pesticides are industrial chemicals that also can be chemical agents.

Infectious agents—Biological agents capable of reproducing in an infected host.

Infectivity— (1) The ability of an organism to spread. (2) The number of organisms required to cause an infection to secondary hosts. (3) The capability of an organism to spread out from the site of infection and cause disease in the host organism. Infectivity also can be viewed as the number of organisms required to cause an infection.

Level A protection—The level of protective equipment in situations where the hazardous material is considered acutely vapor toxic to the skin or hazards are unknown. Full encapsulation, airtight chemical suit with SCBA or SABA.

Level B protection—The level of protective equipment in situations where the environment is not considered acutely vapor toxic to skin but may cause respiratory effects. Chemical splash suit or full coverage non-airtight chemical suit with SCBA or SABA.

Level C protection—The level of protective equipment required to prevent respiratory exposure but not to exclude possible skin contact. Chemical splash suit with cartridge respirator.

Level D protection—The level of protective equipment required when the atmosphere contains no known hazard, when splashes, immersions, inhalation, or contact with hazardous levels of any chemical is precluded. Work uniform such as coveralls, boots, leather gloves and hard hat.

Liquid agent—A chemical agent that appears to be an oily film or droplets. The color ranges from clear to brownish amber.

Mycotoxin—A toxin produced by fungi.

Microorganism—Any organism, such as bacteria, viruses, and some fungi, that can be seen only with a microscope.

Mustard (vesicants) agents—See Casualty agents.

N.B.C. nuclear, biological, and chemical—the three forms of nonconventional warfare.

Nerve agents—Substances that interfere with the central nervous system. Exposure is primarily through contact with the liquid (skin and eyes) and secondarily through inhalation of the vapor. Three distinct symptoms

associated with nerve agents are pinpoint pupils, an extreme headache, and severe tightness in the chest. (See also Casualty agents.)

Nonpersistent agent—An agent that upon release loses its ability to cause casualties after 10 to 15 minutes. It has a high evaporation rate and is lighter than air and will disperse rapidly. It is considered to be a short-term hazard. However, in small unventilated areas, the agent will be more persistent.

Organism—Any individual living thing, whether animal or plant.

Organophosphorus compound—A compound, containing the elements phosphorus and carbon, whose physiological effects include inhibitation of acetylcholinesterase. Many pesticides (malathion and parathion) and virtually all nerve agents are organophosphorus compounds.

Parasite—Any organism that lives in or on another organism without providing benefit in return.

Pathogen—Any organism (usually living) capable of producing serious disease or death, such as bacteria, fungi, and viruses.

Pathogenic agents—Biological agents capable of causing serious diseases.

PEL—Permissible exposure limit. An occupational health term used to describe exposure limits for employees. Usually described in time weighted averages (TWA) or short-term exposure limits (STEL).

Percutaneous agent—Substance that is able to be absorbed through the skin.

Persistent agent—An agent that upon release retains its casualty-producing effects for an extended period of time, usually anywhere from 30 minutes to several days. A persistent agent usually has a low evaporation rate and its vapor is heavier than air. Therefore, its vapor cloud tends to hug the ground. It's considered to be a long-term hazard. Although inhalation hazards are still a concern, extreme caution should be taken to avoid skin contact as well.

Precursor—A chemical substance required for the manufacture of chemical agent.

SABA— Supplied air breathing apparatus.

SCBA—Self-contained breathing apparatus.

Spore—A reproductive form some microorganisms can take to become resistant to environmental conditions, such as extreme heat or cold, while in a "resting phase."

Tear agents—Substances that produce irritating or disabling effects that rapidly disappear within minutes after exposure.

Terrorism—The unlawful use of force or violence against people or property to intimidate or coerce a government, the civilian population, or any segment thereof, in

furtherance of political or social objectives. Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of the U.S. government or population without foreign direction. International terrorism involves terrorist activity committed by groups or individuals who are foreign-based and/or directed by countries or groups outside the United States or whose activity transcends national boundaries.

Toxicity—A measure of the harmful effect produced by a given amount of toxin on a living organism. The relative toxicity of an agent can be expressed in milligrams of toxin needed per kilogram of body weight to kill experimental animals.

Triage—A sorting technique of establishing rescue, decontamination, treatment, and transportation priorities in any event where the number of casualties overwhelm the resources of the emergency response organizations.

V-series nerve agents—Chemical agents of the moderate to high toxicity developed in the 1950s. They are generally persistent.

Vaccine—A preparation of killed or weakened microorganism products used to artificially induce immunity against a disease.

Vapor agent—A gaseous form of a chemical agent. If heavier than air, the cloud will be close to the ground; if lighter than air, the cloud will rise and disperse more quickly.

Virus—An infectious microorganism that exists as a particle rather than as a complete cell. Particle sizes range from 200 to 400 nanometers (one-billionth of a meter). Viruses are not capable of reproducing outside of a host cell.

Volatility—A measure of how readily a substance will vaporize.

Vomiting agents—Substances that produce nausea and vomiting effects; can also cause coughing, sneezing, pain in the nose and throat, nasal discharge, and tears.