Emergency Action

Chemical and Biological Warfare Agents

D. Hank Ellison

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D. Hank Ellison, C.H.M.M.

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Introduction

This book contains abridged versions of the class indices from the *Handbook of Chemical and Biological Warfare Agents*. These indices are response guides similar in concept to those found in the *North American Emergency Response Guidebook*. They deal with classes of agents (e.g., nerve, blister, etc.) instead of focusing on specific agents. Each index contains information on the toxicology/health impacts, physical characteristics, hazards from fire or reactivity, protection of personnel, and general first aid for that agent class. They were developed because in many cases, due to the limitations of currently available detection equipment; identifying the actual agent(s) involved in the release will not be possible. This can limit the value of agent-specific information.

This book was designed to provide rapid access to critical emergency information at the scene of a release of chemical or biological warfare agents and facilitate coordination with off-site personnel who have access to more comprehensive information in the *Handbook of Chemical and Biological Warfare Agents*. In addition to the class indices, the *Handbook* contains detailed information on the physical, chemical, biological and toxicological properties of a large number of warfare agents, key precursors used to synthesize chemical agents, and industrial materials that could potentially be used as improvised warfare agents.

This book is a compilation of information gathered from numerous sources and arranged into the current format. In general the most conservative recommendations for response actions have been incorporated into each index. As with all hazardous materials and safety information, readers are encouraged to evaluate as many sources as they can find in order to make the most informed decisions. Any use of the information contained in this book must be determined by the user to be in accordance with their standard operating procedures as well as applicable federal, state, and local laws and regulations.

How to Use this Book

The Class Indices were formulated around the basic military classification system of nerve agents, vesicants (blister agents), blood agents, choking agents, incapacitating agents, vomiting agents, and tear agents. While the acute physiological impacts from the various agents within each of these classes are essentially the same, there are variations in the physical/chemical properties and decomposition products. In some cases, the clinical presentation of symptoms can vary significantly. To account for these variations, the seven basic classes were divided into subclasses and a Class Index was developed for each of these subclasses. If the general type of agent is known, then the Class Index can be accessed directly.

This book also contains a list of common potential chemical and biological agents as identified in Field Manual 3-9 *Potential Military Chemical/Biological Agents and Compounds*, and Technical Manual 3-216 *Technical Aspects of Biological Defense*. Agents in this list, located in Chapter 1, are cross-referenced to the appropriate Class Index in Chapter 2. A more extensive list of potential agents and precursors can be found in the *Handbook of Chemical and Biological Warfare Agents*.

In the event that the identity of the agent or the class of agent cannot be determined, responders should refer to Class Index C00. This Index was developed to provide general response information appropriate to the deliberate release of hazardous materials. In addition to emergency information, it is designed to help responders determine the class of agent released through evaluation of the physical characteristics of the released material and the physiological effects on casualties.

Author

D. Hank Ellison, C.H.M.M., has served active duty in the United States Army as both an enlisted infantry soldier and a commissioned officer in the Chemical Corps. At the time of his service, Mr. Ellison was one of a very limited number of Airborne Ranger Chemical Officers in the Army. Serving as a Chemical Officer with both an infantry battalion and artillery battalion in the 101st Airborne Division, Mr. Ellison was responsible for managing training in all aspects of nuclear, biological, and chemical defense. Mr. Ellison was also an instructor on the construction and deployment of improvised flame munitions.

Mr. Ellison was employed by the U.S. Environmental Protection Agency as both a Remedial Project Manager and Federal On-Scene Coordinator. As a Remedial Project Manager in the Superfund Program, he managed the investigation and remediation of various hazardous waste sites. As an On-Scene Coordinator, he has responded to and managed numerous types of hazardous material emergencies throughout the Midwest. Mr. Ellison received numerous awards while employed at the EPA including a Bronze Medal for Commendable Service, and he was named the 1994 Region 5 On-Scene Coordinator of the Year.

As a private consultant, Mr. Ellison has responded to both transportation and fixed facility hazardous material incidents throughout the state of Michigan. He has acted as incident commander, safety officer, and response specialist at scenes involving chemical fires, water reactive materials and shock sensitive materials. He has provided chemical and biological counterterrorism training to members of hazardous materials (HazMat) teams, police Special Weapons and Tactics (SWAT) teams and Explosive Ordinance Disposal (EOD) teams. He is president of Cerberus & Associates, Inc. which provides specialized training and consulting services in chemical, nuclear, and biological agent awareness, counterterrorism security, coordination of incident response and technical information resources.

Mr. Ellison has a master of science degree in chemistry from the University of California, Irvine. His graduate research involved methods to synthesize poisons extracted from Colombian poison-dart frogs. He has a bachelor of science in chemistry from the Georgia Institute of Technology. Mr. Ellison has received specialized training from the U.S. Drug Enforcement Administration in operations involving clandestine drug laboratories. He is a graduate of the Radiation Safety course taught at Northwestern University. Mr. Ellison is a Certified Hazardous Materials Manager at the Master's Level. He is a member of the American Chemical Society and Federation of American Scientists. He is also a member of the Michigan Workgroup on Counterterrorism and a founding member of the Wayne County Emergency Management Division Technical Assistance Team for Weapons of Mass Destruction.

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Class Indices

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Class Indices

Class Index C00
Unknown Agent(s)

Toxicology

Effects:

Agents can produce both local and systemic effects. Assume that exposure to solids, liquids, or vapors from agents is hazardous and will potentially cause death within minutes after exposure. However, effects from some agents do not appear for up to 24 hours after exposure. Lack of immediate symptoms should not be taken as evidence that individuals have not been exposed. Some agents are carcinogenic.

Pathways:

Agents are potentially hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Characteristics

Physical Appearance/Odor:

Agents can be solids, liquids, or gases. Agents may be colorless when pure but yellow to brown to black depending on impurities. Liquid agents have a consistency ranging from near that of water up to that of motor oil. Most agents have poor warning properties. If the properties of these agents do give an indication of their presence, then they are usually only detected at levels much greater than is considered safe. Furthermore, any potential warning property, as well as any distinguishing physical characteristic such as color, may not be apparent because multiple agents have been employed or the materials released may be impure.

Odor	***Potential Class of Agent***
Pepper-like odor	Halogenated tear agents (C17) Tear agents in solvents (C19)
Garlic-like odor	Sulfur mustard agents (C07) Mixed sulfur/arsenical mustard agents (C10) Arsenical blood agents (C13) Vomiting agents (C20)
Fishy odor	Nitrogen mustard agents (C09)
"Musty" odor	Nitrogen mustard agents (C09)
"Sweetish" odor	Non-halogenated tear agents (C18) Tear agents in solvents (C19)
"Soft-soap" like odor	Nitrogen mustard agents (C09)
Horseradish-like odor	Sulfur mustard agents (C07) Mixed sulfur/arsenical mustard agents (C10)
Odor of bitter almonds or peach kernels	G-series nerve agents (C01) General blood agents (C12) Vomiting agents (C20)
Odor of sour or rotten fruit	Non-halogenated tear agents (C18)
Odor of new mown hay or freshly cut grass	Choking agents (C14)
Fruity or floral odors	G-series nerve agents (C01) Arsenical mustard agents (C08) Halogenated tear agents (C17) Tear agents in solvents (C19)
Biting or irritating odors	Arsenical mustard agents (C08) General blood agents (C12) Choking agents (C14) Tear agents (C17 – C19) Vomiting agents (C20)

Persistency:

Agents can be either persistent or nonpersistent. Persistency of agents released in enclosed spaces (e.g., inside buildings) is dramatically increased.

Environmental Fate:

Vapors from most agents have a density greater than air and tend to collect in low places. Many agents are absorbed into porous material, including painted surfaces. These materials could continue to re-release vapor after exposure has ceased. Most agents have minimal solubility in water.

Additional Hazards

Fire:

Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, agents may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 700 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military

CAM: Semi-quantitative identification of nerve agents (C01 – C05) and most blister agents (C07, C09, C10)

M256A1 Kit: Qualitative identification of nerve agents (C01 – C05), blister agents (C07, C08, C10, C11), and general blood agents (C12)

Rapid diagnostic assays for detection of biological agents are available for Anthrax; Crimean-Congo Hemorrhagic Fever; Dengue (DF, DHF, DSS); Mediterranean Spotted Fever; Q Fever; Plague; Relapsing Fever; Rift Valley Fever; Sandfly Fever, Naples; Sandfly Fever, Sicilian; Sindbis Fever; Tularemia; Typhus, Murine (Endemic); and West Nile Fever/Encephalitis.

Rapid diagnostic assays for detection of toxin agents are available for Botulinum Toxin; Clostridium Perfringens Toxin; Staphylococcal Enterotoxin B; and Staphylococcal Enterotoxins A/C1,2,3/D

Civilian

APD 2000: Semi-quantitative identification of nerve agents (C01 – C05), most blister agents (C07 – C10), and limited tear agents (pepper spray and mace)

Photo Ionization Detectors: General surveys of organic agent vapors other than phosgene and the cyanide agents. However, because these systems will not differentiate between hazardous materials and any other ionizable chemical vapor, interpretation of the screening results is necessary.

Flame Ionization Detectors: General surveys of organic agent vapors. However, because these systems will not differentiate between hazardous materials and any other ionizable chemical vapor, interpretation of the screening results is necessary.

Colorimetric Tubes: Many of these tubes have cross sensitivities and care must be taken to correctly interpret the results.

Phosphoric Acid esters:	Nerve agents (C01 – C05)
Thioethers:	Sulfur blister agents (C07, C10)
Organic Basic Nitrogen Compounds:	Nitrogen blister agents (C09), V and GV-series nerve agents (C02, C03)
Organic Arsenic Compounds:	Arsenical blister agents (C08, C10), arsenical blood agents (C13), and vomiting agents (C20)
Hydrogen Cyanide:	Specific to this blood agent (C12)
Cyanogen Chloride:	Specific to this blood agent (C12)
Phosgene:	Some choking agents (C14)
Chloroformates:	Some choking agents (C14)

Carbon Tetrachloride:	Halogen choking agents (C14) and chloropicrin (C17)
Chlorine:	Halogen choking agents (C14)

Rapid diagnostic SMART Tickets are currently available for identification of biological agents Anthrax and Plague.

Rapid diagnostic SMART Tickets are currently available for identification of toxin agents Botulinum Toxin and Staphylococcus Enterotoxin B (SEB).

> **Because of the high volatility and nonpersistence of some agents, lack of positive field identification should not be considered proof that agents were not released. Unless the release occurred in an enclosed or confined space, then by the time testing can be undertaken there may not be a detectable level of agent remaining at the scene.**

Personal Protective Requirements:

Assume that agents pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Refer to appropriate Class Index based on Field Detection/Identification or casualty Signs & Symptoms

First Aid

Signs & Symptoms:

The following symptoms may be manifested by casualties within approximately the first two hours after exposure. However, effects from some agents do not appear for up to 24 hours after exposure. Lack of immediate symptoms should not be taken as evidence that individuals have not been exposed. Appearance of the symptoms, as well as the severity, is dependent on the amount of exposure and susceptibility of the exposed individuals.

> **Many of these symptoms are also common to individuals who are experiencing panic or extreme stress.**

Prostration without signs of physical injury	Nerve agents (C01 – C06) Blister agents (C07 – C11)

	Blood agents (C12 – C13) Incapacitating agents (C16)
Involuntary twitching, jerking, or trembling	Nerve agents (C01 – C06) Blood agents (C12 – C13) Incapacitating agents (C16)
Convulsions	Nerve agents (C01 – C06) Blood agents (C12 – C13) Choking agents (C14 – C15)
Reddening of lips or skin	Blister agents (C07 – C11) Blood agents (C12 – C13) Incapacitating agents (C16)
Gray area of dead skin that does not blister	Blister agents (C08, C10)
Sunburn like appearance (erythema) of exposed skin	Blister agents (C07 – C11) Toxins posing a dermal hazard (C23)
Pain, burning sensation or stinging of eyes or skin	Blister agents (C07 – C11) Choking agents (C14) Tear agents (C17 – C19) Toxins posing a dermal hazard (C23)
Pinpointing of pupils (miosis)	Nerve agents (C01 – C06) Incapacitating agents (C16)
Enlargement of pupils (dilation)	Incapacitating agents (C16)
Inability to open the eyes	Blister agents (C07 – C11) Tear agents (C17 – C19)
Tearing (lacrymation)	Blister agents (C07 – C11) Blood agents (C12) Choking agents (C14) Tear agents (C17 – C19) Toxins posing a dermal hazard (C23)
Severe coughing or sneezing	Blister agents (C07 – C11) Blood agents (C12) Choking agents (C14) Vomiting agents (C20) Toxins (C22 – C23)
Nosebleed (epistaxis)	Blister agents (C07 – C11) Blood agents (C12) Choking agents (C14) Vomiting agents (C20) Toxins posing a dermal hazard (C23)
Severe runny nose (rhinorrhea)	Nerve agents (C01 – C06) Blister agents (C07 – C11) Vomiting agents (C20) Toxins (C22 – C23)
Difficulty breathing, shortness of breath	Nerve agents (C01 – C06) Blister agents (C07 – C11)

	Choking agents (C14 – C15)
	Vomiting agents (C20)
Extremely dry mouth or throat	Incapacitating agents (C16)
Severe headache	Nerve agents (C01 – C06)
	Blood agents (C12 – C13)
	Choking agents (C14 – C15)
	Vomiting agents (C20)
	Incapacitating agents (C16)
Involuntary defecation and urination	Nerve agents (C01 – C06)
Nausea	Nerve agents (C01 – C06)
	Blister agents (C08, C10)
	Blood agents (C12 – C13)
	Choking agents (C14 – C15)
	Vomiting agents (C20)
	Incapacitating agents (C16)
	Toxins (C22 – C23)
Vomiting	Nerve agents (C01 – C06)
	Blister agents (C08, C10)
	Blood agents (C12 – C13)
	Choking agents (C14 – C15)
	Vomiting agents (C20)
	Incapacitating agents (C16)
Localized sweating	Nerve agents (C01 – C06)
Excessive sweating	Nerve agents (C01 – C06)
Inability to sweat	Incapacitating agents (C16)

Patient Management:

Refer to appropriate Class Index based on Field Detection/Identification or casualty Signs & Symptoms

Class Index C01
Nerve Agents – "G" Series

Toxicology

Effects:

Nerve Agents are the most toxic of the known chemical agents. Liquids or vapors from these agents are hazardous and can cause death within minutes after exposure. Nerve Agents disrupt the function of the nervous system by interfering with the enzyme acetylcholinesterase. The major effects will be on skeletal muscles, certain organs, and the central nervous system. These compounds are similar to, but much more deadly than, agricultural organophosphate pesticides.

Pathways:

"G" series Nerve Agents are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Exposure Hazards:

LC_{50}s for inhalation of "G" series Nerve Agents are as low as 1 ppm (10 minute exposure).

LD_{50}s for skin exposure to liquid "G" series Nerve Agents are as low as 0.3 gm per individual.

The rate of detoxification of these agents by the body is very low and exposures are essentially cumulative.

Latency Period:

Vapor: Effects from vapor exposure begin to appear 30 seconds to 2 minutes after exposure.

Liquid: There is almost always a latent period with no visible effects between the time of exposure and the onset of symptoms. Effects from liquid exposure begin to appear from several minutes up to 18 hours after exposure. Onset of symptoms from exposure to large amounts of liquid agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Characteristics

Physical Appearance/Odor:

"G" series Nerve Agents are colorless to brownish liquids with a consistency ranging from near that of water up to that of light machine oil. These agents have little or no odor when pure. Agents can be thickened with various substances to increase persistency and percutaneous hazard. When thickened, agents have a consistency similar to honey. Conversely, various solvents can be added to dilute the agents. Solvents may also dramatically increase the rate that agents penetrate the skin.

Persistency:

Unthickened "G" series Nerve Agents can be either nonpersistent or persistent depending on the specific agent as well as weather conditions. Evaporation rates range from near that of water up to that of light machine oil. Thickened agents last significantly longer.

Environmental Fate:

"G" series Nerve Agent vapors have a density greater than air and tend to collect in low places. Nerve Agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased. Clothing may re-release agent for up to 30 minutes after contact with vapor. Solubility in water ranges from completely soluble to almost insoluble. The liquid densities of these agents are slightly greater than that of water.

Additional Hazards

> **Exposure of skin to various solvents (e.g., acetone, alcohols, ethers, gasoline) prior to exposure to nerve agents may increase the percutaneous hazard and decreases survival time associated with agent exposure.**

Fire:

"G" series Nerve Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, "G" series Nerve Agents may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Most of the "G" series Nerve Agents decompose slowly in water. Raising the pH increases the rate of decomposition significantly. Reaction with dry bleach may produce toxic gases.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 700 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (Table 3.1):

Military: *Vapor:* "G" series Nerve Agents can be detected by the M8A1 Alarm, M256A1 Kit, and CAM.
Liquids: "G" series Nerve Agents can be detected by M8 and M9 papers.

Civilian: The ADP 2000 provides semi-quantitative identification of nerve agents. Colorimetric tubes are available which are designed to qualitatively detect vapors of phosphoric acid esters as well as the decomposition products hydrogen fluoride (HF), hydrogen chloride (HCl), and hydrogen cyanide (HCN). Detection of agents with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

"G" series Nerve Agents pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Thickened agents pose a less significant vapor hazard but a much more significant contact hazard.

Decontamination:

Vapor: *Casualties/personnel:* Skin decontamination may not be necessary after exposure to vapor alone. If decontamination is deemed appropriate, wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Ventilation. In heavily contaminated areas, decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight) may be required. If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent vapor may be required as these materials could continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible. Minimize spreading the agent during this process. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, or towels. Place the absorbed material into containers with a high-density polyethylene liner. Decontaminate the area with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent liquid may be required as these materials could continue to re-release liquid and/or vapor after exposure has ceased.

First Aid

Signs & Symptoms:

Vapor: Miosis (pinpointing of pupils) and rhinorrhea (runny nose) may be the first indications of exposure to nerve agent vapor. Miosis is indicative of vapor exposure unless liquid agent has been in contact with the eyes. Difficulty breathing (shortness of breath or tightness of the chest) may also be present. Inhalation of lethal amounts of vapor can cause loss of consciousness and convulsions within 30 seconds to 2 minutes of exposure, followed by cessation of breathing and flaccid paralysis after several more minutes.

Liquid: Localized sweating, nausea, vomiting, involuntary urination/defecation, and a feeling of weakness are signs of small to moderate Nerve Agent exposure. Involvement of the gastrointestinal tract (i.e., vomiting, urination, or defecation) is generally indicative of liquid agent exposure. Large exposures cause copious secretions, loss of consciousness, convulsions progressing into flaccid paralysis, and cessation of breathing.

Patient Management:

Decontaminate casualty insuring that all agent has been removed. Ventilate patient (there may be an increase in airway resistance due to constriction of the airway and the presence of secretions). If breathing is difficult, administer oxygen. Administer antidotes as soon as possible.

Antidotes:

Atropine alone or in combination with pralidoxime chloride (2-PAMCl) or other oxime. Diazepam may be required to control severe convulsions.

Class Index C02
Nerve Agents – "V" Series

Toxicology

Effects:

Nerve Agents are the most toxic of the known chemical agents. Solids, liquids, or vapors from these agents are hazardous and can cause death within minutes after exposure. Nerve Agents disrupt the function of the nervous system by interfering with the enzyme acetylcholinesterase. The major effects will be on skeletal muscles, certain organs, and the central nervous system. These compounds are similar to, but much more deadly than, agricultural organophosphate pesticides.

Pathways:

Although Nerve Agents are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris), the primary risk posed by "V" series Nerve Agents is through percutaneous exposure.

Exposure Hazards:

LC_{50}s for inhalation of "V" series Nerve Agents are as low as 0.3 ppm (10 minute exposure).

LD_{50}s for skin exposure to liquid "V" series Nerve Agents are as low as 0.01 gm per individual.

The rate of detoxification of these agents by the body is very low and exposures are essentially cumulative.

Latency Period:

Vapor:	Effects from vapor exposure begin to appear 30 seconds to 2 minutes after exposure.
Liquid:	There is almost always a latent period with no visible effects between the time of exposure and the onset of symptoms. Effects from liquid exposure begin to appear from several minutes up to 18 hours after exposure. Onset of symptoms from exposure to large amounts of liquid

agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Solid: Moist (sweaty) areas are more susceptible to solid Nerve Agents. There is almost always a latent period with no visible effects between the time of exposure and the onset of symptoms. Effects from solid exposure begin to appear from several minutes up to 18 hours after exposure. Onset of symptoms from exposure to large amounts of solid agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Characteristics

Physical Appearance/Odor:

"V" series Nerve Agents can be either solids or liquids. Liquids are colorless to brownish in color. Liquid agents have a consistency ranging from near that of light machine oil up to that of motor oil. These agents have little or no odor when pure. Liquid agents can also be thickened with various substances to increase their persistency and percutaneous hazard. When thickened, agents have a consistency similar to honey. Conversely, various solvents can be added to dilute the agents. Solvents may also dramatically increase the rate that agents penetrate the skin.

Persistency:

All unthickened "V" series Nerve Agents are classified as persistent. Evaporation rates ranging from near that of light machine oil up to that of motor oil. Thickened agents last significantly longer.

Environmental Fate:

Although "V" series Nerve Agents have very little vapor pressure, significant amounts of vapor can accumulate in confined or enclosed spaces. Vapors have a density greater than air and tend to collect in low places. Nerve Agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased (clothing may re-release agent for up to 30 minutes after contact with vapor). "V" series Nerve Agents are unusual in that they may be more soluble in cool water than warm water. The liquid density of these agents is slightly greater than that of water.

Additional Hazards

> **Exposure of skin to various solvents (e.g., acetone, alcohols, ethers, gasoline) prior to exposure to nerve agents may increase the percutaneous hazard and decrease survival time associated with agent exposure.**

Fire:

Nerve Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic gases.

Reactivity:

Most of these Nerve Agents are decomposed slowly in water. Raising the pH increases the rate of decomposition significantly. Extremely hazardous decomposition products, some with toxicities near those of the original agents, are produced by hydrolysis.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 700 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: *Vapor:* "V" series Nerve Agent can be detected by the M8A1 Alarm, M256A1 Kit, and CAM. However, since these agents have minimal vapor pressure, it may be difficult to effectively identify "V" series Nerve Agent vapors except in a confined or enclosed space.
Liquids: "V" series Nerve Agent can be detected by M8 and M9 papers.

Solids: There are currently no methods for direct detection of solid agents fielded by the U.S. Military.

Civilian: The ADP 2000 provides semi-quantitative identification of nerve agents. Colorimetric tubes are available which are designed to qualitatively detect vapors of phosphoric acid esters. Detection of agents with PIDs or FIDs may be possible. However, since these agents have minimal vapor pressure, it may be difficult to effectively identify "V" series Nerve Agent vapors except in a confined or enclosed space.

Personal Protective Requirements:

Although "V" series Nerve Agents pose primarily a severe contact hazard, significant amounts of vapor can accumulate in confined or enclosed spaces and pose a severe respiratory hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Solid and thickened agents pose a less significant vapor hazard but a much more significant contact hazard. If solid agents have been released, dust control during windy conditions will be essential.

Decontamination:

Vapor: *Casualties/personnel:* Skin decontamination may not be necessary after exposure to vapor alone. If decontamination is deemed appropriate, wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Ventilation. In heavily contaminated areas, decontamination with a fresh solution of HTH pool bleach in denatured alcohol (approximately 9 percent by weight) followed by decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). Vigorous off-gassing may occur during this process. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent vapor may be required as these materials could continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels or cloth towels. Place the absorbed material into containers with a high-density polyethylene liner. Decontaminate the area with a fresh solution of HTH pool bleach in denatured alcohol (approximately 9 percent by weight) followed by decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). Vigorous off-gassing may occur during this process. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent liquid may be required as these materials could continue to re-release liquid and/or vapor after exposure has ceased.

Solids: *Casualties/personnel:* Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water.

Small Areas: Consolidate as much material as possible and place into containers. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. Decontaminate the area with a fresh solution of HTH pool bleach in denatured alcohol (approximately 9 percent by weight) followed by decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). Vigorous off-gassing may occur during this process.

First Aid

Signs & Symptoms:

Vapor: Miosis (pinpointing of pupils) and rhinorrhea (runny nose) may be the first indications of exposure to nerve agent vapor. Miosis is indicative of vapor exposure unless liquid has been in contact with the eyes. Difficulty breathing (shortness of breath or tightness of the chest) may also be present. Lethal amounts of vapor cause loss of consciousness and convulsions within 30 seconds to 2 minutes of exposure, followed by cessation of breathing and flaccid paralysis after several more minutes.

Liquid/Solids: Localized sweating, nausea, vomiting, involuntary urination/defecation, and a feeling of weakness are signs of small to moderate Nerve Agent exposure. Involvement of the gastrointestinal tract (i.e., vomiting, urination, or defecation) is generally indicative of liquid or solid exposure. Large exposures cause copious secretions, loss of consciousness, convulsions progressing into flaccid paralysis, and cessation of breathing.

Patient Management:

Decontaminate casualty insuring that all agent has been removed. Ventilate patient (there may be an increase in airway resistance due to constriction of the airway and the presence of secretions). If breathing is difficult, administer oxygen. Administer antidotes as soon as possible.

Antidotes:

Atropine alone or in combination with pralidoxime chloride (2-PAMCl) or other oxime. Diazepam may be required to control severe convulsions.

Class Index C03
Nerve Agents – "GV" Series

Toxicology

Effects:

Nerve Agents are the most toxic of the known chemical agents. The "GV" series is a relatively new sub-class of the standard "G" series Nerve Agents. Solids, liquids, or vapors from these agents are hazardous and can cause death within minutes after exposure. Nerve Agents disrupt the function of the nervous system by interfering with the enzyme acetylcholinesterase. The major effects will be on skeletal muscles, some organs, and the central nervous system. These compounds are similar to, but much more deadly than, agricultural organophosphate pesticides.

Pathways:

"GV" series Nerve Agents are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Exposure Hazards:

Human toxicity data for the "GV" series Nerve Agents has not been published or has not been established. However, "GV" Nerve Agents combine attributes of both the "G" series (see Class Index C01) and the "V" series (see Class Index C02). "GV" series Nerve Agents present greater percutaneous hazards than the standard "G" series Nerve Agents and a greater vapor hazard than the "V" series Nerve Agents. Toxicities of the "GV" series Nerve Agents appear to be in a range nearly as low as the "V" series Nerve Agents.

The rate of detoxification of these agents by the body is very low and exposures are essentially cumulative.

Latency Period:

Vapor:	Effects from vapor exposure begin to appear 30 seconds to 2 minutes after exposure.
Liquid:	There is almost always a latent period with no visible effects between the time of exposure and the onset of

symptoms. Effects from liquid exposure begin to appear from several minutes up to 18 hours after exposure. Onset of symptoms from exposure to large amounts of liquid agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Solid: Moist (sweaty) areas are more susceptible to solid Nerve Agents. There is almost always a latent period with no visible effects between the time of exposure and the onset of symptoms. Effects from solid exposure begin to appear from several minutes up to 18 hours after exposure. Onset of symptoms from exposure to large amounts of solid agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Characteristics

Physical Appearance/Odor:

"GV" series Nerve Agents may be liquids or solids.

Persistency:

"GV" series Nerve Agents are also known as intermediate volatility agents (IVAs). They are significantly more persistent than other "G" series Nerve Agents (see Class Index C01) but with a significantly greater vapor pressure (i.e., pose a greater inhalation hazard) than the "V" series Nerve Agents (see Class Index C02). In general, "GV" series Nerve Agents should be considered persistent.

Environmental Fate:

"GV" series Nerve Agents are not as stable as either "G" series or "V" series Nerve Agents and tend to decompose on storage. Agent vapors have a density greater than air and tend to collect in low places. Nerve Agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased. Clothing may re-release agent for up to 30 minutes after contact with vapor. Solubility of the agents in water is not available but should be considered moderate. Solubility of the salts of agents should be considered significant. The liquid densities of these agents are greater than that of water.

Additional Hazards

> **Exposure of skin to various solvents (e.g., acetone, alcohols, ethers, gasoline) prior to exposure to nerve agents may increase the percutaneous hazard and decreases survival time associated with agent exposure.**

Fire:

"GV" series Nerve Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, "GV" series Nerve Agents may react with steam or water during a fire to produce toxic and corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Most of the "GV" series Nerve Agents decompose slowly in water. A significant change in the pH (either higher or lower) increases the rate of decomposition considerably.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 700 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: Information on detection of "GV" series Nerve Agents is not available. However, based on their similarity to "G" and "V" series agents, it is likely that agent vapor can be detected by the M256A1 Kit and that liquid agents can be detected by M8 and M9 papers.

Civilian: The APD 2000 provides semi-quantitative identification of nerve agents. Colorimetric tubes are available which are designed to qualitatively detect vapors of phosphoric acid esters as well as the key decomposition products hydrogen fluoride (HF) and organic amines. Detection of agents with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

"GV" series Nerve Agents pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Solid agents pose a less significant vapor hazard but a much more significant contact hazard. Dust control during windy conditions will be essential.

Decontamination:

Vapor: *Casualties/personnel:* Skin decontamination may not be necessary after exposure to vapor alone. If decontamination is deemed appropriate, wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Ventilation. In heavily contaminated areas, decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight) may be required. If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent vapor may be required as these materials continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water.

In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels or cloth towels. Place the absorbed material into containers with a high-density polyethylene liner. Decontaminate the area with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent liquid may be required as these materials could continue to re-release liquid and/or vapor after exposure has ceased.

Solids: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water.

Small Areas: Consolidate as much material as possible and place into containers. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. Decontaminate the area with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). If sodium hydroxide solution is not available, then sodium carbonate may be used.

First Aid

Signs & Symptoms:

Vapor: In contrast to either the "G" or "V" series Nerve Agents, the observable signs and symptoms of exposure to the "GV" series Nerve Agents are more insidious and tend to be very mild and transient. Miosis (pinpointing of pupils) and rhinorrhea (runny nose) may be the first indications of exposure to Nerve Agent vapor. Miosis is indicative of vapor exposure unless liquid has been in contact with the eyes. Difficulty breathing (shortness of breath or tightness of the chest) may also be present. Lethal amounts of vapor cause loss of consciousness and convulsions within 30 seconds to 2 minutes of exposure, followed by cessation of breathing and flaccid paralysis after several more minutes.

Liquid/Solids: In contrast to either the "G" or "V" series of Nerve Agents, the observable signs of exposure to the "GV" series Nerve Agents are more insidious and tend to be very mild and transient. Even convulsions occurring just prior to death are usually milder than with the other series of Nerve Agents. The progression of signs and symptoms from percutaneous exposure to the "GV" series Nerve Agents may not follow the same order as with the other series Nerve Agents. However, the general signs and symptoms of small to moderate exposure include localized sweating, nausea, vomiting, involuntary urination/defecation, and a feeling of weakness. Involvement of the gastrointestinal tract (i.e., vomiting, urination, or defecation) is indicative of exposure to either liquid or solid agent. Large exposures cause copious secretions, loss of consciousness, convulsions progressing into flaccid paralysis, and cessation of breathing.

Patient Management:

Decontaminate casualty insuring that all agent has been removed. Ventilate patient (there may be an increase in airway resistance due to constriction of the airway and the presence of secretions). If breathing is difficult, administer oxygen. Administer antidotes as soon as possible.

Antidotes:

Atropine alone or in combination with pralidoxime chloride (2-PAMCl) or other oxime. Diazepam may be required to control severe convulsions.

Class Index C04
Nerve Agents – Novichok

Toxicology

Effects:

Nerve Agents are the most toxic of the known chemical agents. The Novichok series is a new class of Nerve Agents developed by the former Soviet Union. Minimal information has been published about these agents. However, as with other Nerve Agents (see Class Indices C01 through C03), liquids or vapors from these agents are hazardous and can cause death within minutes after exposure. Nerve Agents disrupt the function of the nervous system by interfering with the enzyme acetylcholinesterase. The major effects will be on skeletal muscles, certain organs, and the central nervous system. These compounds are similar to, but much more deadly than, agricultural organophosphate pesticides.

Pathways:

Nerve Agents are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Exposure Hazards:

Human toxicity data for the Novichok series Nerve Agents has not been published or has not been established. However, available information indicates that under optimum conditions Novichok agents are 5 to 8 times more effective than nerve agent VX (see Agent Index A010, Class Index C02).

Novichok Nerve Agents may occur in a binary form (see Class Index C05). Components, byproducts, or solvents may have toxic properties and present additional hazards. These materials may also impact the rate that the agents volatilize or penetrate the skin.

> **The rate of detoxification of other nerve agents by the body is very low and exposures are essentially cumulative. It should be assumed that Novichok agents are also cumulative.**

Latency Period:

Vapor:	Unavailable. However, effects from vapor exposure to other classes of nerve agents begin to appear 30 seconds to 2 minutes after exposure (see Class Indices C01 through C03). It is probable that this is also true for Novichok Agents.
Liquid:	Unavailable. However, effects from liquid exposure to other classes of nerve agents begin to appear from several minutes up to 18 hours after exposure (see Class Indices C01 through C03). It is probable that this is also true for Novichok Agents.

Characteristics

Physical Appearance/Odor:

Information on any physical characteristics of Novichok Nerve Agents has not been published.

The binary version of these agents will consist of two relatively "nontoxic" chemicals which form the Novichok Nerve Agent when mixed. Prior to mixing, components may be either liquids or solids. Because mixing occurs just prior to, or as a result of, deployment, the crude Nerve Agent formed will be a mixture of the agent, components, and byproducts. The color, odor, and consistency of the crude Nerve Agent will vary based on the quality of the components and the degree of mixing.

Persistency:

Information on the persistency of Novichok Nerve Agents has not been published.

Environmental Fate:

Novichok Nerve Agent vapors have a density greater than air and tend to collect in low places. As with other Nerve Agents (see Class Indices C01 through C03), it is likely that Novichok Nerve Agents will be absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased. The solubility of these agents in water is unavailable. The liquid densities of these agents is unavailable.

Additional Hazards

Exposure of skin to various solvents (e.g., acetone, alcohols, ethers, gasoline) prior to exposure to nerve agents may increase the percutaneous hazard and decrease survival time associated with agent exposure.

Fire:

Nerve Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. If the binary form of the agents is released, flammable solvents used to facilitate mixing of the binary components may be present and pose an additional fire hazard.

Reactivity:

Unavailable.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 700 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military:	*Vapor:* It is not known which, if any, detector systems are capable of detecting Novichok Nerve Agents. *Liquids:* It is not known which, if any, detector systems are capable of detecting Novichok Nerve Agents.
Civilian:	Colorimetric tubes are available which are designed to qualitatively detect vapors of phosphoric acid esters. Detection of agents with PIDs or FIDs may be possible. However, it is not known if these agents have enough vapor pressure to facilitate effective field identification.

Personal Protective Requirements:

As with other Nerve Agents (see Class Indices C01 through C03) Novichok Nerve Agents pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Vapor: *Casualties/personnel:* Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Ventilation. In heavily contaminated areas, decontamination with a fresh solution of HTH pool bleach in denatured alcohol (approximately 9 percent by weight) followed by decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). Vigorous off-gassing may occur during this process. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent vapor may be required as these materials could continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels or cloth towels. Place the absorbed material into containers with a high-density polyethylene liner. Decontaminate the area with a fresh solution of HTH pool bleach in denatured alcohol (approximately 9 percent by weight) followed by decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). Vigorous off-gassing may occur during this process. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent liquid may be required as these materials could continue to re-release liquid and/or vapor after exposure has ceased.

First Aid

Signs & Symptoms:

Vapor: Miosis (pinpointing of pupils) and rhinorrhea (runny nose) may be the first indications of exposure to nerve agent vapor. Miosis is indicative of vapor exposure unless liquid has been in contact with the eyes. Difficulty breathing (shortness of breath or tightness of the chest) may also be present. Lethal amounts of vapor cause loss of consciousness and convulsions within 30 seconds to 2 minutes of exposure, followed by cessation of breathing and flaccid paralysis after several more minutes.

Liquid: Localized sweating, nausea, vomiting, involuntary urination/defecation, and a feeling of weakness are signs of small to moderate Nerve Agent exposure. Involvement of the gastrointestinal tract (i.e., vomiting, urination, or defecation) is generally indicative of liquid or solid exposure. Large exposures cause copious secretions, loss of consciousness, convulsions progressing into flaccid paralysis, and cessation of breathing.

Patient Management:

Decontaminate casualty insuring that all agent has been removed. Ventilate patient (there may be an increase in airway resistance due to constriction of the airway and the presence of secretions). If breathing is difficult, administer oxygen. Administer antidotes as soon as possible.

Antidotes:

It has not been published how Novichok Nerve Agents will respond to treatment with standard antidotes (i.e., atropine in combination with pralidoxime chloride. See Class Indices C01 through C03). It is known that some of the agents in this class have been designed to be resistant to therapy.

Class Index C05
Nerve Agents – Binary and Components

Toxicology

Effects:

Nerve Agents are the most toxic of the known chemical agents. Solids, liquids, or vapors from these agents are hazardous and can cause death within minutes after exposure. Nerve Agents disrupt the function of the nervous system by interfering with the enzyme acetylcholinesterase. The major effects will be on skeletal muscles, some organs, and the central nervous system. These compounds are similar to, but much more deadly than, agricultural organophosphate pesticides.

Pathways:

Nerve Agents are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Exposure Hazards:

Are the same as the non-Binary Nerve Agents (see Class Indices C01 through C04). Components, byproducts, or solvents may have toxic properties and present additional hazards. These materials may also impact the rate that the Binary Nerve Agents volatilize or penetrate the skin.

> **The rate of detoxification of nerve agents by the body is very low and exposures are essentially cumulative.**

Latency Period:

Vapor:	Effects from vapor exposure begin to appear 30 seconds to 2 minutes after exposure.
Liquid/Solid:	There is almost always a latent period with no visible effects between the time of exposure and the onset of symptoms. Effects from liquid exposure begin to appear from several minutes up to 18 hours after exposure. Onset of symptoms from exposure to large amounts of liquid agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Characteristics

Physical Appearance/Odor:

Binary Nerve Agents consist of two relatively "nontoxic" chemicals which form a standard "G" series (Class Index C01), "V" series (Class Index C02), or "GV" series (Class Index C03) Nerve Agent when mixed. Prior to mixing, components may be either liquids or solids. Upon mixing, crude "G" series, "V" series, or "GV" series Nerve Agents are formed. Because mixing occurs just prior to or as a result of deployment, the crude Nerve Agent formed will be a mixture of the agent, components, and byproducts. The color, odor and consistency of the crude Nerve Agent will vary based on the quality of the components and the degree of mixing.

Persistency:

Binary Nerve Agents may be either nonpersistent or persistent. Evaporation rates, decomposition rates, and permeation rates in porous material of the crude Nerve Agents may be different from the standard "G" series, "V" series, or "GV" series agents because of the presence of unreacted components and reaction byproducts.

Environmental Fate:

Binary Component vapors have a density greater than air and tend to collect in low places. The liquid density of components ranges from slightly less than that of water to greater than that of water.

Nerve Agent vapors have a density greater than air and tend to collect in low places. Nerve Agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased. Clothing may re-release agent for up to 30 minutes after contact with vapor. Nerve agent solubility in water ranges from completely soluble to almost insoluble. The liquid density of the resulting Nerve Agents is slightly greater than that of water.

Additional Hazards

> **Exposure of skin to various solvents (e.g., acetone, alcohols, ethers, gasoline) prior to exposure to nerve agents may increase the percutaneous hazard and decrease survival time associated with agent exposure.**

Fire:

Binary Nerve Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, either the components or the crude

Nerve Agents may react with steam or water during a fire to produce toxic, flammable and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present. Flammable solvents used to facilitate mixing of the binary components may be present and pose an additional fire hazard.

Reactivity:

Many Binary Nerve Agent Components are corrosive or react with water to form corrosive materials. Components may also react with water to produce extremely toxic materials. Other common chemicals, such as alcohols, radiator fluids, dry cleaning solvents, or sulfur containing (vulcanized) products may react with components to form toxic materials. Reaction with dry bleach may produce toxic gases. In some cases, extremely hazardous decomposition products, some with toxicities near those of the original agents, are produced by hydrolysis of either the components or the Nerve Agents formed.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 700 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent, and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (Table 3.1):

Military: *Nerve Agent Vapor:* Can be detected by the M8A1 Alarm, M256A1 Kit, and CAM.
Nerve Agent Liquid: Can be detected by M8 and M9 papers.
Component Liquid/Vapor: Currently there is no field system employed by the U.S. Military that is designed to detect Binary Nerve Agent Components.

Civilian: The APD 2000 provides semi-quantitative identification of nerve agents. Colorimetric tubes are available which are designed to qualitatively detect vapors of phosphoric acid esters. Colorimetric tubes are available which can detect hydrogen chloride (HCl) and hydrogen fluoride (HF) gases. Detection with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Binary Components and the resultant Nerve Agents pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Nerve Vapor: *Casualties/personnel:* Skin decontamination may not be necessary after exposure to vapor alone. If decontamination is deemed appropriate, wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Ventilation. In heavily contaminated areas, decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight) may be required. If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent vapor may be required as these materials could continue to re-release vapor after exposure has ceased.

Nerve Liquid: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels, or cloth towels. Place the absorbed material into containers with a high-density polyethylene liner. Decontaminate the area with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent liquid may be required as these materials could continue to re-release liquid and/or vapor after exposure has ceased.

Components: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with copious quantities of water. *Small Areas:* Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels, or cloth towels. Place the absorbed material into containers with a high-density polyethylene liner. Decontaminate the area with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed components may be required as these materials could continue to re-release liquid and/or vapor after exposure has ceased.

First Aid

Signs & Symptoms:

Nerve Vapor: Miosis (pinpointing of pupils) and rhinorrhea (runny nose) may be the first indications of exposure to nerve agent vapor. Miosis is indicative of vapor exposure unless liquid has been in contact with the eyes. Difficulty breathing (shortness of breath or tightness of the chest) may also be present. Lethal amounts of vapor cause loss of consciousness and convulsions within 1 to 2 minutes of exposure, followed by cessation of breathing and flaccid paralysis after several more minutes.

Nerve Liquid:	Localized sweating, nausea, vomiting, involuntary urination/defecation, and a feeling of weakness are signs of small to moderate Nerve Agent exposure. Involvement of the gastrointestinal tract (i.e., vomiting, urination, or defecation) is indicative of liquid exposure. Large exposures cause copious secretions, loss of consciousness, convulsions progressing into flaccid paralysis, and cessation of breathing.
Components:	Vapors may cause eye and airway irritation, shortness of breath, and a feeling of chest tightness. In extreme cases, lung membranes swell, lungs become filled with liquid (pulmonary edema), and death may result from lack of oxygen. Vapors or liquids may cause skin irritation progressing to second or third degree burns as a result of formation of hydrogen fluoride (HF) when components contact moisture on the skin. Components may also disrupt the function of the nervous system by interfering with the enzyme acetylcholinesterase producing similar symptoms to nerve agents.

Patient Management:

Decontaminate casualty insuring that all components or agents have been removed. Ventilate patient (there may be an increase in airway resistance due to constriction of the airway and the presence of secretions). If breathing is difficult, administer oxygen. Administer antidotes as soon as possible.

Antidotes:

Nerve Agents:	Atropine alone or in combination with pralidoxime chloride (2-PAMCl) or other oxime. Diazepam may be required to control severe convulsions.
Components:	Treat hydrogen fluoride (HF) skin burns by soaking in iced zephiran, Epsom salt, or fresh dilute solution of sodium bicarbonate. If available, use calcium gluconate gel to treat burns. Alternatively, magnesium oxide and magnesium sulfate dressing can be used.

Class Index C06
Nerve Agents – Carbamates

Toxicology

Effects:

Nerve Agents are the most toxic of the known chemical agents. Solids, liquids or vapors from these agents are hazardous and can cause death within minutes after exposure. Nerve Agents disrupt the function of the nervous system by interfering with the enzyme acetylcholinesterase. The major effects will be on skeletal muscles, certain organs, and the central nervous system. These compounds are similar to, but much more deadly than, agricultural carbamate pesticides.

Pathways:

Carbamate Nerve Agents are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Exposure Hazards:

Human toxicity data for the Carbamate Nerve Agents has not been published or has not been established. However, based on animal studies, toxicities of some agents appear to be in a range nearly as low as the "V" series Nerve Agents (see Class Index C02).

These agents are rapidly detoxified or eliminated from the body and there is little or no cumulative toxicity.

Latency Period:

Vapor:	Effects from vapor exposure begin to appear 30 seconds to 2 minutes after exposure.
Liquid:	There is almost always a latent period with no visible effects between the time of exposure and the onset of symptoms. Effects from liquid exposure begin to appear from several minutes up to several hours after exposure. Onset of symptoms from exposure to large amounts of liquid agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Solid: Moist (sweaty) areas are more susceptible to solid Nerve Agents. There is almost always a latent period with no visible effects between the time of exposure and the onset of symptoms. Effects from solid exposure begin to appear from several minutes up to several hours after exposure. Onset of symptoms from exposure to large amounts of solid agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Characteristics

Physical Appearance/Odor:

Carbamate Nerve Agents may be liquids or solids and have little or no odor. Various solvents can be added to dilute the agents changing both their appearance and physical/chemical properties. Solvents may also dramatically increase the rate that agents penetrate the skin.

Persistency:

Carbamate Nerve Agents are persistent.

Environmental Fate:

Carbamate Nerve Agent vapors have a density greater than air and tend to collect in low places. Nerve Agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased. Clothing may continue to re-release vapor after contact with agents has ceased. Solubility in water ranges from completely soluble to almost insoluble. The liquid densities of these agents are slightly greater than that of water.

Additional Hazards

Fire:

Carbamate Nerve Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, Carbamate Nerve Agents may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Most of the Carbamate Nerve Agents are stable in water. Raising the pH increases the rate of decomposition significantly.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 700 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military:	Carbamate Nerve Agents are not identifiable by military detection equipment.
Civilian:	Detection of agents with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Carbamate Nerve Agents pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Solid agents pose a less significant vapor hazard but a much more significant contact hazard. Dust control during windy conditions will be essential.

Decontamination:

Vapor:	*Casualties/personnel:* Skin decontamination may not be necessary after exposure to vapor alone. If decontamination is deemed appropriate, wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water.

Wash with soap and water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Ventilation. In heavily contaminated areas, decontamination with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight) may be required. If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent vapor may be required as these materials continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels or cloth towels. Place the absorbed material into containers with a high-density polyethylene liner. Decontaminate the area with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). If sodium hydroxide solution is not available, then sodium carbonate may be used. Removal of porous material, including painted surfaces, that may have absorbed Nerve Agent liquid may be required as these materials could continue to re-release liquid and/or vapor after exposure has ceased.

Solids: *Casualties/personnel:* Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Wash with soap and water. Rinse with copious amounts of water. In all cases, clothing should be removed because it may contain "trapped" dust or vapor.

Small Areas: Consolidate as much material as possible and place into containers. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. Decontaminate the area with copious amounts of aqueous sodium hydroxide solution (a minimum of 10 percent by weight). If sodium hydroxide solution is not available, then sodium carbonate may be used.

First Aid

Signs & Symptoms:

Vapor: Miosis (pinpointing of pupils) and rhinorrhea (runny nose) may be the first indications of exposure to nerve agent vapor. Miosis is indicative of vapor exposure unless liquid agent has been in contact with the eyes. Difficulty breathing (shortness of breath or tightness of the chest) may also be present. Inhalation of lethal amounts of vapor can cause loss of consciousness and convulsions within 30 seconds to 2 minutes of exposure, followed by cessation of breathing and flaccid paralysis after several more minutes.

Liquid/Solids: Localized sweating, nausea, vomiting, involuntary urination/defecation, and a feeling of weakness are signs of small to moderate Nerve Agent exposure. Involvement of the gastrointestinal tract (i.e., vomiting, urination, or defecation) is generally indicative of liquid agent exposure. Large exposures cause copious secretions, loss of consciousness, convulsions progressing into flaccid paralysis, and cessation of breathing.

Patient Management:

Decontaminate casualty insuring that all agent has been removed. Ventilate patient (there may be an increase in airway resistance due to constriction of the airway and the presence of secretions). If breathing is difficult, administer oxygen. Administer antidotes as soon as possible.

Antidotes:

Atropine. Severely poisoned individuals may exhibit tolerance to atropine and require large doses. Oximes such as pralidoxime chloride (2-PAMCl) do not significantly increase the effectiveness of atropine and in some cases may be contraindicated.

Class Index C07
Vesicants – Sulfur Based

Toxicology

Effects:

Vesicants affect both exterior and interior parts of the body. Vesicants cause inflammation, blisters, and general destruction of tissues. Vapors have a greater impact on moist areas of the body. Eyes are especially susceptible to Vesicants. Inhalation of Vesicants can cause lung membranes to swell and become filled with liquid (pulmonary edema). Death may result from lack of oxygen. Vesicants are also systemic agents and readily pass through the skin to affect susceptible tissue including those that produce blood. Sulfur Vesicants are carcinogenic.

Pathways:

Vesicants are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Exposure Hazards:

Skin impacts from Sulfur Vesicant vapor occur at concentrations as low as 15 ppm (10 minute exposure). Hot, moist skin is at greater risk. High risk areas include the crotch and armpits.

Eye impacts from Sulfur Vesicant vapor occur at concentrations as low as 3 ppm (10 minute exposure).

LC_{50}s for inhalation of Sulfur Vesicants are as low as 6 ppm (10 minute exposure).

LD_{50}s for skin exposure to liquid Sulfur Vesicants are as low as 7 gm per individual.

Sulfur vesicants are slowly detoxified by the body; exposures are essentially cumulative.

Latency Period:

Tissue damage occurs within minutes of exposure to Sulfur Vesicants, but clinical effects may not appear for up to 24 hours. Pulmonary edema caused by inhalation of the agent vapor may be delayed for several hours.

Characteristics

Physical Appearance/Odor:

Sulfur Vesicants may be liquids or solids. Agents may be colorless when pure, but generally are amber to black. Sulfur Vesicants generally have an odor similar to onions, garlic, or horseradish. Agents can be thickened with various substances to increase their persistency and dermal hazard. When thickened, agents have a consistency similar to honey. Sulfur Vesicants have also been absorbed onto finely ground powders (e.g., carbon black) and disseminated as dust clouds. The dust particles carry the absorbed agent into the lower lung and thereby increase the lethality of the agents.

Persistency:

Sulfur Vesicants are persistent agents and, under proper conditions, remain hazardous in soils for several years. Thickened agents last significantly longer.

Environmental Fate:

Vapors from Sulfur Vesicants have a density greater than air and tend to collect in low places. Liquids are very persistent and have remained hazardous in soils for several years after a release. Agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased. Solubility in water is negligible. The liquid density of these agents is greater than that of water.

Additional Hazards

Fire:

Vesicants may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, Sulfur Vesicants may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Sulfur Vesicants are incompatible with strong oxidizers, such as dry HTH pool bleach, and will spontaneously ignite. Lack of solubility inhibits reaction of these agents with water.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military:	*Vapor:* Some, but not all, Sulfur Vesicants can be detected by the M256A1 Kit and the CAM. *Liquids:* Sulfur Vesicants can be detected by M8 and M9 papers.
Civilian:	The APD 2000 provides semi-quantitative identification of sulfur vesicants. Colorimetric tubes are available which can detect thioethers. Detection with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Sulfur Vesicants pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Impregnated solids or thickened agents pose a less significant vapor hazard but a much more significant contact hazard. If impregnated solids have been released, dust control during windy conditions will be essential.

Decontamination:

Vapor: *Casualties/personnel:* Speed in decontamination is absolutely essential. Immediately wash skin and clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Decontaminate with copious amounts of full strength household bleach. Removal of porous material, including painted surfaces, that may have absorbed Vesicant vapor may be required as these materials could continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Speed in decontamination is absolutely essential. Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Immediately wash skin and clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels or cloth towels. Remove all material and place in a container. Decontaminate the area with copious amounts of full strength household bleach. A 10 weight percent HTH pool bleach/water slurry may be substituted for the bleach solution. Removal of porous material, including painted surfaces, that may have absorbed Vesicant liquid may be required as these materials could continue to re-release vapor after exposure has ceased. Surfaces contaminated with Vesicants and only rinsed may still evolve sufficient agent vapor to produce a physiological response.

Impregnated Solid: *Casualties/personnel:* Speed in decontamination is absolutely essential. Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Immediately wash skin with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. Remove all clothing from casualties regardless of apparent contamination. **Extreme care must be exercised when dealing with impregnated solids as agents may adhere to the skin or clothing and present a contact and inhalation hazard later.** Immediately wash clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water.

Small Areas: Consolidate as much material as possible and place into containers. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. Decontaminate the area with copious amounts of full strength household bleach. A 10 weight percent HTH pool bleach/water slurry may be substituted for the bleach solution.

First Aid

Signs & Symptoms:

There is an asymptomatic latent period (4 to 24 hours) followed by inflammation and redness of the skin progressing to blisters. Exposure of the eyes to small amounts of vapor produces irritation and a feeling of grit in the eyes. There may also be inflammation of the eyes. Larger amounts of vapor cause swelling of the eyelids. Pain in the eyes may cause spasms and eventually cause the eyes to close. Upper respiratory signs vary with the amount of exposure and include nasal irritation, scratchy throat, laryngitis, and a feeling of shortness of breath.

Patient Management:

Immediate decontamination of any exposure is essential. Otherwise, treatment consists of symptomatic management of lesions. If a casualty has inhaled sulfur vesicant vapor but does not display any signs or symptoms of an impacted airway, it may still be appropriate to intubate the casualty since laryngeal spasms or edema may make it difficult or impossible later.

Asymptomatic individuals suspected of exposure to Vesicants should be kept under observation for at least 8 hours.

Antidotes:

No antidote is available.

Class Index C08
Vesicants – Arsenic Based

Toxicology

Effects:

Vesicants affect both exterior and interior parts of the body. Vesicants cause inflammation, blisters, and general destruction of tissues. Vapors have a greater impact on moist areas of the body. Eyes are especially susceptible to Vesicants. Inhalation of Vesicants can cause lung membranes to swell and become filled with liquid (pulmonary edema). Death may result from lack of oxygen. Arsenical Vesicants are also systemic agents and readily pass through the skin to affect susceptible tissue including blood cells and the liver. Arsenical Vesicants also act as Vomiting Agents (see Class Index C20) and produce violent sneezing and regurgitation. Arsenical Vesicants should be considered carcinogenic.

Pathways:

Vesicants are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris). Liquid agents are much more hazardous than their vapors.

Exposure Hazards:

Skin impacts from Arsenical Vesicant vapor occur at concentrations as low as 17 ppm (10 minute exposure).

Eye impacts from Arsenical Vesicant vapor occur at concentrations as low as 3 ppm (10 minute exposure). Permanent eye damage may occur at concentrations as low as 18 ppm (10 minute exposure).

LC_{50}s for inhalation of Arsenical Vesicants are as low as 17 ppm (10 minute exposure).

LD_{50}s for skin exposure to liquid Arsenical Vesicants are as low as 2.8 gm per individual.

Although sub-lethal doses of some Arsenical Vesicants are rapidly detoxified by the body, *many agents are not detoxified and exposures are cumulative.*

Latency Period:

Arsenical Vesicants produce pain immediately. Skin impacts begin appearing within minutes of exposure, although it may be up to 18 hours before the full lesion develops. Inhalation of high concentrations may be fatal in as short a time as 10 minutes. Pulmonary edema caused by inhalation of the agent vapor may be delayed for several hours.

Characteristics

Physical Appearance/Odor:

Arsenical Vesicants are colorless to brown liquids. These agents generally have fruity or flowery odors although pure materials may be odorless. Agents can be thickened with various substances to increase their persistency and dermal hazard. When thickened, agents have a consistency similar to honey.

Persistency:

Arsenical Vesicants are persistent agents. However, agent vapors rapidly react with high humidity to lose most of their vesicant properties. Limited solubility slows the hydrolysis of liquid agents.

Environmental Fate:

Vapors from Arsenical Vesicants have a density greater than air and tend to collect in low places. Liquids are persistent but are rapidly decomposed by water. These agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased. Agent vapor is rapidly decomposed by moisture in the air. The rate of hydrolysis of liquid agents is limited by their low solubility in water. The liquid density of these agents is greater than that of water.

Additional Hazards

Fire:

Vesicants may be volatilized during a fire or be spread by efforts to extinguish the fire. Combustion of Arsenical Vesicants will produce volatile, toxic arsenic decomposition products. In addition, Arsenical Vesicants may react with steam or water during a fire to produce toxic, corrosive and/or flammable vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Arsenical Vesicant vapors are decomposed rapidly by high humidity. Limited solubility slows the rate of hydrolysis of liquid agents.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military:	*Vapor:* Lewisite is the only Arsenical Vesicant that can be detected by the M256A1 Kit. *Liquids:* Lewisite can be detected by M8 paper and all Arsenical Vesicants can be detected by M9 paper.
Civilian:	The APD 2000 provides semi-quantitative identification of Lewisite (L). Colorimetric tubes are available which can detect organic arsenic compounds as well as arsine. Detection with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Arsenical Vesicants pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Thickened agents pose a less significant vapor hazard but a much more significant contact hazard.

Decontamination:

Vapor: *Casualties/personnel:* Speed in decontamination is absolutely essential. Immediately wash skin and clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Decontaminate with copious amounts of full strength household bleach. Removal of porous material, including painted surfaces, that may have absorbed Arsenical Vesicant vapor may be required as these materials could continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Speed in decontamination is absolutely essential. Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Immediately wash skin and clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels, or cloth towels. Remove all material and place in a container. Decontaminate the area with copious amounts of household bleach. Removal of porous material, including painted surfaces, that may have absorbed Vesicant liquid may be required as these materials could continue to re-release vapor after exposure has ceased. Surfaces contaminated with Vesicants, then only rinsed may still evolve sufficient agent vapor to produce a physiological response.

First Aid

Signs & Symptoms:

Pain and irritation from exposure to either agent liquid or vapor are immediate. Skin impacts may appear in as short a time as 5 minutes although full progression to blisters may not develop for up to 18 hours. Exposure of the eyes to small amounts of vapor produces immediate tearing and pain. Vomiting may occur as a result of exposure to Arsenical Vesicants. Upper respiratory signs vary with the amount of exposure and include nasal irritation, scratchy throat, laryngitis, and a feeling of shortness of breath.

Patient Management:

Immediate decontamination of any exposure is essential. Symptomatic management of lesions with administration of antidote for treatment of systemic effects.

> **Asymptomatic individuals suspected of exposure to Vesicants should be kept under observation for at least 8 hours.**

Antidotes:

BAL (British-Anti-Lewisite, dimercaprol) will alleviate some effects. BAL is available as a solution in oil for intramuscular administration to counteract systemic effects. BAL skin ointment and BAL ophthalmic ointment are not currently manufactured.

Class Index C09
Vesicants – Nitrogen Based

Toxicology

Effects:

Vesicants affect both exterior and interior parts of the body. Vesicants cause inflammation, blisters, and general destruction of tissues. Vapors have a greater impact on moist areas of the body. Eyes are especially susceptible to vesicants. Inhalation of Vesicants can cause lung membranes to swell and become filled with liquid (pulmonary edema). Death may result from lack of oxygen. Vesicants are also systemic agents and readily pass through the skin to affect susceptible tissue including those that produce blood. Nitrogen Vesicants should be considered carcinogenic.

Pathways:

Vesicants are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Exposure Hazards:

Skin impacts from Nitrogen Vesicant vapor occur at concentrations as low as 30 ppm (10 minute exposure).

Eye impacts from Nitrogen Vesicant vapor occur at concentrations as low as 1 ppm (10 minute exposure).

LC_{50}s for inhalation of Nitrogen Vesicants are as low as 18 ppm (10 minute exposure).

LD_{50}s for skin exposure to liquid Nitrogen Vesicants are as low as 0.7 gm per individual.

Nitrogen vesicants are not detoxified by the body; exposures are cumulative.

Latency Period:

Tissue damage occurs within minutes of exposure to Nitrogen Vesicants, but clinical effects may not appear for up to 24 hours. Eye irritation may develop immediately. Pulmonary edema caused by inhalation of the agent vapor may be delayed for several hours.

Characteristics

Physical Appearance/Odor:

Nitrogen Vesicants may be liquids or solids. Solid agents are not currently employed by the military. Agents may be colorless to yellow oily liquids. Nitrogen vesicants may be odorless, may have a fishy or musty odor in low concentrations or a fruity odor at higher concentrations.

Persistency:

Nitrogen Vesicants are among the most persistent agents and, under proper conditions, remain hazardous in soils for years.

Environmental Fate:

Vapors from Nitrogen Vesicants have a density greater than air and tend to collect in low places. Liquids are very persistent. These agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceased. Solubility in water ranges from sparingly soluble to insoluble. The liquid density of these agents is greater than that of water.

Additional Hazards

Fire:

Vesicants may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, Nitrogen Vesicants may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present. Nitrogen Vesicants tend to polymerize and the polymerization products may present an explosion hazard.

Reactivity:

Nitrogen Vesicants tend to polymerize. Polymerization may generate enough heat to cause an explosion. In addition, polymerized components may present an explosion hazard. Lack of solubility inhibits hydrolysis of Nitrogen Vesicants.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: *Vapor:* Some, but not all Nitrogen Vesicants can be detected by the CAM.

Liquids: Nitrogen Vesicants can be detected by M8 and M9 papers.

Solids: There are currently no methods for direct detection of solid agents fielded by the U.S. Military.

Civilian: The ADP 2000 provides semi-quantitative identification of nitrogen vesicants. Colorimetric tubes are available which can detect organic basic nitrogen compounds. Detection with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Nitrogen Vesicants pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Solid agents pose a less significant vapor hazard but a much more significant contact hazard. If solid agents have been released, dust control during windy conditions will be essential.

Decontamination:

Vapor: *Casualties/personnel:* Speed in decontamination is absolutely essential. Immediately wash skin and clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Decontaminate with copious amounts of full strength household bleach. Removal of porous material, including painted surfaces, that may have absorbed Nitrogen Vesicant vapor may be required as these materials could continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Speed in decontamination is absolutely essential. Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Immediately wash skin and clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. **However, to prevent systemic toxicity, decontamination should be done as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction.** In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels or cloth towels. Remove all material and place in a container. Decontaminate the area with copious amounts of household bleach. A 10 weight percent HTH/water slurry may be substituted for the bleach solution. Removal of porous material, including painted surfaces, that may have absorbed Vesicant liquid may be required as these materials could continue to re-release vapor after exposure has ceased. Surfaces contaminated with Vesicants then only rinsed may still evolve sufficient agent vapor to produce a physiological response.

Solid: *Casualties/personnel:* Speed in decontamination is absolutely essential. Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Immediately wash skin with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. **However, to prevent systemic toxicity, decontamination**

should be done as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction. Remove all clothing from casualties regardless of apparent contamination. **Extreme care must be exercised when dealing with solids as agents may adhere to the skin or clothing and present a contact and inhalation hazard later.** Immediately wash clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water.

Small Areas: Consolidate as much material as possible and place into containers. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. Decontaminate the area with copious amounts of full strength household bleach. A 10 weight percent HTH pool bleach/water slurry may be substituted for the bleach solution.

First Aid

Signs & Symptoms:

Mild vapor exposure may not produce skin lesions. There is an asymptomatic latent period (4 to 24 hours) followed by inflammation and redness of the skin progressing to blisters. Eye impacts, including irritation, tearing, and sensitivity to light may appear immediately. There may also be inflammation of the eyes. Larger amounts of vapor cause swelling of the eyelids. Pain in the eyes may cause spasms and eventually cause the eyes to close. Upper respiratory signs vary with the amount of exposure and include nasal irritation, scratchy throat, laryngitis, and a feeling of shortness of breath.

Patient Management:

Immediate decontamination of any exposure is essential. If the casualty has been exposed to Nitrogen Vesicant liquid, then **decontamination should be done as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction.** This must be done to prevent systemic toxicity. Otherwise, treatment consists of symptomatic management of lesions.

Asymptomatic individuals suspected of exposure to vesicants should be kept under observation for at least 8 hours.

Antidotes:

No antidote is available.

Class Index C10
Vesicants – Mixture of Sulfur and Arsenic

Toxicology

Effects:

Sulfur/Arsenical Vesicants are mixtures of Sulfur Vesicants (see Class Index C07) and Arsenical Vesicants (see Class Index C08). Sulfur/Arsenical Vesicants affect both exterior and interior parts of the body. They cause inflammation, blisters, and general destruction of tissues. Vapors have a greater impact on moist areas of the body. Eyes are especially susceptible to vesicants. Inhalation of Vesicants can cause lung membranes to swell and become filled with liquid (pulmonary edema). Death may result from lack of oxygen. Sulfur/Arsenical Vesicants are systemic agents and readily pass through the skin to affect susceptible tissue including blood-forming tissues, blood cells, and the liver. Sulfur/Arsenical Vesicants are carcinogenic.

Pathways:

Vesicants are hazardous through inhalation, skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris).

Exposure Hazards:

Skin impacts from Sulfur/Arsenical Vesicant vapor occur at concentrations as low as 15 ppm (10 minute exposure). Hot, moist skin is at greater risk. High risk areas include the crotch and armpits.

Eye impacts from Sulfur/Arsenical Vesicant vapor occur at concentrations as low as 3 ppm (10 minute exposure). Permanent eye damage may appear at concentrations as low as 18 ppm (10 minute exposure).

LC_{50}s for inhalation of Sulfur/Arsenical Vesicants are as low as 6 ppm (10 minute exposure).

LD_{50}s for skin exposure to liquid Sulfur/Arsenical Vesicants are as low as 2.8 gms per individual.

Sulfur/arsenical vesicants are detoxified slowly or not at all by the body; exposures are essentially cumulative.

Latency Period:

Sulfur/Arsenical Vesicants produce pain immediately. Skin impacts begin appearing within minutes of exposure, although it may be up to 18 hours before the full lesion develops. Inhalation of high concentrations may be fatal in as short a time as 10 minutes. Pulmonary edema caused by inhalation of the agent vapor may be delayed for several hours.

Characteristics

Physical Appearance/Odor:

Sulfur/Arsenical Vesicants are liquids. Agents may be colorless when pure, but are generally amber to black. These agents generally have an odor similar to onions, garlic, or horseradish.

Persistency:

Sulfur/Arsenical Vesicants are persistent agents and, under proper conditions, remain hazardous in soils for several years. Thickened agents last significantly longer.

Environmental Fate:

Vapors from Sulfur/Arsenical Vesicants have a density greater than air and tend to collect in low places. Liquids are very persistent and have remained hazardous in soils for several years after a release. These agents are absorbed into porous material, including painted surfaces, and these materials could continue to re-release vapor after exposure has ceases. Solubility in water is negligible. The liquid density of these agents is greater than that of water.

Additional Hazards

Fire:

Vesicants may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, Sulfur/Arsenical Vesicants may react with steam or water during a fire to produce toxic and/or corrosive vapors.

Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Sulfur Vesicants are incompatible with strong oxidizers, such as dry HTH pool bleach, and will spontaneously ignite. Lack of solubility inhibits reaction of these agents with water.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: *Vapor:* Some, but not all components of Sulfur/Arsenical Vesicants can be detected by the M256A1 Kit, and the CAM.
Liquids: Some, but not all components of Sulfur/Arsenical Vesicants can be detected by M8 paper. All components of Sulfur/Arsenical Vesicants can be detected by M9 papers.

Civilian: The APD 2000 provides semi-quantitative identification of sulfur mustard/Lewisite mixtures. Colorimetric tubes are available which can detect thioethers, organic arsenic compounds as well as arsine (AsH_3). Detection with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Sulfur/Arsenical Vesicants pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Thickened agents pose a less significant vapor hazard but a much more significant contact hazard.

Decontamination:

Vapor: *Casualties/personnel:* Speed in decontamination is absolutely essential. Immediately wash skin and clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. In all cases, clothing should be removed because it may contain "trapped" vapor.

Small Areas: Decontaminate with copious amounts of full strength household bleach. Removal of porous material, including painted surfaces, that may have absorbed Vesicant vapor may be required as these materials could continue to re-release vapor after exposure has ceased.

Liquid: *Casualties/personnel:* Speed in decontamination is absolutely essential. Remove contaminated clothing immediately. Remove as much of the agent from the skin as fast as possible without spreading the material. Immediately wash skin and clothes with a bleach solution that is no less than one part household bleach in nine parts water. Rinse with copious amounts of water. To be effective, decontamination must be completed within one minute of exposure. In all cases, clothing should be removed because it may contain "trapped" liquid or vapor.

Small Areas: Puddles of liquid must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels or cloth towels. Remove all material and place in a container. Decontaminate the area with copious amounts of household bleach. A 10 weight percent HTH pool bleach/water slurry may be substituted for the bleach solution. Removal of porous material, including painted surfaces, that may have absorbed Vesicant liquid may be required as these materials could continue to re-release vapor after exposure has ceased. Surfaces contaminated with Vesicants then only rinsed may still evolve sufficient agent vapor to produce a physiological response.

First Aid

Signs & Symptoms:

Pain and irritation from exposure to either liquid or vapor are immediate. Skin impacts may appear is as short a time as 5 minutes although full progression to blisters may not develop for 4 to 24 hours. Exposure of the eyes to small amounts of vapor produces immediate tearing and pain. Larger amounts of vapor cause swelling of the eyelids. Pain in the eyes may cause spasms and eventually cause the eyes to close. Upper respiratory signs vary with the amount of exposure and include nasal irritation, scratchy throat, laryngitis and a feeling of shortness of breath.

Patient Management:

Immediate decontamination of any exposure is essential. Symptomatic management of lesions with application of antidote for treatment of systemic effects.

Asymptomatic individuals suspected of exposure to Vesicants should be kept under observation for at least 8 hours.

Antidotes:

No antidote is available for treatment of the sulfur component of Sulfur/Arsenical Vesicants. BAL (British-Anti-Lewisite, dimercaprol) will alleviate some effects of the arsenical component. BAL is available as a solution in oil for intramuscular administration to counteract systemic effects. BAL skin ointment and BAL ophthalmic ointment are not currently manufactured.

Class Index C11
Urticants

Toxicology

Effects:

Urticants produce instant, almost intolerable pain. They cause local tissue destruction immediately on contact with skin and mucous membranes. Sensations range from mild prickling to almost intolerable pain resembling a severe bee sting. Direct contact of the agent with the skin produces a corrosive type lesion. Skin lesions may not fully heal for over 2 months. Inhalation of Urticant vapor can cause lung membranes to swell and become filled with liquid (pulmonary edema). Death may result from lack of oxygen.

Pathways:

Urticants are hazardous through inhalation, skin and eye exposure, and ingestion.

Exposure Hazards:

Skin impacts from Urticant vapor occur at concentrations as low as 0.04 ppm (10 minute exposure). Effects may become unbearable at a concentration of 0.6 ppm (one minute exposure).

Eye impacts from Urticant vapor occur at very low concentrations.

LC_{50}s for inhalation of Urticants are as low as 69 ppm (10 minute exposure).

LD_{50}s for skin exposure to Urticants are as low as 1.8 gm per individual.

Latency Period:

Urticants produce immediate effects on skin and eyes. Pulmonary edema caused by inhalation of the agent vapor may be delayed for several hours.

Characteristics

Physical Appearance/Odor:

Urticants are colorless liquids or crystalline solids. Odors are intense, penetrating, disagreeable, and violently irritating.

Persistency:

Urticants are unstable and decompose rapidly in soil. Agents are relatively nonpersistent on surfaces and in water.

Environmental Fate:

Vapors from Urticants have a density greater than air and tend to collect in low places. Urticants are unstable and decompose rapidly in soil. Agents dissolve slowly but completely in water and may take days to decompose once in solution.

Additional Hazards

Fire:

Urticants may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, Urticants may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Urticants are corrosive to most metals. Traces of iron chloride, formed by action of hydrogen chloride (HCl) — a decomposition product of Urticants — on iron, may cause explosive decomposition. Urticants react violently to alkaline solutions.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: *Vapor:* Urticants can be detected by the M256A1 Kit.
Liquids: Urticants can be detected by M8 and M9 papers.

Civilian: Detection with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Urticants pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Casualties/personnel: Speed in decontamination is absolutely essential. Because of the rapid reaction of Urticants with skin, decontamination will not be entirely effective after pain occurs. Nevertheless, decontamination should be accomplished as rapidly as possible by flushing the area with copious amounts of water to remove any agent that has not reacted with the skin. In all cases, clothing should be removed because it may contain "trapped" agent.

Small Areas: Use large amounts of water to wash the agents into collection areas. Rinse water and runoff may contain active agent. Because Urticants are only slowly dissolved in water, and because rinsing may drive agents into cracks and crevices, decontamination will not be entirely effective.

First Aid

Signs & Symptoms:

Urticant vapors are violently irritating to the eyes. Very low concentrations can cause inflammation, lacrymation, and temporary blindness; higher concentrations can cause corneal corrosion and dimming of vision. Solid, liquid, or vapor contact with the skin can cause corrosive type lesions. Within 30 seconds after contact, the skin becomes pale and a red ring surrounds the area. Swelling below the skin follows in about 15 minutes and a wheal is formed. After 24 hours, the skin in the central blanched area becomes brown and dies. A scab is formed in a few days. Healing is accompanied by sloughing of the scab; itching may be present throughout healing. Urticants may cause pulmonary edema through inhalation or skin absorption.

Patient Management:

Immediate decontamination of any exposure is essential. Otherwise, treatment consists of symptomatic management of lesions.

Antidotes:

No antidote is available.

Class Index C12
Blood Agents – General

Toxicology

Effects:

Blood Agents are compounds that stop the transfer of oxygen from the blood system to the rest of the body by inhibiting the enzyme cytochrome oxidase. The lack of oxygen rapidly affects all body tissues, especially the central nervous system. Some Blood Agents will also cause lung membranes to swell and become filled with liquid (pulmonary edema).

Pathways:

Blood Agents are primarily an inhalation hazard. However, liquid agents are hazardous through skin and eye exposure, ingestion, and abraded skin (e.g., breaks in the skin or penetration of skin by debris). At high concentrations, agents vapor may pose a skin absorption hazard. Agents may be mixed with solvents (i.e., carbon disulfide (CS_2), chloroform ($CHCl_3$)) or other hazardous components (i.e., arsenic trichloride ($AsCl_3$), stannic chloride ($SnCl_4$) or various chloroformic acid esters) to increase their persistency, pulmonary effects, and/or skin/eye toxicity.

Exposure Hazards:

LC_{50}s for inhalation of Blood Agents are as low as 180 ppm (10 minute exposure).

LD_{50}s for skin exposure to liquid Blood Agents are as low as 7 gm per individual.

Latency Period:

Vapor:	Effects from vapor exposure begin to appear 1 to 2 minutes after exposure. Pulmonary edema caused by inhalation of some Blood Agents may be delayed for several hours.
Liquid:	Effects from liquid exposure may be delayed from several minutes up to 2 hours after exposure.

Characteristics

Physical Appearance/Odor:

Blood Agents are either volatile liquids or gases. Most agents are colorless. Odors vary from mildly pleasant to harsh and irritating. The ability to detect the odor of some agents is transient and may provide the impression that agents are no longer present. Some agents, especially in high concentration, may cause eye irritation and tearing. Agents may be mixed with solvents (i.e., carbon disulfide (CS_2), chloroform ($CHCl_3$)) or other hazardous components (i.e., arsenic trichloride ($AsCl_3$), stannic chloride ($SnCl_4$), or various chloroformic acid esters) to increase their persistency and/or skin/eye toxicity. The color, odor, and consistency of these mixtures will vary depending on the concentration of agents and nature of the solvents/components.

Persistency:

Blood Agents are nonpersistent. Cold weather may increase persistency by decreasing the rate of volatilization of any liquid agents.

Environmental Fate:

The environmental fate of Blood Agents is highly dependent on the agent. Due to volatile nature of Blood Agents, there is minimal extended risk except in an enclosed or confined space. Blood Agent vapors have densities that range from slightly less than air to significantly greater than air. Vapors, therefore, may or may not collect in low places. The solubility of Blood Agent in water ranges from completely soluble to almost insoluble. The liquid densities of these agents range from approximately half that of water to significantly greater than water.

Additional Hazards

Fire:

Some Blood Agents are flammable and can form explosive mixtures with air. Some Blood Agents may polymerize and explode when heated. Blood Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Some Blood Agents are highly water soluble and runoff may pose a significant hazard. In addition, some Blood Agents may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present. Solvents mixed with some agents are flammable and may pose an additional fire hazard. Added components may react with steam or water during a fire to produce toxic, flammable, and/or corrosive vapors.

Reactivity:

Many Blood Agents must be stabilized or they will polymerize on standing. Some Blood Agents are slowly hydrolyzed by water to produce corrosive and toxic gases. Blood Agents are incompatible with strong oxidizers; many are incompatible with strong corrosives. Added components may react with water to produce toxic, flammable and/or corrosive vapors.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 300 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military:	*Vapor:* Cyanide Blood Agents can be detected by the M256A1 Kit. *Liquids:* Cyanide Blood Agents can be detected by M9 papers.
Civilian:	Colorimetric tubes are available that can detect hydrogen sulfide (H_2S), hydrogen cyanide (HCN), and cyanogen chloride (ClCN). Detection of some Blood Agents with PIDs or FIDs may be possible. In addition, because of the high flammability of some of the agents, combustible gas indicators can be used to screen for agents. However, the detection limits will be far in excess of lethal limits. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Blood Agents are primarily a respiratory hazard; however, liquids or high vapor concentrations may pose a percutaneous hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Vapor: Ventilation. Because the boiling point of some cyanide Blood Agents is near normal room temperature (70°F), agent vapors may condense on cooler surfaces and pose a percutaneous hazard. Liquids can then re-volatilize when the temperature rises.

Liquid: *Casualties/personnel:* Remove wet clothing from individuals and wash exposed skin with large amounts of water.
Small Areas: Ventilation. In heavily contaminated areas, decontaminate by washing with copious amounts of household bleach followed by rinsing with water.

First Aid

Signs & Symptoms:

Most indications of Blood Agent poisoning are non-specific. For most cyanides, casualties experience few effects when exposed to less than lethal doses. These may include temporary increase in breathing rate, dizziness, nausea, vomiting, and headache. Classic "cherry-red" skin and lips attributed to cyanide poisoning are not always present. Some Blood Agents may produce eye, nose and throat irritation similar to Tear Agents (see Class Indices C17 through C19). Pulmonary edema caused by some Blood Agents may be delayed for several hours. Inhalation of a high concentration of Blood Agents may produce temporary rapid and deep breathing followed by convulsions and unconsciousness. The casualty will stop breathing within 2 to 4 minutes after exposure. Death will occur 4 to 8 minutes after exposure.

Patient Management:

Remove casualty to fresh air and provide oxygen for respiratory distress. Antidote should be administered as soon as possible. If halogenated Blood Agents are suspected, asymptomatic individuals should be monitored for possible complications caused by pulmonary edema.

Antidotes:

The Lilly Cyanide Antidote Kit contains amyl nitrite, sodium nitrite, and sodium thiosulfate. Dimethylaminophenol, cobalt edetate, or vitamin B_{12a} are alternative antidotes for cyanide poisoning.

Class Index C13
Blood Agents – Arsenic Based

Toxicology

Effects:

Arsenical Blood Agents are compounds that affect the ability of the blood system to carry oxygen by destroying red blood cells. The lack of oxygen rapidly affects all body tissues, especially the central nervous system. Arsenical Blood Agents may also affect the kidneys, liver, and heart. Arsenical Blood Agents are carcinogenic.

Pathways:

Arsenical Blood Agents are an inhalation hazard.

Exposure Hazards:

Inhalation LC_{50}s of Arsenical Blood Agents are as low as 157 ppm (10 minute exposure).

Latency Period:

Effects from exposure can be delayed from 20 minutes up to 36 hours depending on the level of exposure.

Characteristics

Physical Appearance/Odor:

Arsenical Blood Agents are gases or solids. Gases are colorless with a mild garlic-like odor. Effects from cumulative exposure may occur at levels below the odor threshold. Solids produce arsine gas (AsH_3) when they come into contact with moisture.

Persistency:

Gaseous Arsenical Blood Agents are nonpersistent. Solid agents will retain the potential to produce arsine (AsH_3) until they react with water.

Environmental Fate:

Due to the volatile nature of gaseous Arsenical Blood Agents, there is minimal extended risk except in an enclosed or confined space. Solid agents pose an extended risk in that agents will retain the potential to produce arsine gas (AsH_3) until they react with water. Vapors have a density greater than air and tend to collect in low places. Most agents have minimal solubility in water.

Additional Hazards

Fire:

Arsenical Blood Agents are highly flammable gases that may form explosive mixtures in air. Hydrogen gas produced by photolytic decomposition of the agents may be present. Decomposition of the agents during a fire will produce poisonous arsenic oxides that may be present in smoke from the fire. Solid agents will react with water to form arsine gas (AsH_3).

Reactivity:

Arsenical Blood Agents are incompatible with strong oxidizers and various metals (e.g., aluminum, copper, brass, nickel). Arsenical Blood Agents may decompose on exposure to light to produce hydrogen gas and arsenic metal. Solid agents will react with water to form arsine gas (AsH_3).

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: Arsenical Blood Agents are not identifiable by military detection equipment.

Civilian: Colorimetric tubes are available that can detect arsine. Detection of Arsenical Blood Agents with PIDs or FIDs may be possible. In addition, because of the high flammability of the agents, combustible gas indicators can be used to screen for agents. However, the detection limits will be far in excess of lethal limits. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Arsenical Blood Agents are primarily a respiratory hazard. However, decomposition products may pose a contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Ventilation. If decomposition occurs, arsenic metal or arsenic oxides may be present and require additional appropriate decontamination.

First Aid

Signs & Symptoms:

Immediate symptoms may include giddiness, headache, lightheadedness, and dizziness. After a latency period, symptoms may include chills, headache, malaise, weakness, dizziness, difficult breathing, abdominal pain, nausea, vomiting, jaundice, bloody urine, and coma.

Asymptomatic individuals suspected of exposure to arsenical blood agents should be evaluated at a medical facility for hematological, renal and/or hepatic damage.

Patient Management:

Remove casualty to fresh air and provide oxygen for respiratory distress. In severe cases, blood transfusions may be required.

Antidotes:

No antidote is available.

Class Index C14
Choking Agents

Toxicology

Effects:

Choking Agents injure an unprotected person chiefly in the respiratory tract. In extreme cases, membranes swell, lungs become filled with liquid (pulmonary edema), and death results from lack of oxygen. Some agents can also readily pass through the skin to induce systemic intoxication.

Pathways:

Choking Agents are primarily an inhalation hazard although in high concentrations, agents and decomposition products may exhibit some corrosive properties on skin. Exposure to solid, liquid or gaseous halogens may pose a significant dermal hazard. Some agents also readily pass through the skin to induce systemic intoxication.

Exposure Hazards:

LC_{50}s for inhalation of Choking Agents are as low as 35 ppm (10 minute exposure).

Latency Period:

Pulmonary effects are usually delayed 2 to 24 hours. Exposure to high concentrations may produce immediate symptoms. Generally, the more rapid the onset of symptoms, the more grave the prognosis.

Characteristics

Physical Appearance/Odor:

Choking Agents are either volatile liquids or gases. Most agents are colorless. Odors vary from mildly pleasant to harsh and irritating. Some agents, especially in high concentration, may cause eye irritation and tearing. Choking Agents have been absorbed into porous powders (e.g., pumice) and disseminated as dust clouds. The agents are slowly released by the dust particles thereby greatly increasing the persistency of the agents.

Persistency:

Choking Agents are nonpersistent. Cold weather may decrease the rate of volatilization of any liquids present and increase persistency. Agents absorbed into porous powders may be significantly more persistent than normal. Decomposition products from the breakdown of some Choking Agents can pose a persistent hazard.

Environmental Fate:

Due to volatile nature of Choking Agents, there is minimal extended risk except in an enclosed or confined space. Vapors have a density greater than air and tend to collect in low places. Most agents have minimal solubility in water.

Additional Hazards

Fire:

Most Choking Agents are either non-flammable or difficult to ignite. Some Choking Agents are strong oxidizers and will support combustion. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, Choking Agents may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Some Choking Agents readily react with water while others are slowly decomposed by water. Some are oxidizers and will support combustion.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: There are currently no hand-held methods for identification of Choking Agents fielded by the U.S. Military.

Civilian: Colorimetric tubes are available that can detect phosgene ($COCl_2$), nickel tetracarbonyl ($Ni(CO)_3$), inorganic arsenic compounds, chloroformates and halogens. Detection of some Choking Agents with PIDs or FIDs may be possible. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available.

Personal Protective Requirements:

Choking Agents are primarily a respiratory hazard; however, high concentrations may pose a dermal hazard due to the corrosive/oxidative nature of some of the agents. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. If impregnated solids have been released, dust control during windy conditions will be essential.

Decontamination:

Vapor: Ventilation.

Liquid: *Casualties/personnel:* Remove wet clothing from exposed individuals and wash exposed skin with large amounts of water.

Small Areas: Most liquid agents are highly volatile and may quickly evaporate. Puddles of liquid may be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, paper towels or cloth towels. Remove all material and place in a container.

Impregnated Solid: *Casualties/personnel:* Remove contaminated clothing from exposed individuals and wash exposed skin with large amounts of water.

Small Areas: Consolidate as much material as possible and place into containers. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. Ventilate any enclosed or confined spaces.

First Aid

Signs & Symptoms:

Exposure to low concentrations may not produce immediate effects. However, the severity of poisoning is not related to the presentation or magnitude of immediate symptoms. Symptoms may include eye and airway irritation, tearing, shortness of breath, coughing, wheezing, chest tightness, and delayed pulmonary edema. If halogens have been released, there may be redness of the skin, chemical burns or even thermal burns.

Patient Management:

Remove casualty to fresh air and provide oxygen for respiratory distress. **Enforce rest as even minimal physical exertion may shorten the clinical latent period.**

> **Asymptomatic individuals suspected of exposure to choking agent should be kept under observation for at least 6 hours.**

Antidotes:

No antidote is available. Chelation therapy may be appropriate for exposure to agents containing heavy metals.

Class Index C15
Choking Agents – Metal Fume

Toxicology

Effects:

Choking Agents injure an unprotected person chiefly in the respiratory tract. In extreme cases, membranes swell, lungs become filled with liquid (pulmonary edema), and death results from lack of oxygen. Some agents may also pose a dermal hazard.

Pathways:

Metal Fume Choking Agents are primarily delivered employing incendiary devices, allowing the smoke plume to carry the agents. These agents are primarily an inhalation hazard although in high concentrations, agents and decomposition products may pose a dermal hazard.

Exposure Hazards:

Human toxicity data for these agents has not been published or has not been established. However, the industrial IDLH levels for these agents are as low as 2 ppms.

Latency Period:

Pulmonary effects are usually delayed 2 to 24 hours. Exposure to high concentrations may produce immediate symptoms. Generally, the more rapid the onset of symptoms, the more grave the prognosis.

Characteristics

Physical Appearance/Odor:

Agents are odorless solids dispersed as aerosols from incendiary devices. Depending on various factors, the aerosol may or may not be visible.

Persistency:

Aerosols of agents are not persistent. However, the solid agents can persist in the environment for extended periods. Since the primary route of exposure to Metal Fume Choking Agents is through inhalation and agents have very little vapor pressure, there is minimal risk once the initial aerosol has settled.

However, re-suspension of any dust contaminated with metal oxides can pose a continuing hazard.

Environmental Fate:

Metal Fume Choking Agents are metal oxides deployed as dust aerosols that have no appreciable vapor. Once the aerosols settle, there is minimal extended hazard from the agents unless the dust is re-suspended. Oxides are generally insoluble in water.

Additional Hazards

Fire:

Metal Fume Choking Agents are generally deployed by an incendiary device. In addition, agents may be volatilized during a fire or be spread by efforts to extinguish the fire.

Reactivity:

Agents may be incompatible with strong acids or reducing agents.

Protection

Evacuation:

Immediately isolate an area around the fire for at least 200 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the size of the fire, the amount of material aerosolized and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible.

Field Detection/Identification (See Table 3.1):

Military:	There are currently no methods for identification of Metal Fume Choking Agents fielded by the U.S. Military.
Civilian:	Samples may be collected and analyzed at a standard laboratory.

Personal Protective Requirements:

Metal Fume Choking Agents are primarily a respiratory hazard; however, contact with solid agents may pose both a local and systemic hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. If bulk agents are dispersed without the aid of an incendiary device, dust control during windy conditions will be essential.

Decontamination:

Casualties/personnel: Remove contaminated clothing. Wash potentially exposed area with copious amounts of water.

Small Areas: Consolidate as much solid material as possible and place in appropriate containers. Care should be made to minimize the aerosolization of agent. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much dust as possible.

First Aid

Signs & Symptoms:

Exposure to low concentrations may not produce immediate effects. However, the severity of poisoning is not related to the presentation or magnitude of immediate symptoms. Symptoms may include headache, nausea, vomiting, eye and airway irritation, shortness of breath, coughing, wheezing, chest tightness, and delayed pulmonary edema.

Patient Management:

Remove casualty to fresh air and provide oxygen for respiratory distress. **Enforce rest as even minimal physical exertion may shorten the clinical latent period.**

> **Asymptomatic individuals suspected of exposure to choking agent should be kept under observation for at least 6 hours.**

Antidotes:

No antidote is available. Chelation therapy may be appropriate to minimize systemic toxicity.

Class Index C16
Incapacitating Agents

Toxicology

Effects:

Incapacitating Agents produce their effects mainly by altering or disrupting the higher regulatory activity of the central nervous system. In normal usage, Incapacitating Agents will not cause permanent or long-lasting injury. Unlike Tear Agents (see Class Indices C17 through C19) or Vomiting Agents (see Class Index C20), Incapacitating Agents produce effects that may last for hours or days after exposure to the agent has ceased. There are two main types of Incapacitating Agents. Depressant Incapacitating Agents have the predominant effect of depressing or blocking the activity of the central nervous system, often by interfering with the transmission of neural impulses across synapses. These agents may disturb the higher integrative functions of memory, problem-solving, attention, and comprehension. High doses may produce delirium. Stimulant Incapacitating Agents cause excessive nervous activity, often by boosting or facilitating transmission of impulses that might otherwise be insufficient to cross certain synapses. The effect is to flood the brain with too much information.

Pathways:

Incapacitating Agents are primarily a hazard via the inhalation pathway. However, ingestion, abraded skin (e.g., breaks in the skin or penetration of skin by debris), or dermal exposure may also produce effects.

Exposure Hazards:

This class of agents does not seriously endanger life except at exposures greatly exceeding an effective dose. The military does not consider lethal agents at sublethal doses as Incapacitating Agents. Incapacitating effects from agents may occur at concentrations as low as several milligrams per cubic meter.

Latency Period:

Effects from exposure may appear in seconds or may be delayed up to several hours depending on the specific agent. Effects from dermal exposure may be delayed up to several days.

Characteristics

Physical Appearance/Odor:

Agents may be solids, liquids, or gases. Many solid agents are actually salts of oily organic compounds. Agents may or may not have an odor.

Persistency:

Agents may be nonpersistent or persistent depending on the specific agent and environmental conditions.

Environmental Fate:

Varies depending on the specific agent. Agents which are salts may be significantly more soluble in water than the parent compound. Neutralization of salts may significantly change the environmental fate of the agents.

Additional Hazards

Fire:

Incapacitating Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In addition, Incapacitating Agents may react with steam or water during a fire to produce toxic and/or corrosive vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Some agents may be slowly decomposed by water.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 200 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: There are currently no field methods for detection of Incapacitating Agents employed by the U.S. Military.

Civilian: Varies according to agent used. Many Incapacitating Agents have minimal vapor pressure making field detection difficult.

Personal Protective Requirements:

While Incapacitating Agents primarily pose a severe respiratory hazard, they may also pose a significant contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. Solid agents pose a less significant vapor hazard but a much more significant contact hazard. If solid agents have been released, dust control during windy conditions will be essential.

Decontamination:

Casualties/personnel: Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water. Delayed effects, as much as 24 hours after exposure, can occur even though the skin was washed within 1 hour of exposure. In all cases, clothing should be removed because it may contain "trapped" agent.

Small Areas: In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. Wash all surfaces with straight household bleach followed by soap and water. Rinse with copious amounts of water.

First Aid

Signs & Symptoms:

Varies according to the specific agent. Care must be taken in that many signs and symptoms associated with exposure to Incapacitating Agents are also associated with an anxiety attack. Potential indications of exposure include restlessness, dizziness, confusion, erratic behavior, inappropriate smiling or laughing, irrational fear, difficulty in expressing self (mumbling, slurred or nonsensical speech), euphoria, lethargy, trembling, pleading, crying, perceptual distortions, hallucinations, disrobing, stumbling or staggering, blurred vision, dilated pupils, flushed face, elevated temperature, dry mouth, stomach cramps, vomiting, change in pulse rate (slow or elevated), change in blood pressure (lowered or elevated), stupor or coma.

Patient Management:

General treatment consists of observation, supportive care with fluids, and possibly restraint or confinement. Casualties should be isolated in a safe area. Remove any potentially harmful material from individuals suspected of being exposed to Incapacitating Agents including such items as cigarettes, matches, medications, and other small items they might attempt to ingest. Observe casualties for signs of heatstroke as some Incapacitating Agents eliminate the ability of exposed individuals to sweat. Monitor to insure that casualties are breathing. If casualties become comatose and regurgitate, there is a risk that they may aspirate vomitous material. Casualties will usually recover from exposure to Incapacitating Agents without medical treatment; however, full recovery from effects may take several days.

Antidotes:

Varies depending on the agent. Some of the common potential types of Incapacitating Agents include anticholinerginics, indoles, and cannabinols. Because of the widely differing means of producing incapacitation within these categories, no medication should be given until reasonably certain of the specific agent to which casualties have been exposed.

Class Index C17
Tear Agents – Halogenated

Toxicology

Effects:

Tear Agents cause tears and intense eye pain. They may also irritate the respiratory tract, causing the sensation that the casualty has difficulty breathing. In high concentrations, tear compounds are irritating to the skin and cause a temporary burning or itching sensation. High concentration can also cause burns, nausea, and/or vomiting. In an enclosed or confined space, very high concentration of Tear Agents can be lethal.

Pathways:

Tear Agents are primarily an eye-contact and inhalation hazard. Aerosols and vapors are irritating to the eyes and skin at low concentrations but relatively nontoxic via these pathways.

Exposure Hazards:

IC_{50}s (tearing) impacts from eye exposure to Halogenated Tear Agent vapor occur at concentrations as low as 1 mg/m^3 (10 minute exposure).

LC_{50}s for inhalation of Halogenated Tear Agents are as low as 200 mg/m^3 (10 minute exposure).

Latency Period:

Tear Agents produce instantaneous effects.

Characteristics

Physical Appearance/Odor:

Halogenated Tear Agents may be liquids or solids. Agents are colorless to yellow in appearance. Odors of Halogenated Tear Agents range from floral to pepper-like.

Persistency:

When Tear Agents are employed as aerosols they are not persistent. However, a significant release of Tear Agent can deposit large amounts of solid or liquid material and pose a persist hazard.

Environmental Fate:

Tear Agent vapors have a density greater than air and tend to collect in low places. Agents may be absorbed into porous material, including painted surfaces, and these materials may be difficult to decontaminate. Tear Agents are essentially insoluble in water and have densities that range from near water to greater than water. Lack of solubility inhibits reaction of these agents with water.

Additional Hazards

Fire:

Halogenated Tear Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic, corrosive and/or flammable vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Halogenated Tear Agents are generally very slowly decomposed by water. Agents may be corrosive and can react with metal. In some cases these reactions may be violent. Most Halogenated Tear Agents are incompatible with strong oxidizers, including chlorine bleach, and may produce toxic decomposition products.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 200 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: There are currently no methods for identification of Tear Agents fielded by the U.S. Military.

Civilian: The APD 2000 provides qualitative identification of mace (CN). Colorimetric tubes are available which can detect halogenated hydrocarbons. Detection of agents with PIDs or FIDs may be possible. Detection and identification of agent vapors with FT-IR is possible provided that the appropriate reference spectra are available. Incendiary aerosols of Tear Agents may not be detectable by FT-IR because of defraction of the beam.

Personal Protective Requirements:

Tear Agents are primarily an eye and respiratory hazard; however, at elevated concentrations, agents may also pose a dermal hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. If solid agents have been released, dust control during windy conditions will be essential.

Decontamination:

Aerosols/Vapor: *Casualties/personnel:* Ventilation. If decontamination is deemed appropriate, flush skin with cool water followed by soap and warm water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.**

Small Areas: Ventilation. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. If necessary, wash with copious amounts of alkaline detergent and water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce highly toxic decomposition products.** Porous surfaces may be difficult to decontaminate.

Liquid/Solid: *Casualties/personnel:* Remove contaminated clothing immediately. Wash skin with copious amounts of cool water followed by soap and warm water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.**

Small Areas: Consolidate as much solid material as possible and place in appropriate containers. Care should be made to minimize the aerosolization of agent. Employ vacuum devices equipped with High Efficiency Particulate Air

(HEPA) filters to remove as much dust as possible. If necessary, wash (wet-vac) with copious amounts of alkaline detergent and water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.** Porous surfaces may be difficult to decontaminate.

First Aid

Signs & Symptoms:

Tear Agents produce intense eye pain and tearing. They may also produce burning or stinging sensations of exposed mucous membranes (e.g., nose and mouth) and skin. Symptoms may also include rhinorrhea (runny nose), sneezing, coughing, respiratory discomfort (tightness of the chest or inability to breathe), nausea and/or vomiting. Increases in ambient temperature and/or humidity exacerbate agent effects.

Patient Management:

Casualties will usually recover from exposure to Tear Agents within 15 minutes after removal from the contaminated atmosphere. **Do not allow casualties to rub eyes or skin as this will exacerbate agent effects.**

Antidotes:

None.

Class Index C18
Tear Agents – Non-Halogenated

Toxicology

Effects:

Tear Agents cause tears and intense eye pain. They may also irritate the respiratory tract, causing the sensation that the casualty has difficulty breathing. In high concentrations, tear compounds are irritating to the skin and cause a temporary burning or itching sensation. High concentration can also cause burns, nausea, and/or vomiting. In an enclosed or confined space, very high concentration of Tear Agents can be lethal.

Pathways:

Tear Agents are primarily an eye-contact and inhalation hazard. Aerosols and vapors are irritating to the eyes and skin at low concentrations but relatively nontoxic via these pathways.

Exposure Hazards:

IC_{50}s (tearing) impacts from eye exposure to Non-Halogenated Tear Agent vapor occur at concentrations as low as 0.15 mg/m^3.

LC_{50}s for inhalation of Non-Halogenated Tear Agents have not been established or are not published.

Latency Period:

Tear Agents produce instantaneous effects.

Characteristics

Physical Appearance/Odor:

Non-Halogenated Tear Agents may be liquids or solids. Agents are colorless to yellow or brown in appearance. Odors of Non-Halogenated Tear Agents range from sweetish to simply producing a burning sensation in the nose and nasal passages.

Persistency:

When Tear Agents are employed as aerosols they are not persistent. However, a significant release of Tear Agent can deposit large amounts of solid or liquid material and pose a persist hazard.

Environmental Fate:

Tear Agent vapors have a density greater than air and tend to collect in low places. Agents may be absorbed into porous material, including painted surfaces, and these materials may be difficult to decontaminate. Tear Agents are essentially insoluble in water and have densities that range from near water to greater than water. Lack of solubility inhibits reaction of these agents with water.

Additional Hazards

Fire:

Non-Halogenated Tear Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic, and/or flammable vapors.

Reactivity:

Non-Halogenated Tear Agents generally do not react with water or are very slowly decomposed by water. Non-Halogenated Tear Agents are incompatible with strong oxidizers, including chlorine bleach, and may produce toxic decomposition products.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: There are currently no methods for identification of Tear Agents fielded by the U.S. Military.

Civilian: Detection of agents with PIDs or FIDs may be possible. Detection and identification of agent vapors with FT-IR is possible provided that the appropriate reference spectra are available. Incendiary aerosols of Tear Agents may not be detectable by FT-IR because of defraction of the beam.

Personal Protective Requirements:

Tear Agents are primarily an eye and respiratory hazard; however, at elevated concentrations, agents may also pose a dermal hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events. If solid agents have been released, dust control during windy conditions will be essential.

Decontamination:

Aerosols/Vapor: *Casualties/personnel:* Ventilation. If decontamination is deemed appropriate, flush skin with cool water followed by soap and warm water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.**

Small Areas: Ventilation. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. If necessary, wash with copious amounts of alkaline detergent and water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.** Porous surfaces may be difficult to decontaminate.

Liquid/Solid: *Casualties/personnel:* Remove contaminated clothing immediately. Wash skin with copious amounts of cool water followed by soap and warm water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.**

Small Areas: Consolidate as much solid material as possible and place in appropriate containers. Care should be made to minimize the aerosolization of agent. Employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much dust as possible. If necessary, wash (wet-vac) with copious amounts of alkaline detergent and water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.** Porous surfaces may be difficult to decontaminate.

First Aid

Signs & Symptoms:

Tear Agents produce intense eye pain and tearing. They may also produce burning or stinging sensations of exposed mucous membranes (e.g., nose and mouth) and skin. Symptoms may also include rhinorrhea (runny nose), sneezing, coughing, respiratory discomfort (tightness of the chest or inability to breath), nausea and/or vomiting. Increases in ambient temperature and/or humidity exacerbate agent effects.

Patient Management:

Casualties will usually recover from exposure to Tear Agents within 15 minutes after removal from the contaminated atmosphere. **Do not allow casualties to rub eyes or skin as this will exacerbate agent effects.**

Antidotes:

None.

Class Index C19
Tear Agents – In Solvents

Toxicology

Effects:

Tear Agents cause tears and intense eye pain. They may also irritate the respiratory tract, causing the sensation that the casualty has difficulty breathing. In high concentrations, tear compounds are irritating to the skin and cause a temporary burning or itching sensation. High concentration can also cause burns, nausea, and/or vomiting. In an enclosed or confined space, very high concentration of Tear Agents can be lethal. Both Halogenated (Class Index C17) and Non-Halogenated (Class Index C18) Tear Agents may be dispersed in solvents. Typical solvents include propylene glycol, benzene, carbon tetrachloride, chloroform, and/or trioctylphosphite. In many cases, solvents will increase the efficacy of the Tear Agent.

Pathways:

Tear Agents are primarily an eye-contact and inhalation hazard. Aerosols and vapors are irritating to the skin and eyes at low concentrations but relatively nontoxic via these routes. Solvents may increase the eye, dermal and/or inhalation hazards of the Tear Agents as well as pose toxic hazards themselves (e.g., chloroform, carbon tetrachloride, and benzene).

Exposure Hazards:

IC_{50}s (tearing) impacts from eye exposure to vapor from Tear Agents dispersed in solvents occur at concentrations as low as 0.15 mg/m^3 (10 minute exposure).

LC_{50}s for inhalation of Tear Agents dispersed in solvents occur at concentrations as low as 1,100 mg/m^3 (10 minute exposure).

Latency Period:

Tear Agents produce instantaneous effects.

Characteristics

Physical Appearance/Odor:

Agents are solutions or suspensions in solvents. Agent odor and/or appearance (see Class Indices C17 and C18) may be altered or masked by the solvent.

Persistency:

When Tear Agents are employed as aerosols, they are not persistent. However, a significant release of Tear Agent can deposit large amounts of solid or liquid material and pose a persist hazard.

Environmental Fate:

Tear Agents vapors have a density greater than air and tend to collect in low places. Agents may be absorbed into porous material, including painted surfaces, and these materials may be difficult to decontaminate. Tear Agents are essentially insoluble in water and have densities that range from near water to greater than water. Lack of solubility inhibits reaction of these agents with water. Further, solvents used to disperse Tear Agents are generally insoluble in water and will help prevent interaction of the agent with water. Solvents may have densities less than or greater than water and may cause agents to either float or sink in a water column.

Additional Hazards

Fire:

Tear Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic, corrosive and/or flammable vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present. Solvents may or may not be flammable. Combustion of solvents may produce toxic, corrosive and/or flammable vapors.

Reactivity:

Tear Agents generally do not react with water or are very slowly decomposed by water. Tear Agents may be corrosive and react with metal. In some cases these reactions may be violent. Most Tear Agents are incompatible with strong oxidizers, including chlorine bleach, and may produce toxic decomposition products. Solvents used to disperse Tear Agents may be incompatible with strong oxidizers and may decompose to form toxic and/or corrosive decomposition products.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 400 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: There are currently no methods for identification of Tear Agents fielded by the U.S. Military.

Civilian: The APD 2000 provides qualitative identification of pepper spray (oc). Colorimetric tubes are available which can detect halogenated hydrocarbons. Detection of agents with PIDs or FIDs may be possible. Colorimetric tubes are available which can detect many solvents used to disperse Tear Agents. Detection of solvents used to disperse Tear Agents may be possible with FIDs or PIDs. Detection and identification of either Tear Agent or solvent vapors with FT-IR is possible provided that the appropriate reference spectra are available. Aerosols of Tear Agents may not be detectable by FT-IR because of defraction of the beam.

Personal Protective Requirements:

Tear Agents are primarily an eye and respiratory hazard; however, in elevated concentrations, agents may also pose a dermal hazard. In addition to increasing the efficacy and/or dermal hazard of Tear Agents, solvents themselves may also pose respiratory or contact hazards. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Aerosols/Vapor: *Casualties/personnel:* Ventilation. If decontamination is deemed appropriate, flush skin with cool water followed by soap and warm water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.**

Small Areas: Ventilation. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much agent as possible. If necessary, wash with copious amounts of alkaline detergent and water. **Do not use bleach or detergents containing bleach as they may interact with agents to**

produce toxic decomposition products. Porous surfaces may be difficult to decontaminate.

Liquid/Solid: *Casualties/personnel:* Remove contaminated clothing immediately. Wash skin with copious amounts of cool water followed by soap and warm water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.**

Small Areas: Consolidate as much solid material as possible and place in appropriate containers. Care should be made to minimize the aerosolization of agent. Employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much dust as possible. If necessary, wash (wet-vac) with copious amounts of alkaline detergent and water. **Do not use bleach or detergents containing bleach as they may interact with agents to produce toxic decomposition products.** Porous surfaces may be difficult to decontaminate.

First Aid

Signs & Symptoms:

Tear Agents produce intense eye pain and tearing. They may also produce burning or stinging sensations of exposed mucous membranes (e.g., nose and mouth) and skin. Symptoms may also include rhinorrhea (runny nose), sneezing, coughing, respiratory discomfort (tightness of the chest or inability to breath), nausea and/or vomiting. Increases in ambient temperature and/or humidity exacerbate agent effects. Effects from solvents will be minimal in comparison to the impacts caused by Tear Agents.

Patient Management:

Casualties will usually recover from exposure to Tear Agents within 15 minutes after removal from the contaminated atmosphere. **Do not allow casualties to rub eyes or skin as this will exacerbate agent effects.**

Antidotes:

None.

Class Index C20
Vomiting Agents

Toxicology

Effects:

Vomiting Agents, originally developed as sternutators (sneezing agents), cause regurgitation. They may also cause coughing, sneezing, pain in the nose and throat, nasal discharge, and/or tears. Headaches often follow exposure to vomiting agents. Vomiting Agents may produce dermatitis on exposed skin. When released in an enclosed or confined space, vomiting agents can cause serious illness or death. Many vomiting agents contain arsenic as a constituent and decomposition products may pose a serious health hazard.

Pathways:

Vomiting Agents are primarily an inhalation hazard. Aerosols are irritating to the skin and eyes at low concentrations but relatively nontoxic via these routes. However, direct eye or skin contact with the liquid or solid agents may pose both a significant local and systemic hazard. Ingestion of vomiting agents or some decomposition products may pose a significant hazard.

Exposure Hazards:

IC_{50}s (sneezing, and regurgitation) for inhalation of Vomiting Agents are as low as 1.2 mg/m^3 (10 minute exposure).

LC_{50}s for inhalation of Vomiting Agents are as low as 1,000 mg/m^3 (10 minute exposure).

Latency Period:

Depending on dose, the effects from exposure may be delayed from 30 seconds to several minutes and last up to several hours. Mild effects may persist for several days.

Characteristics

Physical Appearance/Odor:

Vomiting Agents are colorless liquids or colorless to light yellow or green solids. Odors range from non-detectable to pleasantly sweet to garlic or bitter almonds.

Persistency:

When Vomiting Agents are employed as aerosols they are not persistent. However, liquid or solid agents can persist in the environment for extended periods. If solid agents are deployed as aerosols, there is minimal secondary risk once the initial aerosol has settled. However, resuspension of any dust contaminated with Vomiting Agents can pose a continuing hazard. Decomposition products from the breakdown of Vomiting Agents can pose a persistent hazard.

Environmental Fate:

Most Vomiting Agents form no appreciable vapor and are deployed as dust aerosols. Once the aerosols settle, there is minimal extended hazard from the agents unless the dusts are resuspended. Decomposition products can be persistent hazards.

Additional Hazards

Fire:

Vomiting Agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Combustion of Vomiting Agents will produce volatile toxic metal (i.e., arsenic, antimony, lead) decomposition products. In addition, combustion of Vomiting Agents may produce other toxic, corrosive and/or flammable vapors. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Vomiting Agents are generally slow to decompose in water. Some agents are self-protecting and form a protective oxide coating that delays further hydrolysis. Agents may be corrosive to some metals.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 200 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: There are currently no methods for identification of Vomiting Agents fielded by the U.S. Military.

Civilian: Colorimetric tubes are available which can detect organic arsenic compounds as well as arsine (AsH_3). However, since these agents form no appreciable vapor, it is unlikely that these methods will be effective in identifying Vomiting Agents.

Personal Protective Requirements:

Vomiting Agents are primarily a respiratory hazard; however, contact with liquid or solid agents may pose both a local and systemic hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Aerosols: *Casualties/personnel:* Ventilation. If decontamination is deemed appropriate, wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water.

Small Areas: Ventilation. In heavily contaminated areas, employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much dust as possible. If necessary, decontaminate by washing with copious amounts of household bleach followed by rinsing with water. Arsenic or antimony metal and/or oxides, due to decomposition of the agents, may be present and require additional decontamination.

Solids: *Casualties/personnel:* Wash the entire potentially exposed area with a bleach solution avoiding contact with sensitive areas such as the eyes. The bleach solution should be no less than one part household bleach in nine parts water. Rinse with copious amounts of water.

Small Areas: Consolidate as much solid material as possible and place in appropriate containers. Care should be made to minimize the aerosolization of agent. Employ vacuum devices equipped with High Efficiency Particulate Air (HEPA) filters to remove as much dust as possible. If necessary, wash with copious amounts of straight household bleach followed by rinsing with water. Arsenic or antimony metal and/or oxides, due to decomposition of the agents, may be present and require additional decontamination.

First Aid

Signs & Symptoms:

Progression of symptoms is generally irritation of the eyes and mucous membranes, viscous discharge from the nose similar to that caused by a cold, violent uncontrollable sneezing and coughing, severe headache, acute pain and difficulty breathing (tightness of the chest), nausea, and vomiting. Mental depression may occur. Severe effects last from 30 minutes to several hours. Minor effects may persist for 24 hours or longer.

Patient Management:

Casualties will usually recover from exposure to Vomiting Agents within 2 hours after removal from the contaminated atmosphere. Vigorous exercise may lessen and shorten symptoms.

Antidotes:

None.

Class Index C21
Corrosive Smoke

Toxicology

Effects:

Corrosive Smoke agents cause inflammation and general destruction of tissues. Inhalation of these agents can cause lung membranes to swell and become filled with liquid (pulmonary edema). Death may result from lack of oxygen.

Pathways:

Corrosive Smoke agents are hazardous through inhalation as well as skin and eye exposure. Excessive dermal impacts may induce systemic complications.

Exposure Hazards:

Human toxicity data for these agents has not been published or has not been established. However, the industrial IDLH levels for these agents are as low as 3 ppms.

Latency Period:

Tissue damage occurs within minutes of exposure to corrosives. In some cases, clinical effects may not appear for several hours. Pulmonary edema caused by inhalation of the agent vapor may be delayed for several hours.

Characteristics

Physical Appearance/Odor:

Corrosive Smoke agents are colorless to yellow or black solids or liquids with pungent or biting odors.

Persistency:

Corrosive Smoke agents are reactive with most materials and rapidly decompose. However, hazardous residue may remain for extended periods.

Environmental Fate:

Vapors from Corrosive Smoke agents have a density greater than air and tend to collect in low places. Agents are either very soluble in water or are rapidly hydrolyzed. Dilution does not significantly reduce the contact hazard posed by these agents. The liquid density of these agents is greater than that of water.

Additional Hazards

Fire:

Some Corrosive Smoke agents are pyroforic and may spontaneously combust in contact with air. Corrosive Smoke agents may be volatilized during a fire or be spread by efforts to extinguish the fire. Agents may be decomposed by heat to produce other toxic and/or corrosive gases. In some cases, Corrosive Smoke agents may react with steam or water during a fire to produce toxic and/or corrosive vapors. These reactions may be very violent. Hydrogen produced by the action of the corrosive vapors on metals or other corrodible materials may be present.

Reactivity:

Some Corrosive Smoke agents are pyroforic and may spontaneously combust in contact with air. Corrosive Smoke agents are reactive to most metals and organic materials. If these materials are finely divided, interactions may cause spontaneous ignition. Reactions of most Corrosive Smoke agents with water may be violent to the point of explosive.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 200 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Military: There are currently no field methods for detection of Corrosive Smokes employed by the U.S. Military.

Civilian: Colorimetric tubes are available which can detect sulfuric acid (H_2SO_4). Corrosive Smoke agents can be detected with litmus or pH paper. Detection and identification with FT-IR is possible provided that the appropriate reference spectra are available. However, an FT-IR may be ineffective due to defraction of the beam by the cloud.

Personal Protective Requirements:

Corrosive Smoke agents pose both a severe respiratory and severe contact hazard. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). If pyroforic agents are involved, fully encapsulating protective gear may not be appropriate unless the material is fire resistant. Structural firefighters' protective clothing is recommended for fire situations only; it is not effective in spill or release events.

Decontamination:

Casualties/personnel: Speed in decontamination is essential. Remove all clothing and immediately rinse with copious amounts of water. If required, dilute solutions of baking soda may be used to neutralize low pH agents, whereas dilute solutions of vinegar may be used to neutralize high pH agents.

Small Areas: Puddles of liquid must be contained by covering with corrosion resistant absorbent materials. Remove all material and place in a corrosion resistant container. Decontaminate the area with copious amounts of the appropriate dilute neutralizing agent (e.g., baking soda or vinegar). Solid baking soda is effective at neutralizing both high and low pH agents; however, reactions may produce excessive heat and violent off-gassing. Dilution is ineffective and may exacerbate the problem.

First Aid

Signs & Symptoms:

Pain and irritation from exposure to either agent liquid or vapor may be immediate or delayed depending on the concentration of the agent. Skin impacts include pain, red and inflamed skin progressing to severe burns.

Exposure of the eyes results in irritation, pain, swelling, corneal erosion. Upper respiratory signs vary with the amount of exposure and may include sneezing, hoarseness, laryngitis, bleeding of the nose and gums, choking, shortness of breath, chest pain, and delayed pulmonary edema.

Patient Management:

Remove casualty to fresh air and provide oxygen for respiratory distress. Immediately decontaminate any potential exposure. Otherwise, treatment consists of symptomatic management of lesions.

Antidotes:

None.

Class Index C22
Toxins

Toxicology

Effects:

Toxins present a variety of both incapacitating and lethal effects. General types of Toxins include those that disrupt the nervous system (neurotoxins), destroy or damage tissue (cytotoxins) or cause the body to release excessive, and therefore harmful, amounts of chemicals that are normally produced by the body (biomediator Toxins). Toxins may produce effects that are a combination of these general categories.

Pathways:

Varies according to the specific toxin. Toxins may be hazardous through inhalation, ingestion, injection (e.g., stings, bites), and/or abraded skin (e.g., breaks in the skin or penetration of skin by debris). Individual Toxins may be effective through multiple pathways. The route of exposure may significantly change the signs and symptoms associated with any given Toxin. Generally, effects of Toxins are most severe when the Toxin is inhaled. Toxins that have been inhaled then coughed up and swallowed may also pose an ingestion hazard. Although there are exceptions (see Class Index C23), the risks posed by Toxins through dermal exposure are generally minimal. Because of their efficacy, Toxins may be dissolved in solvents and delivered as dilute solutions. These Toxin solutions may pose a significant percutaneous hazard due to solvent properties.

Exposure Hazards:

LD_{50}s for inhalation of Toxin aerosols are as low as 0.00000007 gm per individual.

Latency Period:

Effects from exposure to Toxins can be delayed from minutes up to days. The impacts from some toxins, especially cytotoxins, may occur within minutes but symptoms may not appear for hours. The route of exposure to the Toxin can significantly change the latency period.

Characteristics

Physical Appearance/Odor:

Toxins may be solids or liquids. They are odorless and tasteless. However, the appearance of a specific toxin may not be discernable since Toxins may be deployed as dilute solutions.

Persistency:

Toxins can be persistent or nonpersistent. Generally, Toxins are nonpersistent.

Environmental Fate:

Toxins are non-volatile. Once the aerosol settles, there is minimal inhalation hazard unless the Toxins are re-aerosolized. Many Toxins are not soluble in water. Some Toxins are very stable in the environment and can persist for extended periods.

Additional Hazards

Fire:

Toxins are not volatile but may be spread by efforts to extinguish the fire. Toxins may be decomposed by heat to produce other toxic gases.

Reactivity:

Varies depending on the specific Toxin but generally toxins selected for warfare purposes are not exceptionally reactive to common materials.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 200 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Portable immunoassay kits have been developed for a limited number of Toxins. The kits are capable of identifying Toxins within 30 minutes. Kits for additional Toxins are under development. Clinical immunoassays (ELISA), as well as chemical analytical methods for detection and identification of Toxins are available. These methods can take from 2 to 4 hours to identify individual Toxins even under ideal conditions.

Personal Protective Requirements:

Toxins are generally dispersed as aerosols and pose a severe respiratory hazard. However, Toxins are nonvolatile and do not pose an inhalation hazard once the aerosol has settled. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). There is a significant hazard posed by contact of contaminated material with abraded skin or injection of toxins through contact with debris. Appropriate protection to avoid any potential abrasion, laceration or puncture of the skin is essential.

Decontamination:

Casualties/personnel: Remove potentially contaminated clothing. Wash skin with soap and water.

Small Areas: Wash all surfaces with undiluted household bleach insuring a minimum contact time of 10 minutes. Wash the area with soap and water followed by rinsing with copious amounts of water.

Extreme care must be exercised when dealing with dry or powdered agents as Toxins may adhere to the skin or clothing and present an inhalation hazard later.

First Aid

Signs & Symptoms:

Varies depending on the specific Toxin. Even symptoms presented by Toxins with the same general classification (i.e., neurotoxin, cytotoxin, biomediator Toxin) may vary depending on the specific mechanism of action within the body.

Patient Management:

Ventilate patient if there is difficulty breathing and administer oxygen. Be prepared to treat for shock. If the identity of the Toxin is known, administer antidote if available.

Antidotes:

Antidotes are available for some Toxins and others are being developed. However, many Toxins affect such basic biochemical mechanisms within the body that potential antidotes often have severe debilitating or toxic side effects. Unlike chemical agents, Toxins can cause an immune response. Vaccines are available for some Toxins but generally require 4 to 15 weeks for the body to produce antibodies. Passive immunotherapy is effective for some neurotoxins but must be instituted shortly after exposure.

Class Index C23
Toxins – Dermally Hazardous

Toxicology

Effects:

Toxins present a variety of both incapacitating and lethal effects. Generally, these Toxins destroy or damage tissue (cytotoxins), but may also disrupt the nervous system (neurotoxins), and/or cause the body to release excessive, and therefore harmful, amounts of chemicals that are normally produced by the body (biomediator toxins).

Pathways:

In addition to the hazards posed through inhalation, ingestion, injection (e.g., stings, bites), and/or contact with abraded skin (e.g., breaks in the skin or penetration of skin by debris), these Toxins may damage the eyes as well as any exposed skin surfaces. Local impacts to the nose, throat and/or lungs can result in respiratory problems (e.g., nose bleed, sneezing, pulmonary edema). Toxins that have been inhaled then coughed up and swallowed may also pose an ingestion hazard. Individual Toxins may be effective through multiple pathways. The route of exposure may significantly change the signs and symptoms associated with any given toxin. Generally, effects of toxins are most severe when the toxin is inhaled. Because of their efficacy, Toxins may be dissolved in solvents and delivered as dilute solutions. These Toxin solutions may pose a significant percutaneous hazard due to solvent properties.

Exposure Hazards:

Skin impacts occur at doses as low as 0.00006 gm per square inch of contaminated skin.

Eye impacts occur at doses as low as 0.000001 gm per eye.

LD_{50}s for dermal exposure are as low as 0.1 gm per individual.

LD_{50}s for inhalation of Toxin aerosols are as low as 0.002 gm per individual.

Latency Period:

Local effects from exposure to these Toxins begins within minutes of exposure. Systemic effects may be delayed from hours to days. The route of exposure to the toxin can significantly change the latency period.

Characteristics

Physical Appearance/Odor:

Toxins may be solids or liquids. They are odorless and tasteless. However, the appearance of a specific toxin may not be discernable since toxins may be deployed as dilute solutions.

Persistency:

Toxins can be persistent or nonpersistent. Generally, Toxins are nonpersistent.

Environmental Fate:

Toxins are non-volatile. Once the aerosol settles, there is minimal inhalation hazard unless the toxins are re-aerosolized. Many toxins are not soluble in water. Some toxins are very stable in the environment and can persist for extended periods.

Additional Hazards

Fire:

Toxins are not volatile but may be spread by efforts to extinguish the fire. Toxins may be decomposed by heat to produce other toxic gases.

Reactivity:

Varies depending on the specific toxin but generally toxins selected for warfare purposes are not exceptionally reactive to common materials.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 200 feet in all directions. If possible, identify the agent and develop a downwind hazard diagram (see Table 3.2). Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized, persistence of the agent and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible. Depending on the persistence of the agent and the potential for condensation of agent from the cloud, evacuation of the threatened population after passage of the initial cloud may be appropriate.

Field Detection/Identification (See Table 3.1):

Portable immunoassay kits have been developed for a limited number of toxins. The kits are capable of identifying toxins within 30 minutes. Kits for additional toxins are under development. Clinical immunoassays (ELISA), as well as chemical analytical methods for detection and identification of toxins, are available. These methods can take from 2 to 4 hours to identify individual toxins even under ideal conditions.

Personal Protective Requirements:

These Toxins pose both a severe respiratory and severe contact hazard. Toxins are generally dispersed as aerosols. Although Toxins are nonvolatile and do not pose an inhalation hazard once the aerosol has settled, residue from aerosols of Dermally Hazardous Toxins can still pose a contact threat. Wear appropriate fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). There is a significant hazard posed by contact of contaminated material with abraded skin or injection of toxins through contact with debris. Appropriate protection to avoid any potential abrasion, laceration or puncture of the skin is essential.

Decontamination:

Casualties/personnel: Remove potentially contaminated clothing. Wash skin with soap and water.

Small Areas: Wash all surfaces with undiluted household bleach insuring a minimum contact time of 10 minutes. Wash the area with soap and water followed by rinsing with copious amounts of water.

Extreme care must be exercised when dealing with dry or powdered agents as toxins may adhere to the skin or clothing and present both a contact and an inhalation hazard later.

First Aid

Signs & Symptoms:

Early indication of dermal contact include itching, burning skin pain, redness, tenderness, and blistering. Contact of the eyes with these Toxins produces pain, tearing, redness and the sensation of the presence of a foreign body in the eye. Nasal impacts include itching, pain, sneezing, rhinorrhea (runny nose), and bleeding. System signs and symptoms may be delayed and vary depending on the specific toxin. Even symptoms presented by toxins with the same general classification (i.e., neurotoxin, cytotoxin, biomediator toxin) may vary depending on the specific mechanism of action within the body.

Patient Management:

Ventilate patient if there is difficulty breathing and administer oxygen. Be prepared to treat for shock. If the identity of the toxin is known, administer antidote if available.

Antidotes:

Antidotes are available for some Toxins and others are being developed. However, many Toxins affect such basic biochemical mechanisms within the body that potential antidotes often have severe debilitating or toxic side effects. Unlike chemical agents, toxins can cause an immune response. Vaccines are available for some toxins but generally require 4 to 15 weeks for the body to produce antibodies. Passive immunotherapy is effective for some neurotoxins but must be instituted shortly after exposure.

Class Index C24
Pathogens – Anti-Personnel

Health

Effects:

Pathogens employed as biological weapons can be used for both lethal and incapacitating purposes. Effects may be due to the production of Toxins (see Class Index C22) by the organism. Anti-personnel pathogens can be bacteria, virus, rickettsiae, or fungus. For warfare purpose, agents may be in the form of spores, liquid containing active agents, contaminated material (e.g., dust), or freeze-dried powders. Many pathogen agents are normally zoonoses (i.e., animal diseases) that can also infect people. The diseases produced by these pathogens may be difficult for medical personnel not trained in exotic pathology to diagnose since they may not be familiar with these diseases.

Pathways:

For warfare purposes, inhalation is the most effective route of entry. If the agent is not naturally transmitted as an aerosol, it may be altered (e.g., freeze-dried) to facilitate an inhalation pathway. For this reason, all incidents involving pathogens should be considered posing an inhalation hazard during the initial evaluation. The primary routes of entry of pathogen aerosols include inhalation and/or contact of the aerosol with the mucous membranes of the eyes, nose, or mouth. In addition, although intact skin is an effective barrier against most pathogens, abraded skin (e.g., abrasions, lacerations, or penetration of skin by debris) circumvents this protective barrier and allows entry of the pathogen into the body.

Incubation Period:

Varies depending on the pathogen, but is generally on the order of days to weeks. Exposures to extremely high doses of some pathogens may reduce the incubation period to as short as several hours. Other pathogens may have an incubation period extending for years. Some of these pathogens go through alternating dormant and active cycles producing reoccurring disease within the casualty that can last for years.

Persistency:

In general, unless a local reservoir (e.g., animal or insect in which a pathogen can live and serve as a source for continued infection) is established, pathogens are easily killed by unfavorable environmental factors such as fluctuations in temperature, humidity, food sources, or ultraviolet light. For this reason, their persistency is generally limited to days. However, some bacteria are capable of entering a dormant state, called a spore, which is highly resistant to impacts from changes in environmental factors. These agents can survive as spores for decades and then become active again when the proper conditions occur. In addition, pathogens can be freeze-dried and remain in a preserved state almost indefinitely. Freeze-dried pathogens are reactivated when exposed to moisture.

Additional Hazards

In general, once the initial cloud has settled the risk from re-aerosolization of pathogens is minimal. However, it should not be discounted. In many cases, there is the additional risk of secondary infections due to exposure of personnel to contaminated blood, bodily fluids, or fecal matter from individuals infected during the initial release. In some instances, pathogens are directly transmitted from person to person through aerosols (i.e., sneezing or coughing) or contact. Some pathogens may be absorbed into fomites (e.g., clothing or bedding) and causing these items to become infectious and capable of transmitting the disease.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 100 feet in all directions. Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible.

Field Detection/Identification (See Table 3.1):

Portable immunoassay kits have been developed for a limited number of pathogens. The kits are capable of identifying pathogens within 30 minutes. Kits for additional pathogens are under development. Clinical immunoassays (ELISA) are available as well as traditional techniques to culture and identify the pathogen.

Personal Protective Requirements:

Wear fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). There is a significant hazard posed by contact of contaminated material with abraded skin or injection of pathogens through contact with debris. Appropriate protection to avoid any potential abrasion, laceration or puncture wound is essential.

> **Although latex gloves may normally be adequate protection against disease, some studies have suggested that the protection offered by these gloves may be inadequate for high concentrations of pathogens. The high level of contamination from a deliberate release incident may preclude the use of latex gloves.**

Decontamination:

Casualties/personnel: **Direct exposure to aerosol cloud**: Remove all clothing and double bag in appropriate biological hazard containers. Wash skin with soap and water followed by washing with a solution of one part household bleach in nine parts water. The bleach solution should remain in contact with the contaminated area for 10 to 15 minutes before a second wash with soap and water. **All other exposures**: Thoroughly wash skin with soap and water. Collect and disinfect all wash and rinse solutions.

Equipment: Wash all surfaces with full strength household bleach insuring a minimum contact time of 30 minutes. Follow this with normal cleaning procedures appropriate for the item.

Small Areas: Fumigate with disinfectant gas or aerosol (e.g., formaldehyde). Follow fumigation with a wash of all surfaces employing a disinfectant such as household bleach. Rinse with water.

First Aid

Signs & Symptoms:

Vary depending on the specific pathogen. Generally follow flu-like symptoms including such discomforts as headache, fever, chills, cramping, vomiting, diarrhea, malaise, fatigue, cough, and/or chest discomfort.

Patient Management:

Treated symptomatically. Antibiotics are effective against many bacteria although some strains have developed resistance to these drugs. Some viral pathogens can be treated by anti-viral drugs. Antitoxins are available to treat some pathogen related Toxins (see Class Index 22). Once the pathogen has been identified, then appropriate drugs can be prescribed. Vaccines are available for some pathogens but generally require 4 to 15 weeks for the body to produce antibodies. Passive immunotherapy is effective for some pathogens but must be instituted shortly after exposure.

Class Index C25
Pathogens – Anti-Personnel/Vector

Health

Effects:

Pathogens employed as biological weapons can be used for both lethal and incapacitating purposes. Effects may be due to the production of Toxins (see Class Index C22) by the organism. Anti-personnel pathogens can be either bacteria, virus, rickettsiae, or plasmodia. For warfare purpose, agents may be in the form of spores, liquid containing active agents, contaminated material (e.g., dust), or freeze-dried powders. In addition, these pathogen agents are naturally transmitted by vectors (e.g., mosquitoes, ticks, lice). Many pathogen agents are normally zoonoses (i.e., animal diseases) that can also infect people. The diseases produced by these pathogens may be difficult for medical personnel not trained in exotic pathology to diagnose since they may not be familiar with these diseases.

Pathways:

For warfare purposes, inhalation is the most effective route of entry. If the agent is not naturally transmitted as an aerosol, it may be altered (e.g., freeze-dried) to facilitate an inhalation pathway. For this reason, all incidents involving pathogens should be considered posing an inhalation hazard during the initial evaluation. The primary routes of entry of pathogen aerosols include inhalation and/or contact of the aerosol with the mucous membranes of the eyes, nose, or mouth. In addition, although intact skin is an effective barrier against most pathogens, abraded skin (e.g., abrasions, lacerations, or penetration of skin by debris) circumvents this protective barrier and allows entry of the pathogen into the body.

In addition, these pathogens are also naturally transmitted by vectors and this pathway may also be exploited as a method of delivery of biowarfare agents. Examples of vectors include flies, mosquitoes, ticks, lice, and fleas. Vectors transmit the pathogen when they bite or scratch a new host. In some cases, the pathogen is excreted in the vector's feces as it feeds and forced into the wound by the casualty when scratching the bite. Vectors may be either the reservoir (i.e., animal or insect in which a pathogen normally lives and serves as a source for continued infection) or intermediate host for the pathogen.

Incubation Period:

Varies depending on the pathogen, but is generally on the order of days to weeks. Exposures to extremely high doses of some pathogens may reduce the incubation period to as short as several hours. Other pathogens may have an incubation period extending for years. Some of these pathogens go through alternating dormant and active cycles producing reoccurring disease within the casualty that can last for years.

Persistency:

In general, unless a local reservoir (e.g., animal or insect in which a pathogen can live and serves as a source for continued infection) is established, pathogens are easily killed by unfavorable environmental factors such as fluctuations in temperature, humidity, food sources, or ultraviolet light. For this reason, their persistency is generally limited to days. However, some bacteria are capable of entering a dormant state, called a spore, which is highly resistant to impacts from changes in environmental factors. These agents can survive as spores for decades and then become active again when the proper conditions occur. In addition, pathogens can be freeze-dried and remain in a preserved state almost indefinitely. Freeze-dried pathogens are reactivated when exposed to moisture.

In many cases, once the vector is infected, it is capable of transmitting the disease throughout its life span. Some pathogens that are carried by vectors are transmitted transovarian to the young of the vector so that the next generation is born infected.

Additional Hazards

In general, once the initial cloud has settled the risk from re-aerosolization of pathogens is minimal. However, it should not be discounted. It is possible that infected individuals or some local species of animal that has acquired the pathogen as a result of the release can become a continual source of vector inoculation. The continued reservoir/vector interaction could transmit the disease rapidly throughout an area. There is a minimal risk of secondary infection from such things as bodily fluids and, although there are exceptions, the risk of direct person-to-person transmission is limited.

Protection

Evacuation:

Immediately isolate an area around any liquid or solid contamination for at least 100 feet in all directions. Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible.

Field Detection/Identification (See Table 3.1):

Portable immunoassay kits have been developed for a limited number of pathogens. The kits are capable of identifying pathogens within 30 minutes. Kits for additional pathogens are under development. Clinical immunoassays (ELISA) are available as well as traditional techniques to culture and identify the pathogen.

Personal Protective Requirements:

Wear clothing that minimizes the amount of exposed skin and apply appropriate insect repellant. If an aerosol has been used to disseminate the pathogen, wear fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). There is a significant hazard posed by contact of contaminated material with abraded skin or injection of pathogens through contact with debris. Appropriate protection to avoid any potential abrasion, laceration or puncture of the skin is essential.

> **Although latex gloves may normally be adequate protection against disease, some studies have suggested that the protection offered by these gloves may be inadequate for high concentrations of pathogens. The high level of contamination from a deliberate release incident may preclude the use of latex gloves.**

Decontamination:

Casualties/personnel: **Direct exposure to aerosol cloud**: Wash skin with soap and water followed by washing with a solution of one part household bleach in nine parts water. The bleach solution should remain in contact with the contaminated area for 10 to 15 minutes before a second wash with soap and water. For clothing and equipment, wash all surfaces with full strength household bleach insuring a minimum contact time of 30 minutes. Follow this with normal cleaning procedures appropriate for the item. **Release of non-flying vectors** (e.g., fleas, lice): Remove all potentially infested clothing depositing it in a container that will trap and eliminate any remaining vectors. Wash casualty with soap and water and inspect hairy parts of the body for potential vectors. Apply appropriate repellant. **Release of flying vectors** (e.g., mosquitoes, biting flies): No decontamination is required. Apply appropriate repellant.

Clothing and Equipment: **Direct exposure to aerosol cloud**: Wash all surfaces with full strength household bleach insuring a minimum contact time of 30 minutes. Follow this with normal cleaning procedures appropriate for the item.

Small Areas: **Aerosol**: fumigate with disinfectant gas or aerosol (e.g., formaldehyde). Follow fumigation with a wash of all surfaces employing a disinfectant such as household bleach. Rinse with water. **Vectors**: fumigate with appropriate pesticides.

First Aid

Signs & Symptoms:

Vary depending on the specific pathogen. Generally follow flu-like symptoms including such discomforts as headache, fever, chills, cramping, vomiting, diarrhea, malaise, fatigue, cough, and/or chest discomfort.

Patient Management:

Treated symptomatically. Antibiotics are effective against many bacteria although some strains have developed resistance to these drugs. Some viral pathogens can be treated by anti-viral drugs. Antitoxins are available to treat some pathogen related Toxins (see Class Index 22). Once the pathogen has been identified, then appropriate drugs can be prescribed. Vaccines are available for some pathogens but generally require 4 to 15 weeks for the body to produce antibodies. Passive immunotherapy is effective for some pathogens but must be instituted shortly after exposure.

Contact between infected individuals and potential vectors should be minimized as this may propagate the spread of the disease. Initiate pesticide application to eradicate potential vectors in the area.

Class Index C26
Pathogens – Anti-Personnel/Ingestion

Health

Effects:

Pathogens employed as biological weapons can be used for both lethal and incapacitating purposes. Effects may be due to the production of Toxins (see Class Index C22) by the organism. Pathogens that are primarily an ingestion risk can be either bacteria or virus.

Pathways:

The primary route of entry of these pathogens is ingestion of food or fluids. In addition, although intact skin is an effective barrier against most pathogens, abraded skin (e.g., abrasions, lacerations, or penetration of skin by debris) circumvents this protective barrier and allows entry of the pathogen into the body. Agents may be in the form of spores, liquid containing active agents, contaminated material (e.g., dust), or freeze-dried pathogens (i.e., preserved powders of living agents). For warfare purposes, the most effective route of entry is inhalation (see Class Index C24). Many agents that might otherwise have minimal airborne risk can be modified and dispersed as an aerosol. For this reason, all incidents involving pathogens should be considered an inhalation hazard until determined otherwise.

Incubation Period:

Varies depending on the pathogen, but is generally on the order of hours to days. Exposures to extremely high doses of some pathogens may reduce the incubation period.

Persistency:

Many pathogens can survive in food containers for extended periods. Some pathogens can survive in turbid water for long periods. Some bacteria are capable of entering a dormant state, called a spore, which is highly resistant to impacts from changes in environmental factors. These agents can survive as spores for decades and then become active again when the proper conditions occur. In addition, pathogens can be freeze-dried and remain in a preserved state almost indefinitely. Freeze-dried pathogens are reactivated when exposed to moisture.

Additional Hazards

There is a significant risk of secondary infections from the fecal/oral cycle. Some individuals can become asymptomatic carriers and are capable of spreading the disease long after their recovery (e.g., Typhoid Mary). Some pathogens may be absorbed into fomites (e.g., clothing or bedding) and cause these items to become infectious and capable of transmitting the disease. In addition, mechanical vectors, (e.g., flies, roaches) can transmit pathogens and spread the disease to food not directly contaminated by the release. For pathogens dispersed as aerosols, once the initial cloud has settled the risk from re-aerosolization of pathogens is minimal. However, it should not be discounted.

Protection

Evacuation

Immediately isolate an area around any liquid or solid contamination for at least 100 feet in all directions. Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible.

Field Detection/Identification (See Table 3.1):

Portable immunoassay kits have been developed for a limited number of pathogens. The kits are capable of identifying pathogens within 30 minutes. Kits for additional pathogens are under development. Clinical immunoassays (ELISA) are available as well as traditional techniques to culture and identify the pathogen.

Personal Protective Requirements:

Wear gloves and surgical protective mask. Ensure thorough and frequent washing of hands. If an aerosol has been used to disseminate the pathogen, wear fully encapsulating protective gear with positive pressure self-contained breathing aparatus (SCBA).

Although latex gloves may normally be adequate protection against disease, some studies have suggested that the protection offered by these gloves may be inadequate for high concentrations of pathogens. The high level of contamination from a deliberate release incident may preclude the use of latex gloves.

Decontamination:

Casualties/personnel: **Direct exposure to aerosol cloud**: Wash skin with soap and water followed by washing with a solution of one part household bleach in nine parts water. The bleach solution should remain in contact with the contaminated area for 10 to 15 minutes before a second wash with soap and water. **All other exposures**: Thoroughly wash skin with soap and water. Collect and disinfect all wash and rinse solutions.

Clothing and Equipment: **Direct exposure to aerosol cloud**: Wash all surfaces with full strength household bleach insuring a minimum contact time of 30 minutes. Follow this with normal cleaning procedures appropriate for the item.

Small Areas: **Aerosol**: Fumigate with disinfectant gas or aerosol (e.g., formaldehyde). Follow fumigation with a wash of all surfaces employing a disinfectant such as household bleach. Rinse with water.

First Aid

Signs & Symptoms:

Vary depending on the specific pathogen. Generally include nausea, cramping, vomiting, and diarrhea. Other flu-like symptoms (e.g., headache, fever, chills, malaise, fatigue) may be present.

Patient Management:

Fluid and electrolyte replacement is critical. Often this can be accomplished by the use of oral rehydration salts or dilute sports-type drinks. Otherwise, treated symptomatically. Antibiotics are effective against many bacteria although some strains have developed resistance to these drugs. Some viral pathogens can be treated by anti-viral drugs. Antitoxins are available to treat some pathogen related toxins. Once the pathogen has been identified, then appropriate drugs can be prescribed. Vaccines are available for some pathogens but generally require 4 to 15 weeks for the body to produce antibodies.

Class Index C27
Pathogens – Anti-Animal

Health

Effects:

Pathogens employed as anti-animal biological weapons are generally used to produce lethal effects in the target animal species. Primarily, targeted species provide food or are of economic value to the area. Pathogens can be bacteria, virus, rickettsiae, fungus, or parasites. Agents may be in the form of spores, liquid containing active agents, contaminated material (e.g., dust), or freeze-dried pathogens (i.e., preserved powders of living agents).

Pathways:

Pathogens may be introduced via inhalation, contact, ingestion, injection, or vector.

Incubation Period:

Varies depending on the pathogen, but is generally on the order of days to weeks. Exposures to extremely high doses of some pathogens may reduce the incubation period to as short as several hours.

Persistency:

In general, unless a local reservoir (e.g., animal or insect in which a pathogen normally lives and serves as a source for continued infection) is established, pathogens are easily killed by unfavorable environmental factors such as fluctuations in temperature or humidity, acidity of the medium, food sources, or ultraviolet light. For this reason, their persistency in their active state is generally limited to days. However, some bacteria are capable of entering a dormant state, called a spore, which is highly resistant to impacts from changes in environmental factors. These agents can survive as spores for decades and then become active again when the proper conditions occur. In addition, pathogens can be freeze-dried and remain in a preserved state almost indefinitely. Freeze-dried pathogens are reactivated when exposed to moisture.

Additional Hazards

Although pathogens are selected to target a specific animal species, there is the possibility that the disease may migrate to humans.

Protection

Evacuation

Immediately isolate an area around any liquid or solid contamination for at least 100 feet in all directions. Adjust the initial isolation distance as appropriate. Based on the type of release, amount of material aerosolized and local conditions (e.g., weather, population density, time of day), shelter-in-place until the initial cloud passes may be the most appropriate course of action since timely evacuation of the threatened downwind population may not be possible.

Field Detection/Identification (See Table 3.1):

Clinical immunoassays (ELISA) are available as well as traditional techniques to culture and identify the pathogen.

Personal Protective Requirements:

Wear fully encapsulating protective gear with positive pressure self-contained breathing apparatus (SCBA). There is a significant hazard posed by contact of contaminated material with abraded skin or injection of pathogens through contact with debris. Appropriate protection to avoid any potential abrasion, laceration or puncture wound is essential.

> **Although latex gloves may normally be adequate protection against disease, some studies have suggested that the protection offered by these gloves may be inadequate for high concentrations of pathogens. The high level of contamination from a deliberate release incident may preclude the use of latex gloves.**

Decontamination:

Personnel: **Direct exposure to aerosol cloud**: Wash skin with soap and water followed by washing with a solution of one part household bleach in nine parts water. The bleach solution should remain in contact with the contaminated area for 10 to 15 minutes before a second wash with soap and water. **All other exposures**: Thoroughly wash skin with soap and water. Collect and disinfect all wash and rinse solutions.

Clothing and Equipment: **Direct exposure to aerosol cloud**: Wash all surfaces with full strength household bleach insuring a minimum contact time of 30 minutes. Follow this with normal cleaning procedures appropriate for the item.

Small Areas: **Aerosol**: Fumigate with disinfectant gas or aerosol (e.g., formaldehyde). Follow fumigation with a wash of all surfaces employing a disinfectant such as household bleach. Rinse with water.

First Aid

Signs & Symptoms:

Personnel: Vary depending on the specific pathogen. Generally follow flu-like symptoms including such discomforts as headache, fever, chills, cramping, vomiting, diarrhea, malaise, fatigue, cough and/or chest discomfort.

Animals: Varies depending on the specific pathogen and infected species. Consult veterinarian familiar with exotic diseases.

Patient Management:

Personnel: Treated symptomatically. Antibiotics are effective against many bacteria although some strains have developed resistance to these drugs. Some viral pathogens can be treated by anti-viral drugs. Antitoxins are available to treat some pathogen related Toxins (see Class Index 22). Once the pathogen has been identified, then appropriate drugs can be prescribed. Vaccines are available for some pathogens but generally require 4 to 15 weeks for the body to produce antibodies. Passive immunotherapy is effective for some pathogens but must be instituted shortly after exposure.

Animals: Isolate infected animals. Limit vector access to animals through application of pesticides. Ensure adequate personal hygiene of anyone coming into contact with the animals. Consult veterinarian familiar with possible exotic diseases.

Class Index C28
Pathogens – Anti-Plant

Health

Effects:

Pathogens employed as anti-plant biological weapons are generally employed to produce lethal effects in the target plant species. Primarily target species provide food or other economic value to the area. Pathogens can be bacteria, virus, fungus, or insects. Agents may be in the form of spores, liquid containing active agents, contaminated material (e.g., dust), freeze-dried pathogens (i.e., preserved powders of living agents), eggs, or containers of pests.

Pathways:

Pathogens may be administered via aerosol, direct application, or general release. In addition, pathogens may be applied to soil and become active when crops are planted.

Incubation Period:

Varies depending on the pathogen.

Persistency:

Varies according to the specific species. Some bacteria are capable of entering a dormant state, called a spore, which is highly resistant to impacts from changes in environmental factors. These agents can survive as spores for decades and then become active again when the proper conditions occur. In addition, pathogens can be freeze-dried and remain in a preserved state almost indefinitely. Freeze-dried pathogens are reactivated when exposed to moisture.

Additional Hazards

There is minimal potential for migration of pathogens to humans or animals.

Protection

Evacuation

In order to avoid track out of material, immediately isolate an area around any liquid or solid contamination for at least 50 feet in all directions. Downwind evacuation may not be necessary.

Field Detection/Identification:

Clinical immunoassays (ELISA) are available as well as traditional techniques to culture and identify the pathogen.

Personal Protective Requirements:

Efforts should be made to avoid possible off-site transport of the pathogen by personnel through the use of gloves, disposable foot covers and disposable coveralls.

Decontamination:

Personnel: Wash skin with soap and water. Collect and disinfect all wash and rinse solutions. For clothing and equipment, consult local agriculture assistance offices. If unavailable, wash all surfaces with full strength household bleach insuring a minimum contact time of 30 minutes. Follow this with normal appropriate cleaning procedures for the item.

Small Areas: Consult local agricultural assistance office. If unavailable fumigate with disinfectant gas or aerosol (e.g., formaldehyde). Follow fumigation with a wash of all surfaces employing a disinfectant such as household bleach. Apply appropriate pesticide if insects have been released.

First Aid

Signs & Symptoms:

Varies depending on the specific pathogen. Consult local agricultural assistance office.

Patient Management:

Personnel: Should have minimal impact on personnel.

Crops: Removal and destruction of infected species. Consult local agricultural assistance office.

Class Index C29
Pathogens – Used as Simulants

Health

Effects:

Pathogens employed as biological warfare simulants do not generally pose a significant risk to personnel. However, individuals with respiratory illness or suppressed immune systems may be at risk. Agents may be in the form of spores, liquid containing active agents, contaminated material (e.g., dust), or freeze-dried pathogens (i.e., preserved powders of living agents).

Pathways:

Simulant Pathogens are generally released as aerosols and the primary routes of exposure include inhalation and/or contact of the aerosol with the mucous membranes of the eyes, nose, or mouth. In addition, although intact skin is an effective barrier against most pathogens, abraded skin (e.g., abrasions, lacerations, or penetration of skin by debris) circumvents this protective barrier and allows entry of the pathogen into the body.

Incubation period:

Varies depending on the pathogen.

Persistency:

Varies according to the specific species. Some bacteria are capable of entering a dormant state, called a spore, which is highly resistant to impacts from changes in environmental factors. These agents can survive as spores for decades and then become active again when the proper conditions occur. In addition, pathogens can be freeze-dried and remain in a preserved state almost indefinitely. Freeze-dried pathogens are reactivated when exposed to moisture.

Additional Hazards

There is minimal potential for these pathogens to cause significant infection in humans.

Protection

Evacuation

In order to avoid track out of material, immediately isolate an area around any liquid or solid contamination for at least 50 feet in all directions. Downwind evacuation may not be necessary.

Field Detection/Identification:

Clinical immunoassays (ELISA) are available as well as traditional techniques to culture and identify the pathogen.

Personal Protective Requirements:

Efforts should be made to avoid possible off-site transport of the pathogen by personnel through the use of disposable gloves, booties, and coveralls.

Decontamination:

Personnel: Decontamination may not be required. If deemed appropriate, wash skin with soap and water. For clothing and equipment, follow normal cleaning procedures appropriate for the item.

Small Areas: Decontamination may not be required. If deemed appropriate, wash all exposed surfaces with soap and water. If more extensive decontamination is desired, fumigate with disinfectant gas or aerosol (e.g., formaldehyde). Follow fumigation with a wash of all surfaces employing a disinfectant such as household bleach. Rinse with water.

First Aid

Signs & Symptoms:

Should have minimal impact on personnel.

3

Tables

Chemical and Biological Agent Detector Characteristics

Table 3.1 identifies some of the systems available to detect, and in some cases identify, various chemical and biological agents. The ≥ symbol indicates that the listed value is the minimal concentration detectable by the detector system. If a range of concentrations is listed, then the manufacturer has specified that the detector works optimally within that range. Results from analysis of agent concentrations outside of the specified levels (either greater or lesser values) may not be accurate. A designation of "Qualitative" indicates that the system will only identify the given agent.

Initial Isolation and Protective Action Distances For Chemical Warfare Agents

Table 3.2 identifies appropriate evacuation distances for various chemical warfare agents. All distances listed are for a "small spill" as defined by the 1996 *North American Emergency Response Guidebook (NAERG)* (i.e., the amount of material released does not exceed 55 gallons). These distances indicate areas that would most likely be affected during the first 30 minutes after a release. Because of environmental conditions (e.g., weather, terrain) or the characteristics of the release, the impacted areas could increase with time. For information on response to larger releases, or on industrial materials that may be used as improvised agents, refer to the *NAERG*

A simplified downwind hazard assessment can be developed by plotting these protective action distances in the form of a map overlay. The initial isolation distance is the radius of a circle immediately surrounding the point of release where people may potentially be exposed to dangerous or life threatening concentrations of vapor. The downwind distances indicate the area of potential threat posed by vapors carried by the wind. The downwind threat may change depending on the time of the release. Distances for either day or night releases are indicated in the table. The potential distance of horizontal diffusion of agent vapor is determined by adding one-half of the downwind distance to either side of a line drawn from the middle of the release. Figure 3.1 illustrates a simplified downwind hazard assessment.

TABLE 3.1

Agent Detector Characteristics

Detector System	Agents Detected (Class Index)	Sensitivity	Response Time
Chemical Agent Vapors			
M256A1 Kit[A]	G-series nerve agents (C01)	≥ 0.00009 ppm	15 min
	V-series nerve agents (C02)	≥ 0.002 ppm	15 min
	Sulfur mustard (C07)	≥ 0.03 ppm	15 min
	Lewisite (C08)	≥ 1 ppm	15 min
	Phosgene Oxime (C11)	≥ 0.6 ppm	15 min
	Cyanogen chloride (C12)	≥ 3 ppm	15 min
	Hydrogen cyanide (C12)	≥ 8 ppm	15 min
	Common interferences include high temperatures, petroleum products, burning brush and military decontaminating solution DS2. Kit will not function at temperatures below 25°F.		
CAM/ICAM[B]	Tabun (C01), sarin (C01), VX (C02), sulfur mustard (C07), and nitrogen mustard (C09)	≥ 0.02 ppm	≤ 1 min
	Common interferences include ammonia, burning gasoline, burning grass, gasoline vapor, breath mints, burning kerosene, brake fluid, insect repellent, military decontaminating solution DS2, and the M258 military decontamination kit.		
Colorimetric Tubes[C]			
Phosphoric Acid esters	Nerve agents (C01–05)	Qualitative	300 sec
Thioethers	Sulfur mustards (C07)	Qualitative	80 sec
Organic Basic Nitrogen Compounds	Nitrogen mustards (C09) and some nerve agents (C02–03)	Qualitative	80 sec
Organic Arsenic Compounds	Arsenical mustards (C08), arsine (C13), and vomiting agents (C20)	Qualitative	80–160 sec
Hydrocyanic Acid	Hydrogen cyanide (C12)	2–30 ppm	48 sec
Cyanogen Chloride	Cyanogen chloride (C12)	0.25–5 ppm	12–210 sec
Phosgene	Phosgene (C14)	0.25–15 ppm	53 sec
Carbon Tetrachloride	Phosgene (C14) and chloropicrin (C14)	1–15 ppm	300 sec
Chlorine	Halogens (C14)	50–500 ppm	15 sec
Chloroformates	Diphosgene (C14)	0.2–10 ppm	150 sec

TABLE 3.1 (CONTINUED)

Agent Detector Characteristics

Detector System	Agents Detected (Class Index)	Sensitivity	Response Time
APD 2000[D]	G-series nerve agents (C01)	≥ 0.015 ppm	30 sec
	VX (C02)	≥ 0.004 ppm	30 sec
	Sulfur mustard (C07)	≥ 0.3 ppm	15 sec
	Nitrogen mustard (C09)	≥ 0.3 ppm	15 sec
	Lewisite (C08)	≥ 0.2 ppm	15 sec
	Mace (C17)		
	Pepper Spray (C19)		
Chemical Agent Liquids			
M8 Paper[E]	G series nerve agents (C01), V series nerve agents (C02), sulfur mustard (C07), lewisite (C08), nitrogen mustard (C09), and phosgene oxime (C11)	0.02 ml drops	≤ 30 sec
	Common interferences include high temperatures, certain cleaning solvents, insect repellent, petroleum products, and military decontaminating solution DS2.		
M9 Paper[E]	All liquid agents	0.1 ml	≤ 20 sec
	Common interferences include high temperatures (≥ 125°F) brake fluid, large droplets of gasoline, grease, petroleum-based hydraulic fluids, insect repellents and sprays, gear lubricating oil, ethylene glycol (antifreeze), and military decontaminating solution DS2. M9 paper will not respond to chemical agents when wet and will give false positive indications when abraded against a rough surface.		

Detector System	Agents Detected
Toxin Agents[F]	
Rapid diagnostic assays fielded in support of Operation Desert Storm/Shield	Botulinum Toxin Clostridium Perfringens Toxin Staphylococcal Enterotoxin B (SEB) Staphylococcal Enterotoxins A/C1,2,3/D
Commercially available SMART Tickets	Botulinum Toxin Staphylococcus Enterotoxin B (SEB)
Pathogen Agents[G]	
Rapid diagnostic assays fielded in support of Operation Desert Storm/Shield	Anthrax Crimean-Congo Hemorrhagic Fever Dengue (DF, DHF, DSS) Mediterranean Spotted Fever Q Fever Plague

TABLE 3.1 (CONTINUED)

Agent Detector Characteristics

Detector System	Agents Detected
	Relapsing Fever Rift Valley Fever Sandfly Fever, Naples Sandfly Fever, Sicilian Sindbis Fever Tularemia Typhus, Murine (Endemic) West Nile Fever/Encephalitis
Commercially available SMART Tickets	Anthrax Plague

[A] The most widely available U.S. military detector for chemical agent vapors is the M256Al Chemical Agent Detector Kit. These kits contain cards with vials of liquid chemical reagents attached that are combined and exposed to the air in a specific sequence. The kits must be manually manipulated, and the full sequence of tests takes 20 to 25 minutes. These kits are the most sensitive detector of nerve agent vapor and are not subject to the same type of interferents that can cause false alarms in some of the electronic detector systems.

[B] Although the Chemical Agent Monitor (CAM) and the Improved Chemical Agent Monitor (ICAM) detect chemical agent vapors, they are not designed to function as a survey instruments. In practice they serve as post-attack devices for determining the presence of vapors emanating from residual liquid contamination. In general, the probe of the monitor must be within one inch of any liquid contamination in order to identify the suspected material. This hand-held air sampler detects and identifies nerve and blister agent vapors. The degree of contamination is depicted in a rough quantitative form on a bar-graph display.

[C] Tubes for colorimetric systems are available that are capable of qualitatively identifying nerve agents, blister agents, vomiting agents. Tubes are also available that can identify as well as provide semi-qualitative indication of vapor concentration for blood and choking agents. Many of these tubes have cross sensitivities and, again, care must be taken to correctly interpret the results.

[D] Civilian equivalent of the CAM. In addition to the agents detected by the CAM, the ADP 2000 will also detect pepper spray and Mace.

[E] The most widely available U.S. military detectors for evaluation of liquid contamination are the M8 and M9 papers. These chemically treated papers are sensitive to droplets of liquid chemical agents. They are intended only to provide indication of the presence of a liquid chemical agent hazard. M9 paper merely indicates that presence of a potential liquid chemical agent whereas M8 paper provides a qualitative identification of both nerve and blister agent liquids. However, both paper systems can respond to other organic substances (e.g., brake fluid), and provide false positives. Users must be trained to avoid placing the paper in contact with such substances and to consider other possible indicators of chemical agent presence when assessing a positive indication from the paper.

[F] Since toxins are not volatile, detection of toxins is limited to analysis of liquid or solid agents, residue, or by employing air samplers that collect and concentrate aerosol particles into a liquid sample. Portable immunoassay kits have been developed for a limited number of toxins. While the kits are capable of identifying toxins within 30 minutes, the overall sampling procedure (i.e., air-sampling in conjunction with the immunoassay analysis) can take several hours to produce a result. In addition, clinical immunoassays (ELISA), as well as laboratory analytical methods for detection and identification of toxins are available. These methods can take from 2 to 4 hours to identify individual toxins even under ideal conditions.

TABLE 3.1 (CONTINUED)

Agent Detector Characteristics

[G] Pathogens are very difficult to detect in the environment. Laboratory techniques to culture and identify pathogens as well as clinical immunoassays (ELISA) are available but may require extended periods provide results. Although prototypes are in development, there are currently no fielded systems capable of real time detection and identification of biological agents either military or civilian. During the Gulf War, Britain, Canada, France, and the United States all deployed air samplers that collected and concentrated aerosol particles into a liquid sample suitable for testing with a small antibody-based enzymatic test kit. These portable immunoassay kits have been developed for a limited number of pathogens. While the kits themselves are capable of identifying pathogens within 30 minutes, the overall sampling procedure (i.e., air-sampling in conjunction with the immunoassay analysis) took several hours to produce a result and could only determine retrospectively if a biological attack had taken place.

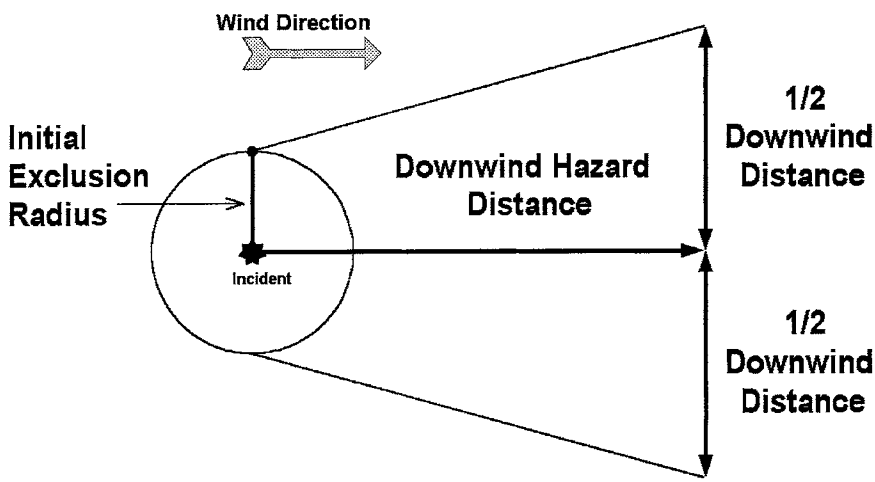

FIGURE 3.1
Standard NAERG downwind hazard diagram

Distances recommended in the NAERG were developed to assist responders at the scene of traditional hazardous materials incidents. It is important to realize that these distances were not developed to account for additional dispersal from an explosive device or from a spray release. In these cases, the initial isolation and downwind evacuation distances should begin at the edge of any liquid or solid contamination caused by the dispersal device. Figure 3.2 illustrates an irregular release downwind hazard assessment.

TABLE 3.2

Initial Isolation and Protective Action Distances for Chemical Warfare Agents

Agent	ID #	Initial Isolation	Downwind (Day)	Downwind (Night)
Arsine	2188	400 feet	0.4 miles (2,110 ft)	1.5 miles (7,920 ft)
Blister Agents (Poisonous Liquid, n.o.s.* Inh** Hazard) Zone B	2810	400 feet	0.5 miles (2,640 ft)	2.1 miles (11,090 ft)
Chloropicrin	1580	300 feet	0.3 miles (1,580 ft)	1.3 miles (6,860 ft)
Cyanogen Chloride	1589	300 feet	0.3 miles (1,580 ft)	1.3 miles (6,860 ft)
Diphosgene	1076	400 feet	0.4 miles (2,110 ft)	1.7 miles (8,980 ft)
Ethyldichloroarsine	1892	300 feet	0.3 miles (1,580 ft)	1.0 miles (5,280 ft)
Hydrogen Cyanide	1051	200 feet	0.1 miles (530 ft)	0.5 miles (2,640 ft)
Methyldichloroarsine	1556	200 feet	0.2 miles (1,060 ft)	0.6 miles (3,170 ft)
Nerve Agents (Poisonous Liquid, n.o.s.* Inh** Hazard) Zone A	2810	700 feet	1.2 miles (6,340 ft)	5.5 miles (29,040 ft)
Phosgene	1076	400 feet	0.4 miles (2,110 ft)	1.7 miles (8,980 ft)

* n.o.s. = not otherwise specified
** Inh = Inhalation

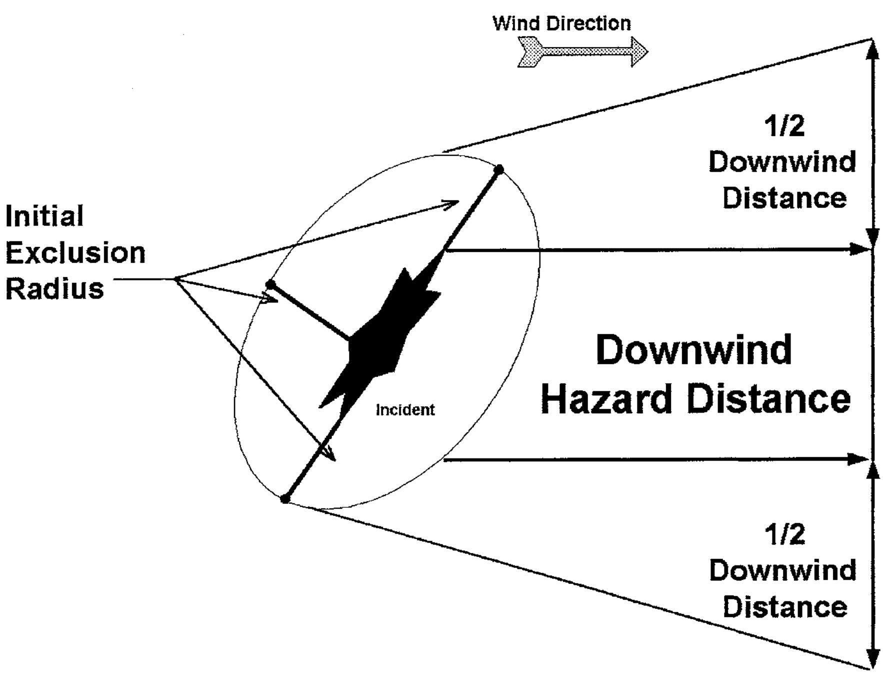

FIGURE 3.2
Irregular release downwind hazard diagram

Sample Collection

Samples of materials suspected of being chemical or biological warfare agents, or of being contaminated with chemical or biological warfare agents, should be collected in the same manner as other hazards material samples. Vapor samples can be obtained using standard absorbent collection systems or by employing pre-set evacuated canisters. One to five grams (one to five milliliters) of pure liquid/solid agent is generally sufficient for laboratory analysis. Table 3.3 provides a general list of standard sample collection sizes for materials suspected of being contaminated with chemical or biological agents.

Extreme care should be exercised to insure that the outside of the sample container has been decontaminated. After sealing and decontaminating the sample container, it should be packaged in a slightly larger container that has been filled with an absorbent material such as absorbent clay (e.g., kitty litter) or vermiculite. The principle hazard during transportation from a leaking sample would be exposure to agent vapor. If the sample is to be transported within an occupied vehicle, it may be advisable to further package the sample in an ice-filled cooler. Cooling the sample will reduce the vapor pressure of the agent and further minimize any potential exposure to agent vapor.

TABLE 3.3
Sample Collection

Media	Size
Chemical Agent Samples	
Concentrated agent	1–5 grams (1–5 milliliters)
Dilute agent	Approximately 10 milliliters
Soil	10 centimeters long × 5 centimeters wide × 1 centimeters deep. Greater depth not as useful.
Water	Maximum of 500 milliliters
Vegetation	Equivalent to 3 tree leaves or 3 hands full of grass depending on amount of contamination.
Biological Agent Samples	
Soil	10 centimeters long × 5 centimeters wide × 1 centimeters deep. Greater depth not as useful.
Vegetation	Enough to fill soft-drink can (12 ounces).

Law Enforcement
Public Safety
Allied Health

A HazMat team evacuates five square miles of a city business district in response to a chemical spill. Ten city blocks away, a police special response team forms a perimeter around an office building where a terrorist threatens the release of a deadly chemical agent. Meanwhile, paramedics administer first aid to victims exposed to a possible vesicant.

In the real-life world of emergency response, nothing is more crucial to crisis personnel than quick and decisive action. D. Hank Ellison's Emergency Action for Chemical and Biological Warfare Agents tells police, paramedics, and firefighters just what actions to take in the event of a crisis involving hazardous materials.

The book contains abridged versions of the class indices from Ellison's larger Handbook of Chemical and Biological Warfare Agents. The indices deal with classes of agents (nerve, blister, etc.) instead of focusing on specific agents. Each index contains information on the toxicology/health impacts, physical characteristics, hazards from fire or reactivity, protection of personnel, and general first aid for that agent class.

Designed to provide rapid access to critical emergency information at the scene of a release of chemical or biological warfare agents, this handy field guide is also ideal for facilitating the coordination with off-site personnel who have access to Ellison's larger Handbook. It differs from its larger companion, however, in that agent specific data, as well as information on evacuation distances, are listed in table form ... for emergency responders deplo...

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