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1999 CSEPP CHEMICAL AWARENESS

STUDENT GUIDE

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LIST OF ACROYNMS

ANCA	Anniston Chemical Activity
BAL	British Anti-Lewisite
BGCA	Blue Grass Chemical Activity
CAIRA	Chemical Accident/Incident Response and Assistance plan
CBDCOM	Chemical and Biological Defense Command (replaced by SBCCOM)
CSDP	Chemical Stockpile Disposal Program
CSEPP	Chemical Stockpile Emergency Preparedness Program
DA	Department of the Army
DCD	Deseret Chemical Depot
EAS	Emergency Alert System
ECA	Edgewood Chemical Activity
EPG	Emergency Planning Guide
EPZ	Emergency Planning Zone
FEMA	Federal Emergency Management Agency
GA	nerve agent
GB	nerve agent
GI	gastrointestinal
H	sulfur mustard agent
HD	sulfur mustard agent
HT	sulfur mustard agent
IRZ	Immediate Response Zone
L	Lewisite
MOU	Memorandum of Understanding
mph	miles per hour
NECD	Newport Chemical Depot
PAZ	Protective Action Zone
PBCA	Pine Bluff Chemical Activity
PUCD	Pueblo Chemical Depot
PZ	precautionary zone
SBCCOM	Soldier and Biological Chemical Command (formerly CBDCOM)
UMCD	Umatilla Chemical Depot
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAMRICD	U.S. Army Medical Research Institute of Chemical Defense
VX	nerve agent

CHAPTER 1. INTRODUCTION

WHAT IS THE PURPOSE OF CSEPP CHEMICAL AWARENESS TRAINING?

Simply put, the purpose of this chemical awareness training is to familiarize you with the chemical warfare agent stockpile and its components, the Chemical Stockpile Disposal Program, and the Chemical Stockpile Emergency Preparedness Program (CSEPP). Also, the course will prepare you to recognize chemical warfare agent characteristics, signs and symptoms of agent exposure, and how to avoid exposure to chemical warfare agents.

WHAT IS IN THIS CHAPTER?

This chapter is your introduction to the study guide and its organization. The topics covered in this chapter are

- who is this course written for?
- how should this study guide be used?
- how is the information in this study guide organized?
- what are the CSEPP Chemical Awareness training objectives?
- how will learning be evaluated?

This chapter introduces and explains the blueprint-like structure for the information you are about to learn and features designed to keep your learning on target.

WHO IS THIS COURSE WRITTEN FOR?

This course is designed for those persons involved in emergency preparedness related to a chemical warfare agent accident.

HOW SHOULD THIS STUDY GUIDE BE USED?

CLASSROOM TRAINING

This study guide can be used as a reference guide for students attending the CSEPP Chemical Awareness Course.

As you participate in this instructor-led class, you can use this study guide to follow along and take notes. Your instructor will refer to portions of the guide as the class progresses. The instructor's presentation and this study guide have been designed to coincide so that your note taking can be minimized.

SELF-STUDY

This guide can also be used for studying on your own because the book has been written to be used by an individual to study independently. For example, you may use the guide

- before you attend the in-class session to do some pre-study on your own,
- during the in-class session as a guide for taking notes or to highlight information as the class progresses,
- after you attend the in-class session to keep as a reference and review resource, or
- in place of attending the in-class session as a self-study resource.

Of course, if you use this guide strictly for self-study, you will not have the benefit of the experience obtained through class sessions. For this reason, you should attend the class if at all possible.

HOW IS THE INFORMATION IN THIS STUDY GUIDE ORGANIZED?

This study guide is divided into 10 chapters. The most important information in this study guide pertains to the agents at the installation near you, the chemical warfare agent characteristics, the signs and symptoms of chemical warfare agent exposure, and how to avoid exposure to chemical warfare agents. This important information is presented in the "Key Chapters" which are

Chapter 3. Stockpile Components and Threats,
Chapter 6. The Role of the Chemical Stockpile Emergency Preparedness Program,
Chapter 7. Avoiding Exposure to Chemical Warfare Agents,
Chapter 8. Nerve Agent Exposure, and
Chapter 9. Blister Agent Exposure.

Other chapters, designed to help you learn the essential information from the Key Chapters, are

Chapter 1. Introduction,
Chapter 2. The U.S. Chemical Stockpile,
Chapter 4. What is an Accident,
Chapter 5. Effects of Weather and Terrain, and
Chapter 10. Source Documents and Review Publications,

WHAT ARE THE CSEPP CHEMICAL AWARENESS TRAINING OBJECTIVES?

Objectives state the learning goals for each chapter. Their function is to help you focus on the main points of the information you are about to learn. You need not wait until you reach the end of a chapter to ask yourself "Now, what am I supposed to learn from this chapter?" By reviewing the objectives for that chapter, you will know exactly what to expect.

OVERALL LEARNING OBJECTIVES

Specifically, at the end of this course you should be able to describe

- the types of chemical warfare agents and munitions stored in your vicinity,
- the major emergency planning steps that can be taken to protect the public in the event of a chemical accident, and
- how to avoid exposure to chemical warfare agents.

ENABLING LEARNING OBJECTIVES

In order to master the three terminal learning objectives, you must be able to describe or identify

- the types of chemical warfare agents stored in your vicinity,
- what the nerve and blister agents are and what they look like,
- the types of munitions in your vicinity and the potential for an off-post release,
- the types of potential chemical accidents and associated hazards,
- the effects of weather on the movement of agent vapor following an accidental release,
- how terrain factors influence the movement of agent vapor following an accidental release,

- the major emergency planning steps to protect individuals in the event of a chemical warfare agent accident,
- the main ways the public can avoid exposure to a chemical warfare agent in the event of an accidental release off-post, and
- the specific signs and symptoms of nerve and sulfur mustard agent exposure.

HOW WILL LEARNING BE EVALUATED?

At the end of the class (or study guide if you are using the self-study mode), there is a quiz concerning all the material in the key chapters.

CHAPTER 2. THE U.S. CHEMICAL STOCKPILE

- DESCRIBE THE TYPES OF CHEMICAL WARFARE AGENTS STORED IN YOUR VICINITY
- DESCRIBE WHAT THE NERVE AND BLISTER AGENTS ARE AND WHAT THEY LOOK LIKE

The Army currently has thousands of tons of stored chemicals that were designed and produced for the sole purpose of warfare. This stored material is referred to as the "chemical stockpile."

The chemical stockpile is stored at eight locations in the continental United States (Fig. 1). Table 1 shows an inventory of the type of agent(s) stored by location. Although the number of installations is small, when the surrounding communities (39 counties) are included, the planning impact is considerably larger. Two installations (Umatilla, Oregon, and Newport, Indiana) also involve parts of two states in their emergency preparedness zones. In addition to those installations shown in Fig. 1, there is another installation, Johnston Atoll Chemical Agent Disposal Facility (JACADS), in the Pacific Ocean approximately 825 miles (1300 kilometers) from Honolulu, Hawaii.

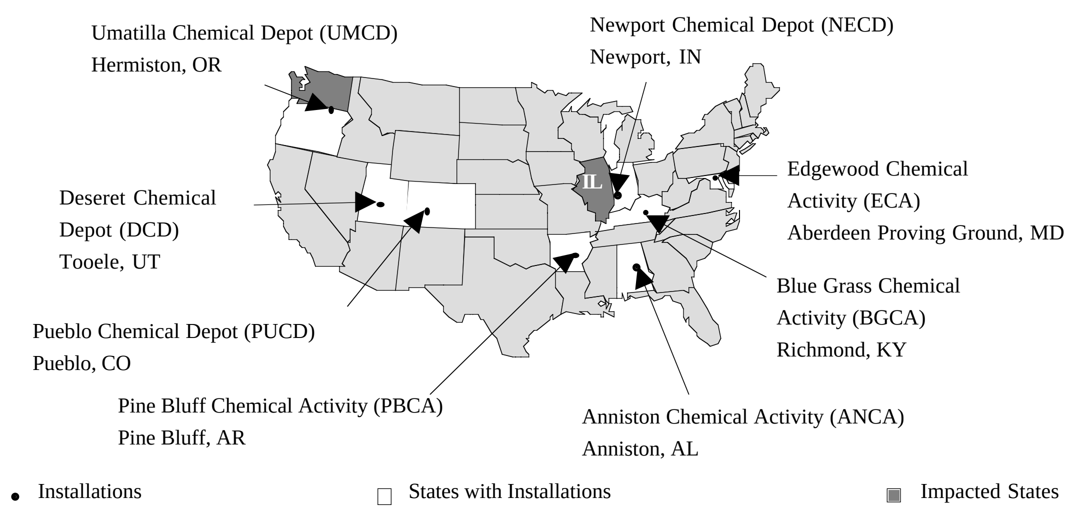


Fig. 1. Stockpile distribution throughout the United States.

Table 1. U.S. Army chemical stockpile inventory

Installation	Agent stored: GA	GB	VX	Sulfur mustard	Lewisite
Anniston		X	X	X	
Blue Grass		X	X	X	
Deseret	X	X	X	X	X
Edgewood				X	
Newport			X		
Pine Bluff		X	X	X	
Pueblo				X	
Umatilla		X	X	X	

The percentage of the stockpile varies from location to location (Fig. 2). The Army began incineration of the Deseret Chemical Depot stockpile located at Tooele, Utah, in August 1996. As of August 1999, approximately 22.7% of the chemical stockpile stored at Deseret had been successfully destroyed.

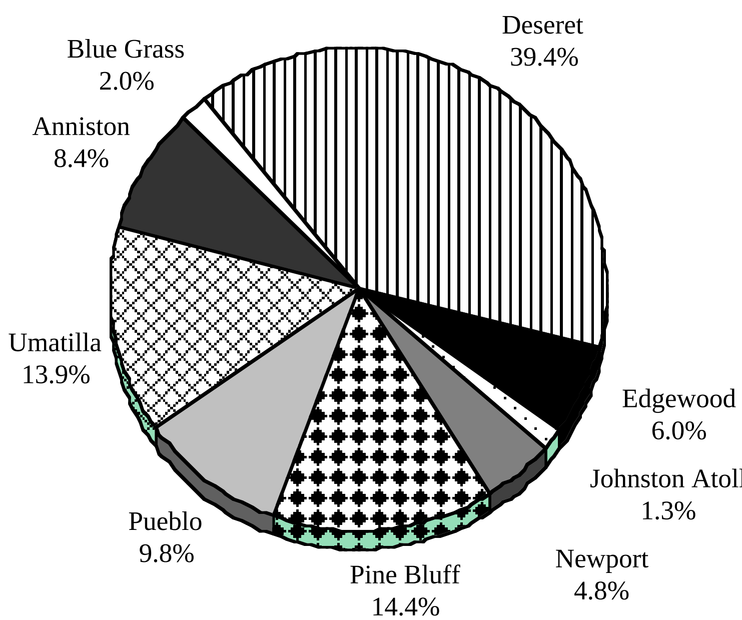


Fig. 2. Percentages of chemical warfare agent by U.S. stockpile locations (as of August 1999).

HOW ARE CHEMICAL WARFARE AGENTS STORED?

STORAGE CONTAINERS

The chemical warfare agents are stored in several configurations including rockets, cartridges, projectiles, mines, one-ton containers, bombs, and aerial spray tanks. Table 2 shows the types of containers being used at the various installations.

Table 2. Stockpile storage configurations

Installation	Rockets	Cartridges and projectiles	Land mines	Bombs	One-ton containers	Aerial spray tanks
Anniston	X	X	X		X	
Blue Grass	X	X				
Deseret	X	X	X	X	X	X
Edgewood					X	
Newport					X	
Pine Bluff	X		X		X	
Pueblo		X				
Umatilla	X	X	X	X	X	X

STORAGE FACILITIES

The chemical warfare agents are currently stored in

- concrete igloos,
- metal storage buildings, or
- outdoor storage yards.

Chemical warfare agents and munitions are stored in restricted access areas set aside especially for these agents. The entire area is surrounded by security fences and equipped with appropriate security devices.

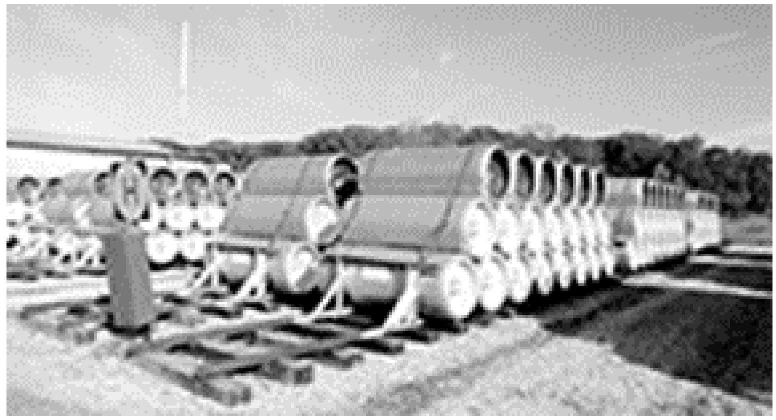
Chemical munitions containing explosives must be stored in concrete structures called "igloos." These igloos have 2 ft of earth covering all sides except their front walls (which are made of reinforced concrete). This earth cover is designed to reduce the spread of fragments and fire in the unlikely event of an accident within the igloo. An exception to this storage practice is at Deseret Chemical Depot where aerial spray tanks are stored in metal structures. These tanks have small amounts of explosive devices stored in a container attached to the outside of the metal shipping and storage container.

A concrete igloo in the U.S. chemical stockpile.

Bulk containers of agent without explosives are also stored in metal storage buildings. Bulk containers of VX nerve agent and HD blister agent are stored in such buildings at Newport Chemical Depot and Umatilla Chemical Depot, respectively.

Metal storage building used to hold bulk containers of agent without explosives.

Bulk containers of blister agents may be stored in outdoor storage yards surrounded by a security fence. Pine Bluff Chemical Activity, the Edgewood Chemical Activity, and Deseret Chemical Depot has bulk H and HD stored outside. Deseret Chemical Depot also has quantities of Lewisite stored outside.



Bulk containers in outdoor storage yard.

AGENT CHARACTERISTICS

The types of chemicals stored include nerve agents (VX, GB, and GA) and blister agents (H, HD, HT, and L). GA and L are stored only at Deseret Chemical Depot.

NERVE AGENTS

Toxic chemical warfare agents that are classified as "nerve agents" are so called because they are capable of attacking the body's nervous system.

Nerve agents are organophosphates, as are certain agricultural insecticides, such as Malathion and Parathion. The term "organophosphate" is the scientific classification that describes compounds containing carbon and phosphorus that inhibit cholinesterase, a naturally occurring enzyme that is important to normal nervous system function. Nerve agents are much more potent organophosphates than agricultural insecticides.

Specific Names

While the term "nerve agent" refers generally to a particular form of chemical warfare agents, specific common and chemical names are associated with this group. The Army's inventory of chemicals includes a variety of nerve agents.

Symbol	Common name	Referred to as
VX	VX	VX
GB	Sarin	GB or G-agent
GA	Tabun	GA or G-agent

There are some technical differences relating to physical properties for the agents listed above. However, when the term “nerve agents” is used in this course, it refers to all of the agents (VX, GB, GA) unless an agent is specifically mentioned.

Physical Properties

In their normal state, nerve agents are liquids. If they are heated, these liquids become volatile and generate vapors. If agent is spilled from a container, the greatest potential downwind hazard is nerve agent vapor. In an explosion or fire, nerve agent can be released as an aerosol and as a vapor. Once in a vapor or aerosol form and mixed with the outside air, the nerve agent is able to move off-post from the storage location.

All nerve agents currently stored in the chemical stockpile are in liquid form. It is not expected that you, or anyone off the installation, will ever come into contact with liquid agents.

The most distinguishable factors among the three specific nerve agents (VX, GB, and GA) are physical consistency and color. Liquid agent VX is thicker in consistency than GB or GA. Liquid agent VX is an oily liquid that resembles lightweight oil in consistency and in appearance—a pale amber color. VX is persistent and was “designed” to cling to whatever it happened to splatter on. VX persistence is weather-dependent. At 99˚F (37.2˚C), 90% of a VX droplet will evaporate in approximately 24 hours; at 50˚F (10˚C), 45 days must pass before 90% of a VX droplet would evaporate.

In its pure form liquid GB is colorless, whereas liquid GA may be pale to dark amber. Liquid GB is usually watery and gives off almost no odor. GB volatilizes at a lower temperature than VX and evaporates more rapidly than VX but less rapidly than water.

BLISTER (VESICANT) AGENTS

Vesicants are poisons that destroy individual cells in target tissues. The most noticeable effect that these agents have are the “vesicles,” or blisters, they cause. For this reason, these types of agents are also referred to as “blister agents.” Since most people are familiar with the lay term, this study guide uses the term “blister” to describe this category of chemical warfare agents.

Specific Names

While the term “blister agent” refers to a particular action of chemical warfare agents, there are specific common names and abbreviations that are associated with this group. The

Army's inventory of chemicals includes two types of blister agents: sulfur mustard and Lewisite.

Symbol	Common name	Referred to as
H, HD, HT	Sulfur mustard	H, HD, HT
L	Lewisite	L

Although the Lewisite agent is in the blister agent family, there is very little of this chemical remaining and it is all stored at Deseret Chemical Depot.

Physical Properties

Early concoctions of blister agents were recognized by a distinctive odor—a mustard-garlic smell. Hence, "mustard" was an obvious nickname that soon became an official designation.

In their normal state, blister agents are either solids or liquids. Agent HD solidifies at a temperature of 55˚ to 59˚F (13˚ to 15˚C). As the temperature of these liquids increases, they become volatile and generate vapors. They are oily liquids that burn well, once ignited. In its liquid form, the blister agent is pale amber brown. When vaporized, the gas is colorless.

Lewisite may be an amber to brown liquid; however, it is colorless when pure. It is approximately 10 times more volatile than H, HD, or HT, and often has an irritating, fruity or geranium-like odor. There is little odor when the compound is pure. It is persistent in the environment and is much more dangerous as liquid than as vapor. Liquid Lewisite will cause severe burns of the eyes and skin. Breathing Lewisite vapors can damage the eyes, skin, and respiratory tract.

CHAPTER 3. STOCKPILE COMPONENTS AND THREAT

- DESCRIBE THE TYPES OF MUNITIONS STORED IN YOUR VICINITY AND THE POTENTIAL FOR AN OFF-POST RELEASE

The different components of the chemical stockpile, described below, are characterized by form of munitions, type of agent, packaging and storage requirements, maintenance requirements, and potential threat of accidental release.

TYPES OF MUNITIONS

The chemical munitions stockpile consists of rockets, cartridges, projectiles, and mines (Fig. 3). Bulk agent is found in a limited quantity of bombs and airborne spray tanks, and in a large number of one-ton containers.

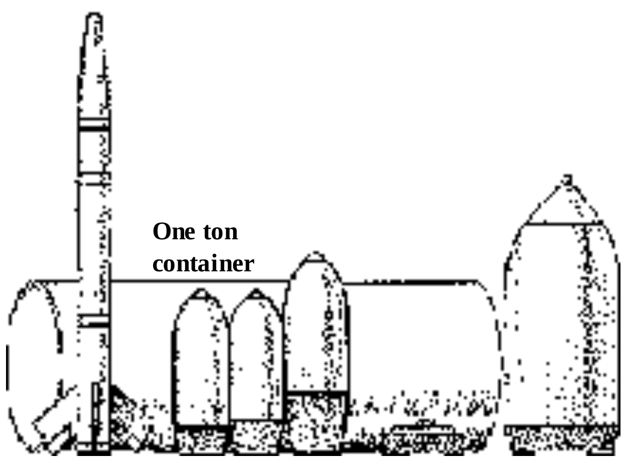
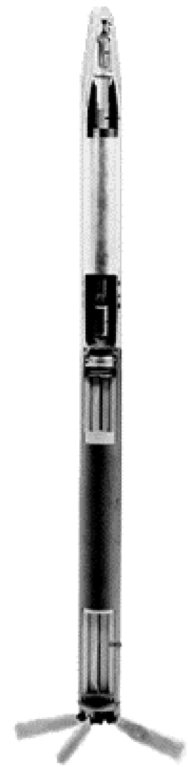


Fig. 3. Types of munitions.

ROCKETS

All of the rockets in the stockpile are obsolete and have been declared hazardous waste. Each rocket contains approximately 10 pounds of either GB or VX in an extruded aluminum warhead. The warhead also includes an explosive charge to burst it open and a fuse to initiate the charge. The solid propellant for the rocket is contained in a steel motor that is threaded onto the warhead.



M55 rocket.

Rockets are stored in fiberglass shipping and firing containers with aluminum ends. Fifteen shipping and firing containers are packaged together to form a pallet unit. In storage, rockets are always in earth-covered igloos and pointed toward the earth-covered concrete wall in the rear. That way, in the unlikely event of accidental ignition, the rocket should not escape the storage structure.

Since the rockets are obsolete, there is no scheduled handling or maintenance of them. Instead, they are checked for leaks on a routine basis. Scheduled inspections are made of the interior of the igloo and inside the shipping and firing container of the individual rockets. Any leaks discovered are promptly contained using approved overpacks.

The Army has performed tests to establish what would happen if one rocket in a pallet of fifteen exploded. Those tests indicated that 2 rockets would explode, spreading their agent payload, and the other 13 rockets would leak, forming an agent puddle. This would occur in an igloo, and tests and modeling have shown that no off-post liquid agent threat would exist and only a low concentration of agent vapor would be likely to pass the installation boundaries. It should be noted that there has never been a fatality associated with storing and managing the U.S. stockpile of chemical warfare agents or munitions.

CARTRIDGES

GB cartridge.

Cartridges come in two types. One type contains approximately 2 to 3 pounds of GB or HD and is fired from a howitzer. The other contains approximately 6 pounds of HD or HT and is fired from a mortar. Both may, on rare occasions, have all the elements needed to be fired encased in a fiberboard container. These elements include the propellant, bursting charge, and a fuze. Two fiberboard containers are packed in a wooden box. The boxes are stored 12 to 36 to a pallet unit.

All cartridges are stored in igloos. Normal maintenance includes rewarehousing, handling, and inspecting for defects and leaks. If a leak is detected, it would most probably be in the form of vapor for GB and liquid for HD and HT. In any case, the effects would be confined to the igloo. The Army has determined that if one cartridge explodes, no other cartridge in the igloo would detonate. No cartridge can spontaneously explode. Some external force such as a fire or accident must occur to cause a cartridge to explode.

PROJECTILES

Projectiles are heavy, thick-walled metal shells of one- or two-piece construction that are filled with chemical warfare agent GB, VX, H, HD, or HT. Projectiles can be filled with approximately 2 to 14 pounds of a chemical warfare agent. A burster well holding the explosives required to burst the shell body extends from nose to base of the projectile. However, in storage, most projectiles are not fuzed. Instead, the projectile has a metal plug screwed into its nose. Also, most projectiles do not have any burster explosives loaded into the shell. The propellant charge required to fire the projectile from a howitzer is shipped, stored, and issued separately from the projectile.

GB projectile.

Projectiles are packaged 6 or 8 to a pallet unit depending on the size of the projectile. All projectiles are stored in igloos. Normal maintenance of projectiles includes rewarehousing, handling, and inspecting for defects and leaks. If a leak is detected, it would most probably be in the form of vapor for GB and a liquid for H, HD, HT or VX. In any case, the effects would be confined to the igloo. The Army has determined that if one projectile somehow explodes, no other projectiles in the pallet or igloo would detonate. Projectiles cannot spontaneously explode. Some external force such as a fire or accident must occur to cause the projectile to explode.

MINES

There is only one type of land mine in the chemical stockpile. It contains 10.5 pounds of liquid VX. The mine contains explosives used to burst the mine open and spread its chemical warfare agent payload. Three mines are packed in a 16-gallon, waterproof, metal drum.

VX land mine.

All mines are stored in igloos. Normal maintenance operations include handling and inspecting for defects and leaks. Leaks, when found, are primarily detected around the base of the mine and in the side fuze well. Leaks are easily detected because they cause portions of the paint and packing supports to dissolve. The liquid and vapors would be confined to the vapor-proof container. The Army has determined that if a mine explodes, the other mines in the same drum would also detonate. Mines cannot spontaneously explode. Some external force such as a fire or accident must occur to cause a mine to explode.

BOMBS

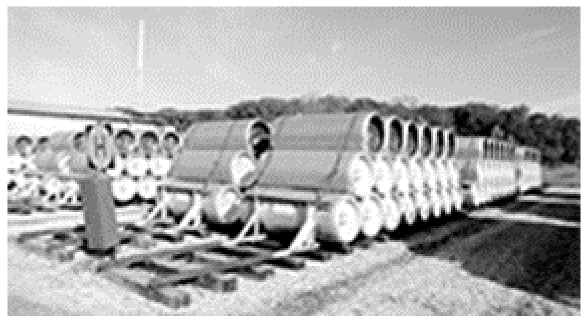
There are three types of bombs in the chemical stockpile. They contain from 105 to 350 pounds of GB, depending on the type. Stored bombs do not contain explosives. The bomb bodies are made of steel or aluminum alloy.

GB 500 lb. bomb.

Bombs are all stored in igloos. The aluminum bomb is packaged individually in a vapor-proof container. The other two older steel body types are usually stored one or two to a pallet unit.

Normal maintenance operations include rewarehousing, handling, and inspecting for defects and leaks. Any leaks would most probably be vapor seeping from welds on the upper portion of the bombs. Since there are no explosives involved, the worst that could happen to a bomb is a liquid spill of its entire contents. This has never happened; however, if it did, the liquid would be confined to the storage structure. Vapors are not likely to reach off-post from such a spill and if weak concentrations did extend off-post, they would likely be far too weak to pose a hazard to the civilian populations.

ONE-TON CONTAINERS



One-ton containers.

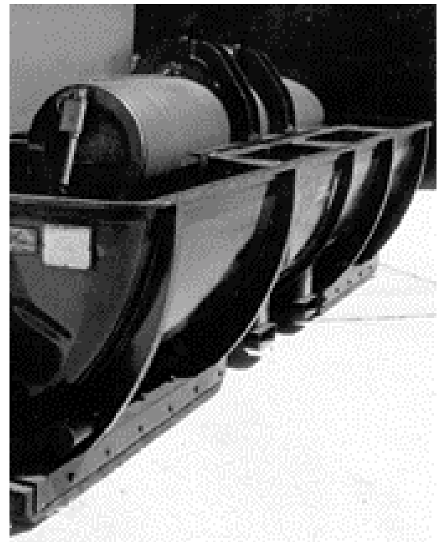
One-ton containers are industrial metal containers manufactured for the storage of bulk liquids. There are no explosives involved. All of the bulk chemical warfare agents in the stockpile are stored in ton containers. The capacity ranges from 1500 to 1800 pounds, depending on the particular chemical warfare agent stored. There are two valves located on one end of the container. Each container has six plugs, three of which are evenly spaced on the bulkhead at each end. The valves and plugs are all made of brass or steel.

Ton containers are stored either in igloos, metal buildings, or in outside storage yards, depending on the chemical warfare agent and location. Normal maintenance operations include painting of the containers stored outside, and replacing all brass valves and plugs with special stainless steel ones. Inspection for defects and leaks is also performed regularly. If a leak is detected, it would likely be from the plugs or valves. Any liquid released would be confined in the storage area.

SPRAY TANKS

Spray tanks contain 1365 pounds of liquid VX. The container is constructed of 1/8-in. stainless steel. The spray tank is overpacked, one to a large metal, vapor-proof, modified jet engine container.

Spray tanks are stored in igloos and metal storage buildings. Normal maintenance of spray tanks includes handling and inspecting for defects and leaks. Vapor leaks have never been detected from the spray tanks, and no liquid leaks have occurred. In the unlikely event of liquid leaks, it would be confined in the vapor-proof container.



Overpacked spray tank.

LEAKING CHEMICAL WARFARE AGENT

Placing a leaker into an approved vapor-proof container.

The Army is prepared to deal with leaking agent from any of the munitions or storage containers. Leaking liquid or vapor is controlled and contained until the leaking item can be disposed of properly. The leaker is sealed in an approved container as soon as possible. If a vapor-proof container is leaking as a result of a defective gasket, the gasket is replaced. If that is not possible, the container is replaced. If no serviceable containers are available, the item is overpacked in a larger vapor-proof container or the agent contents are transferred to another container. Any contamination is promptly neutralized. Storage structures are sealed and equipped with air filters during leaker containerization operations.

Rockets filled with GB have caused the greatest concern over the years because of their design and large numbers. It should be noted that in the current stockpile less than one-tenth of one percent of the rockets have developed leaks. To handle leakers of this type, the Army has developed two specially designed vapor-proof overpacks. Leaking rockets have been stored in these leaker containers (overpacks), and monitored for further leaks, with excellent results.

CHAPTER 4. WHAT IS AN ACCIDENT?

- IDENTIFY THE TYPES OF POTENTIAL CHEMICAL ACCIDENTS AND ASSOCIATED HAZARDS

An accident involving chemical warfare agents can be defined in several ways. One definition is as an unplanned release of chemical warfare agent into the environment at levels that exceed those permitted by state or federal regulations. Another, and more conservative definition, is any unplanned event that could lead to the release of chemical warfare agent.

It is important to know the amount of material accidentally released. People who study accidents call the amount of material released the "source term." The source term and the weather conditions at the time of the release determine how far downwind the hazardous materials will travel and the concentration of chemical warfare agent to which people could be exposed.

It is also important to know how close people might be to a potential accident site and their location with respect to the plume of airborne agent. Whether unprotected people are harmed by a chemical warfare agent release depends on whether they are within the portion of the plume where agent concentrations are hazardous.

The most likely accidents are small ones that do not pose a threat, except to someone in very close proximity to the accident. Large accidents, that is, accidents with source terms large enough to pose a threat to the community, have a much lower probability of occurring. It is unlikely, therefore, that an accident will cause injury or death to anyone. But what is meant by "unlikely" or "likely"?

Scientists studying accidents, their causes, their consequences, and their probability of occurring have developed the best information we have on this topic. In these studies, engineers and scientists systematically studied the different ways accidents could occur and estimated how likely the events were which caused an accident. They also estimated the probabilities of many different accidents and calculated the number of fatalities that could occur for each accident.

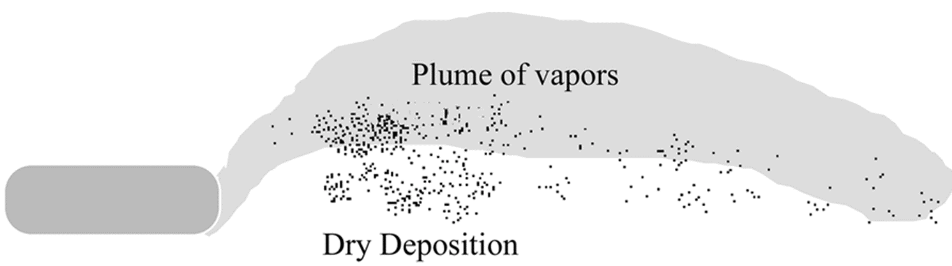
Risk =

Probablility of Accident	**X**	**Consequences**	**∑**	**For all Events**
	(Times)		**(Summed)**	

Calculation of risk.

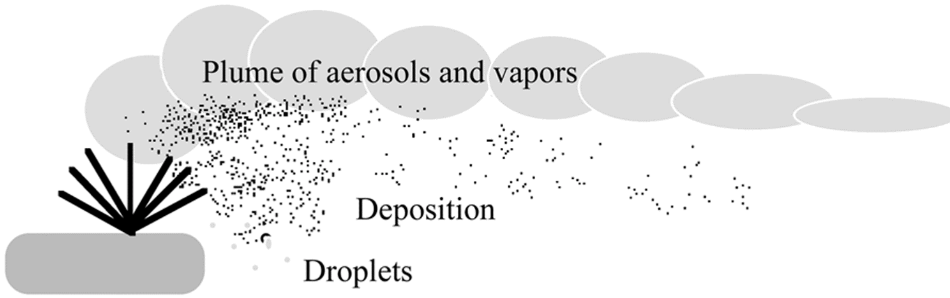
POTENTIAL ACCIDENT TYPES AND HAZARDS

If a chemical warfare agent accident were large enough to pose a threat to the public, the dominant hazard would be from breathing air in which an agent exists as a vapor. Paths for liquid chemical warfare agents to travel from an accident to off-post locations are limited and relatively easy to block; therefore, people off-post are unlikely to encounter liquid agent. Three basic types of potential accidents can occur. The first is a spill of agent onto the ground or other surface. The resulting puddle of agent (liquid deposition) can evaporate into a vapor and drift downwind.



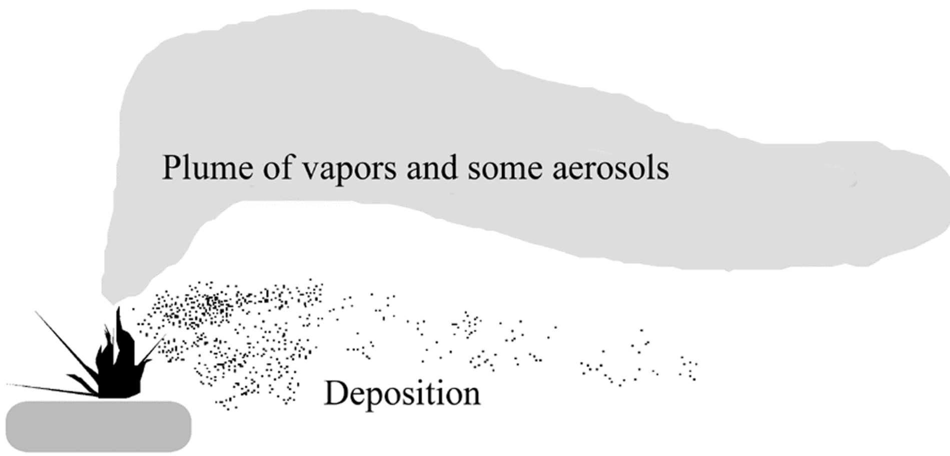
Example of a plume resulting from a spill.

A second type of accident is caused by an explosion. An explosion causes droplets of agent to be formed. The larger, and consequently heavier, droplets quickly fall to the ground. This is called deposition. However, an explosion also releases vapors and aerosols (smaller droplets and particles) that can travel greater distances.



Example of a plume resulting from an explosion.

The third type of accident involves a fire. In such events, both aerosols and vapors are formed. Vapors and aerosols are lifted higher into the air because of the heat from the fire. The hazards are similar to those of an explosion.



Example of a plume resulting from a fire.

To help understand the difference between aerosols and vapors, think of a chemical agent release in terms of the release of hair spray from a spray can. When the spray is released, it is an aerosol. Larger particles and/or droplets are deposited near the point of release. These particles quickly fall out of the air onto your hair and sometimes onto your skin. A person across the room, however, can smell the hair spray from breathing the vapors released.

In a chemical warfare agent accident, it is very unlikely the public would be exposed to droplets and aerosols. These particles will mostly fall out of the plume (via deposition) by the time the plume reaches the installation boundary. For most accidents, the primary health hazard comes from vapors when they are breathed in or come in contact with skin or eyes. The greatest hazard occurs when vapors are inhaled because the lung tissues rapidly absorb the vapors. Skin is a partial barrier to vapor absorption. As a result, the lethal dosage for agent vapor breathed in is several times lower than the lethal dosage for vapor contact with the skin.

ACCIDENT CATEGORIES

The selection of protective action strategies is somewhat contingent on the characteristics of the accidents that form the basis for planning. Accident categories are used as the basis for developing protective action strategies. Accident categories are a group of accident scenarios bound together by common source terms and meteorological conditions. Accident categories are designed to support the grouping of a large number of protective action strategies into just a few so decision makers can quickly decide what protective action recommendation to make to the community. Each installation has a set of accident categories based on that site's geographic, demographic, socioeconomic, and stockpile characteristics.

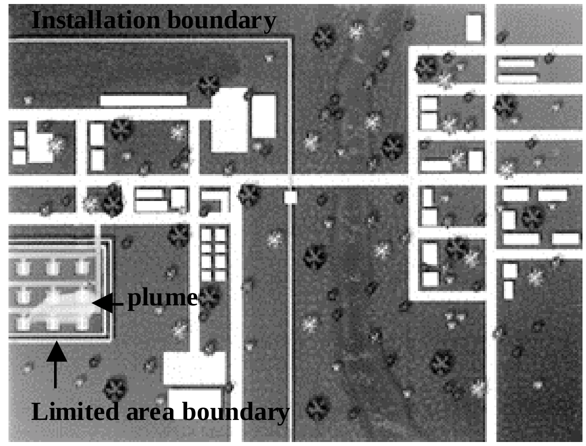
CHEMICAL EVENT EMERGENCY NOTIFICATION SYSTEM

A standard chemical accident notification at the installation storing chemical warfare agents is essential for clear and effective off-post coordination. It provides a common language between the Army installations and off-post emergency responders, and fosters clear understanding and a ready reference for emergency response actions. A joint chemical event emergency notification system is described in Department of the Army Pamphlet 50–6 (*CAIRA Operations*); it establishes four levels of off-post response. One emergency level (Nonsurety Emergency) does not involve chemical warfare agents. Three emergency levels (Limited Emergency, Post-only Emergency, and Community Emergency) involve chemical warfare agents.

NONSURETY EMERGENCY

Events are likely to occur or have occurred that may be perceived as a chemical warfare agent emergency or that may be of general public interest, but which pose no chemical hazard. This includes emergencies that do not involve chemical warfare agents. Action: Notification to immediate response zone (IRZ) designated points of contact.

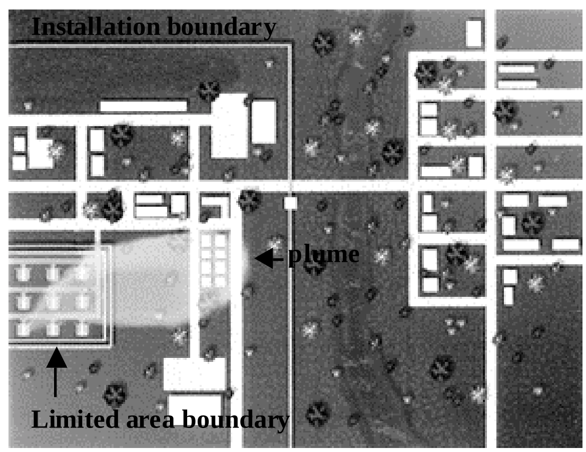
LIMITED AREA EMERGENCY



The plume is expected to be confined to the limited area.

Events are likely to occur or have occurred which involve an agent release outside engineering controls or approved chemical storage facilities. Chemical effects are expected to be confined to the chemical limited area. This level will be declared when the predicted chemical warfare agent no-effects dosage does not extend beyond the chemical limited area where the event occurred. Action: Emergency notification to IRZ and State-designated points of contact. IRZ emergency response officials may go to a level of increased readiness if an off-post response is required.

POST-ONLY EMERGENCY

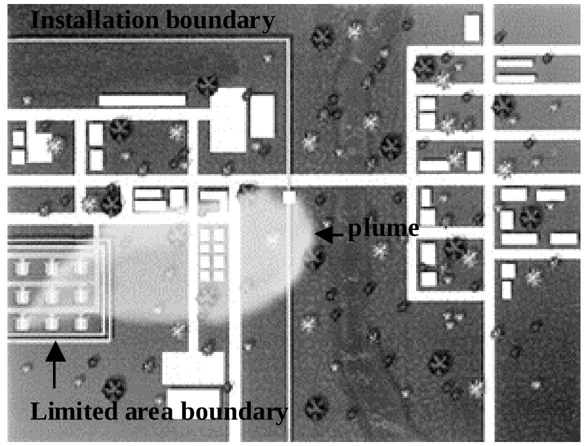


The plume is expected to be confined within the installation boundary.

Events are likely to occur or have occurred which involve agent release with chemical effects beyond the chemical limited area. Releases are not expected to present a danger to the off-post public. This level will be declared when the predicted chemical warfare agent no-effects dosage extends beyond the chemical limited area but does not extend beyond the installation boundary. Action: Notification to IRZ, protective action zone (PAZ), and State-designated points of contact. IRZ response organizations are mobilized to be capable of immediate action. Precautionary protective actions may be initiated in potentially affected areas near the installation boundary.

COMMUNITY EMERGENCY

Events are likely to occur or have already occurred which involve agent release with chemical effects beyond the installation boundary. This level will be declared when the predicted chemical warfare agent no-effects dosage extends beyond the installation boundary. Action: Notification to IRZ, PAZ, and State-designated points of contact. All emergency response organizations are mobilized. IRZ and affected PAZ areas implement specified protective actions.



The predicted agent no-effects dosage extends beyond the installation boundary.

CHEMICAL WARFARE AGENT DETECTION

The most probable form of chemical warfare agent found off-post would be vapor. The Army's detection capability can be broken down into two main types. One type would detect agent at a level that would produce no adverse health effects to an individual who breathed the agent vapors. We call those types "low-level detectors." The other type of detector can detect agent vapors at substantially higher concentrations. Their primary use is to detect agent concentrations generated from enemy attacks or large storage accidents, where high levels of agent may be detected. These types are called "gross-level detectors" and are less sensitive than low-level detectors.

Any vapor detection efforts off-post would be conducted by Army survey teams using the appropriate equipment.

CHAPTER 5. EFFECTS OF WEATHER AND TERRAIN

- DESCRIBE THE EFFECTS OF WEATHER ON THE MOVEMENT OF AGENT VAPOR FOLLOWING AN ACCIDENTAL RELEASE
- DESCRIBE HOW TERRAIN FACTORS INFLUENCE THE MOVEMENT OF AGENT VAPOR FOLLOWING AN ACCIDENTAL RELEASE

When vapors from chemical warfare agents get into the air, they are affected by elements of the weather. The weather elements, along with the chemical properties of the agents themselves, determine how far a chemical warfare agent vapor plume will travel, and how concentrated the chemical warfare agent will be within that plume. Some of the elements of weather, and their effects on the chemical warfare agents, are given below.

WIND

Windspeed is one of the most important factors determining how far a vapor plume will go. For a given stability class, the faster the wind blows, the quicker the vapor plume will be dispersed, and the shorter the downwind hazard distance will be. Conversely, as the windspeed lessens, the vapor plume is more likely to remain intact, lengthening the downwind hazard distance. Of course, since the vapor plume will ride the wind currents, the wind direction is always important. Vapor plumes do not drift upwind. Mechanical turbulence, brought about by wind blowing over and around objects such as buildings, also tends to mix the agent vapor with the surrounding air. This mixing lowers the concentration and thereby reduces the hazard.

VERTICAL TEMPERATURE GRADIENT

The vertical temperature gradient—the difference between the temperature of the air at ground level and at higher levels—is perhaps the most important element in determining vertical dispersion and travel of a vapor plume. Solar radiation heats the ground more than the surrounding air. Therefore, during the daytime the air next to the ground is warm and rises. Cooler air from above sinks to the ground surface. This mixing is called thermal turbulence.

Thermal turbulence disperses the chemical warfare agent vapors, thereby reducing the likelihood of dangerous concentrations of chemical agent vapors in the plume. Such conditions occur only during daylight hours, and are more pronounced on sunny, summer days.

At times, the ground is cooler than the air overhead. This condition is called an "inversion." Thermal mixing does not occur during an inversion. Inversions occur mainly at night.

Weather conditions where thermal mixing is moderate are called a "neutral conditions." Neutral conditions occur when the temperature of the air overhead is somewhat colder than the air at ground level, but the temperature gradient is not great enough to produce strong vertical mixing of the atmosphere. Neutral conditions tend to occur at sunrise, sunset, and during cloudy, overcast days.

Overall, these types of conditions are characterized by a stability class. Strong thermal turbulence conditions are called unstable; inversions are extremely stable. Table 3 depicts the relationship among stability class, solar heating, and vertical mixing.

Table 3. Relationship between stability class, solar heating, and vertical mixing

Stability class	Windspeed	Solar heating	Mixing
A	Slow	Sunshine – strong heating	Good
B	Slow	Sunshine – strong heating	Good
C	Variable	Sunshine – heating	Reduced
D	Variable	Sunshine – heating	Reduced
E	Slow	Night – cooling	Negligible
F	Slow	Night – cooling	Negligible

PRECIPITATION

Precipitation removes agent from the atmosphere. Water runoff containing the chemical warfare agent will collect in low places. The agent is not neutralized, although some chemical change resulting from reaction with water may take place. Snow may cover agent; however, the agent is still toxic even at freezing temperatures. When the snow melts, a chemical warfare agent contamination problem could exist.

TERRAIN

Besides the weather, terrain factors also affect wind direction. Thermal and mechanical effects tend to cause warmer air near the ground to move up mountain or hill slopes in the daytime. At night the colder, denser air near the ground will flow downhill and converge in low places. Open ground warms rapidly on a sunny day, thereby increasing the vertical temperature gradient. Conversely, the ground cools rapidly at night, decreasing or reversing the temperature gradient. Changes in temperature from the ground upward tend to be more pronounced in desert areas than in areas with more vegetation.

Vegetation reduces the spread of contamination. Although vegetation decreases windspeed, it absorbs and adsorbs the chemical warfare agents. Absorption is the penetration of agent into the vegetation, while adsorption is the build-up of agent on the outside of the vegetation. The vegetation may give off agent vapors after absorption and adsorption. Vegetation, especially heavy forests, tends to reduce the amount of thermal turbulence under tree canopies.

Large bodies of water also affect temperature gradients because water retains heat better than the soil.

The hazard from a chemical release would depend on how much agent is released into the air. The amount of agent involved, the chemical properties of the agent, and the temperature gradient would also have to be considered. Windspeed and direction determine how soon an agent plume arrives at a given point.

The Army uses computer simulation models designed to estimate how far the vapor from a chemical release will travel and the concentration of agent at various distances from the source of release. This information is then used in the model to estimate the extent of the hazard. Based upon those results, decisions such as if and where to evacuate, how soon to begin to evacuate, and when to shelter, would be made.

CHAPTER 6. THE ROLE OF THE CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM (CSEPP)

- IDENTIFY THE MAJOR EMERGENCY PLANNING STEPS TO PROTECT INDIVIDUALS IN THE EVENT OF A CHEMICAL WARFARE AGENT ACCIDENT

CSEPP was established to provide a consistent framework for emergency planning for states and communities at all eight installations. That does not mean that identical planning decisions should be made at all eight installations, but that decisions at all installations should be based on the same programmatic criteria and technical information. Each of the communities potentially affected by a chemical warfare accident is responsible for deciding how to prepare for the possibility of a release of chemical warfare agent. CSEPP defines a comprehensive scope for the decisions and defines the elements that State and local decision-makers should address.

The Department of the Army (DA) and the Federal Emergency Management Agency (FEMA) have cooperated to improve emergency preparedness around the chemical stockpile installations for more than 10 years. In 1988, the two agencies signed a memorandum of understanding (MOU) that defined their respective roles in achieving this goal. The definitions of these roles have been revised several times since then, most recently in October 1997, when the agencies signed a new MOU. This MOU defines the current structure of CSEPP. It assigns FEMA total authority, responsibility, and accountability for working with State and local governments to develop their off-post emergency preparedness for responding to chemical agent accidents or incidents. The DA maintains its original program role for chemical stockpile disposal. The new MOU identifies the specific responsibilities of the DA and FEMA, defines areas where each agency can provide expertise, and outlines where cooperation between the two agencies will result in a more efficient use of personnel and material resources.

The basic goal of any emergency management program is to protect people. Stimulating prompt and effective actions by the public is crucial in achieving this goal. Once the basic protective actions are selected, other activities help implement those protective actions. There are two basic protective actions during a chemical emergency: evacuation and sheltering-in-place. These are primarily actions people take to protect themselves after receiving a warning from authorities.

Emergency planning seeks to anticipate possible emergencies and the resources that will be needed at that time. It identifies available resources, as well as any resource shortfall so that the deficiencies can be eliminated or at least reduced. Although local government resources can facilitate and support the protective actions (e.g., traffic control and transportation assistance), the most critical command and control function is to provide timely and accurate public alert, notification, and information to get the quickest public response. Other functions (e.g., medical assistance, mass care) can be provided initially by locally available resources and broadened later when other resources become available.

PROTECTIVE ACTION ZONES

When emergency response officials have been notified that a chemical warfare agent accident may affect off-post areas, they must decide which protective actions are appropriate for different portions of the affected area. This complex decision may have to be made within tight time constraints. The emergency response plan should strive to simplify the decision process and reduce the time that must be devoted to it in an emergency situation by carefully analyzing the variables involved in the decision and pre-establishing criteria to be used in selecting appropriate protective actions.

Elected officials are responsible for deciding what protective actions to recommend at the time of an emergency. While others, such as agency or department heads, may share in the decision-making process, legal responsibility generally rests with elected officials, normally county commissioners.

Emergency planning zones (EPZs) are defined to aid in the decision-making process (see Fig. 4). The IRZ is the zone in which protective action decisions are most critical because of the zone’s proximity to the accident. This zone is generally defined as the area where people would have less than 1 hour to respond before the arrival of a plume during winds of 3 meters per second [6.7 miles per hour (mph)]. Thus, the IRZ extends to approximately 10 kilometers (6 miles) from the stockpile installation. The zone boundaries are adjusted for political boundaries, natural features, and population distribution. Various real-world constraints may make decision making extremely difficult and require automatic processes to offset the constraints.

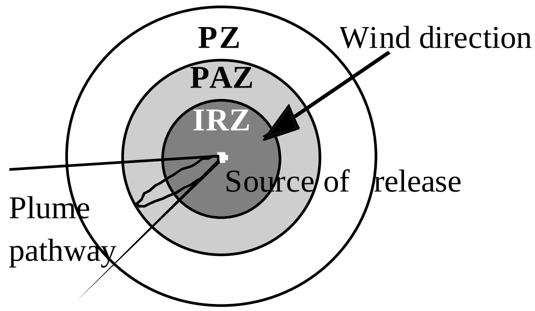


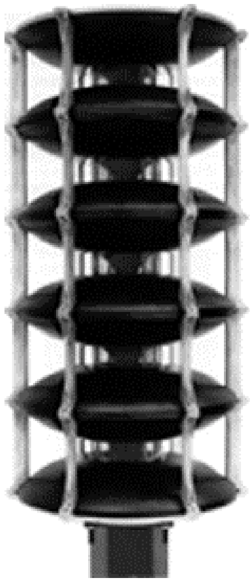
Fig. 4. Three zone concept for emergency planning.

The PAZ is defined as the area with less than 5 hours of response time at windspeeds of 1 to 2 meters per second (2.2 to 4.4 mph), or about 18 to 35 kilometers (11 to 22 miles). In PAZ planning, the constraints remain similar in nature to those of the IRZ but are less restrictive, because availability of time, staff, and options increases. Public officials would likely have time to meet—or at least confer by phone or radio—and make appropriate decisions.

Because of uncertainties over accident consequences and causes, plans should address response to a catastrophic accident. This would include how the resource base would be expanded to handle such accidents. A precautionary zone (PZ), or a zone outside the PAZ, can be established if a catastrophic release occurs or as a host area for evacuees. The PZ offers the advantages of time, distance, and multiple options.

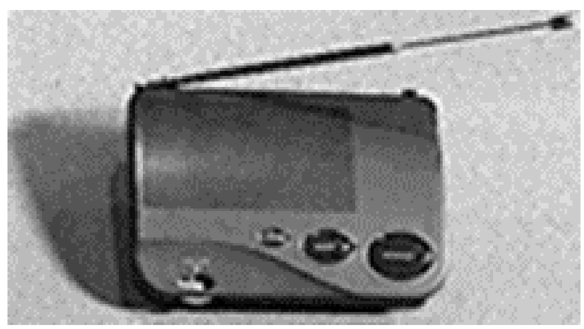
The protective actions chosen must always be weighed against realistic considerations such as time, weather, highway conditions, and the public's general state of readiness to implement the protective actions. The chemical event emergency notification system greatly helps in selecting protective actions. Such a system allows community officials to react quickly to various emergencies using established procedures.

ALERT AND NOTIFICATION



Omni-directional siren.

CSEPP emergency planning must provide for one or more methods of alerting the public. Alerting methods must cover all areas within the EPZs, must be reliable, and must be capable of instantaneous activation. Alert and notification relies upon two separate and distinct steps: (1) attracting the attention of the public by stimulating one or more of the senses, usually hearing (the alerting phase) and (2) communicating information concerning appropriate protective actions (the notification phase). Notification methods may include the use of commercial broadcast radio stations as a part of the Emergency Alert System (EAS) or combinations of broadcast over radio and television stations and cable television systems. Experts have concluded that a combination of indoor and outdoor warning is the most effective warning system for the IRZ. This will consist of outdoor electronic sirens with voice capabilities and indoor alerting devices (tone alert radio, National Oceanic and Atmospheric Administration's Specific Area Message Encoding receiver, or EAS receiver). Both the indoor and outdoor devices provide alert and notification capabilities. Within the PAZ, given the greater warning time available, the primary system is likely to be electronic broadcast media and the EAS, supplemented by sirens for selected urban residential areas and indoor warning for selected institutions and public congregation facilities.



Tone alert radio.

TRAFFIC AND ACCESS CONTROL

When an emergency has occurred, access into the affected area must be quickly controlled to prevent additional people from becoming unnecessarily exposed to the hazard. In any mass evacuation, traffic control is crucial to the timeliness and efficiency of the evacuation, especially in urban areas where potential for traffic congestion is greater.

EVACUEE SUPPORT

Evacuee support consists of various activities designed to process and accommodate evacuees. This includes the population living around the site in the affected zone(s) as well as civilian and military personnel employed at the installation but not considered essential to the chemical event response. The evacuation of nonessential, on-site personnel must be coordinated with the evacuation of the general public. Plans should specify a process for receiving potentially contaminated persons and training evacuation and mass care personnel to recognize signs and symptoms of agent exposure.

There are two primary components of an evacuee support system: reception and mass care. Reception is the process of receiving and registering evacuees, determining their needs (e.g., medical, housing, family reunification), and assigning them to appropriate resources. Mass care is providing temporary shelter, food, family reunification, limited medical care, and social services for evacuees.

The activities outlined above are similar to those followed in the event of any emergency. It is the charge of the CSEPP to provide assistance in making them possible within jurisdictions subject to chemical warfare agent threats.

CHAPTER 7. AVOIDING EXPOSURE TO CHEMICAL WARFARE AGENTS

- DESCRIBE THE MAIN WAYS THE PUBLIC CAN AVOID EXPOSURE TO A CHEMICAL WARFARE AGENT IN THE EVENT OF AN ACCIDENTAL RELEASE OFF-POST

In case of an accidental release of chemical warfare agent, the public should do everything possible to avoid exposure to those agents. There are two main ways to accomplish this: evacuation and/or sheltering-in-place.

EVACUATION

Evacuation consists of removing individuals from an area of actual or potential hazard to a safe area. It is the most effective of all protective actions provided it is completed before the arrival of the toxic plume. Evacuation planning entails

- estimating the number of potential evacuees, with particular emphasis on special populations;
- identifying the most appropriate evacuation routes and designating needed traffic control;
- estimating the time needed for evacuation; and
- anticipating potential problems.

These tasks must be well coordinated with all the other emergency functions.

Evacuation is the best protective action in response to a chemical vapor release if time permits. In order to evacuate the area in a safe and efficient manner, citizens must be familiar with their local evacuation plan. The local evacuation plan should provide information on the best evacuation routes to follow and the location of safe points for evacuees to congregate. The plan should also detail the reentry procedures to be followed to determine if it is safe to return to the evacuated area.

Once familiar with the local evacuation plan and the alert and notification system, citizens must know what notification procedures have been established to inform them when an accident occurs. Citizens should make their own personal plan to evacuate. They should decide who will account for all family members, who will drive whom, and what routes they will take. Where they will shelter, what items to carry to assembly points, and what to do with pets are some other questions that need to be answered.

During an evacuation, the appropriate evacuation routes need to be communicated to the public. While driving, evacuees should keep the windows and vents closed, turn the vehicle's heater or air conditioner off, and keep the radio on. Despite such practices, cars have a high air exchange rate and do not provide an effective shelter from a vapor hazard.

SHELTERING-IN-PLACE

Temporary sheltering-in-place would be advised if there is no time to safely evacuate. Citizens should have a room in their home prepared in advance in accordance with the local plan.

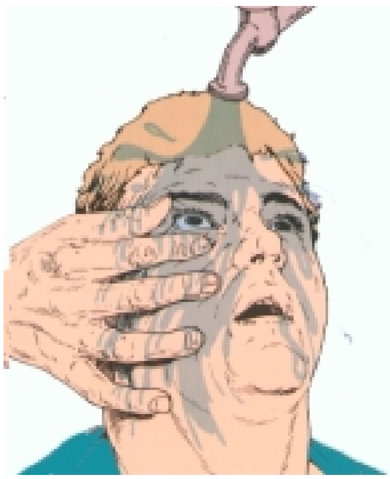
The room should have any openings blocked with tape or other material. All windows and ventilators must be closed, and heating or air conditioner and fans must be turned off before going to the room. Once in the room, those individuals sheltering-in-place should listen to the television or radio for information being provided by local officials. After an agent plume has passed through an area, the agent concentration remains greater in enclosed areas, such as a house, than outside in the open. Citizens must be sure to leave or open up the house when so advised.

Shelter-in-place.

SELF-DECONTAMINATION (DECON)

If there is reason to suspect that a person has been exposed to chemical warfare agent, a person should remove any possible chemical warfare agent residue from their body and change clothes. Immediate decontamination with available materials and methods is more effective at reducing exposure than careful decontamination at a later time.

Self-Decon (or Buddy-Decon), as the name implies, means that a person washes his/her eyes and body carefully or teams up with another individual and the two assist each other. Buddy-Decon is preferred because it is faster and allows for more thorough rinsing of places that are difficult to reach by oneself (back, buttocks, and back of legs).



Decontamination procedure.

An individual should flush exposed eyes with large quantities of clear water, blot exposed skin areas thoroughly with either undiluted chlorine bleach or soap and lukewarm water, then rinse well with clear water. Care should be taken not to get bleach or other substances in the eyes. Individuals should use only plain water in, and around, the eyes. In the absence of the above substances, individuals should use plain water.

CHAPTER 8. NERVE AGENT EXPOSURE

- IDENTIFY THE SPECIFIC SIGNS AND SYMPTOMS OF NERVE AGENT EXPOSURE

If an accident should occur, it is wise to be familiar with the properties of the agents in the stockpile, signs and symptoms of exposure, and recommended treatment for exposed persons. Of all the possible ways of becoming exposed, the one most likely to affect the surrounding communities is breathing agent from an airborne plume. For informational purposes, the following sections summarize nerve agent characteristics, signs and symptoms of exposure, and initial treatment of exposure.

Remember that nerve agents are so called because they are capable of disrupting the body's nervous system. The Army's inventory of chemicals includes a variety of nerve agents. They are VX, GB, and GA. (GA is in the stockpile only at Deseret Chemical Depot.)

HOW NERVE AGENTS WORK

The nervous system controls body functions through the use of chemicals which act as "instructions" to nerves and to the muscles and glands. These "instructions" come in two forms: stimulate (move or work) and relax (stop or rest). When a nerve agent is present it interferes with the normal chemical instructions that direct the muscle (or gland) to return to an unstimulated state and relax.

In normal nervous system function, an electrical impulse travels down a nerve cell to the nerve ending. At the nerve ending, the impulse causes the release of a chemical neurotransmitter called acetylcholine. Acetylcholine crosses the small space, known as a synapse, between the nerve endings of adjacent cells to stimulate receptor sites on the target nerve cell. The stimulated receptor site then activates the target cell. This is how impulses travel between nerve cells.

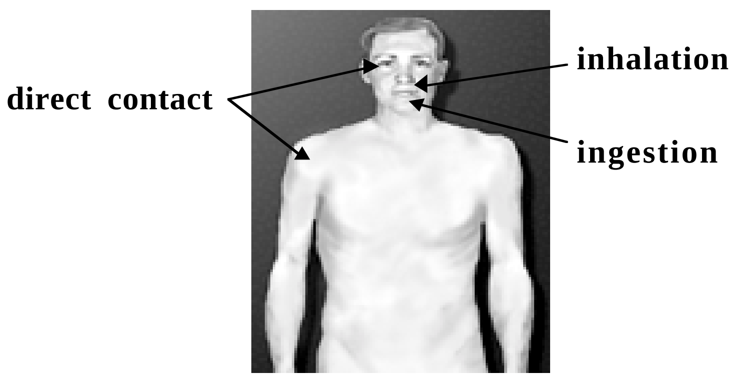
If the nerve cell is at a junction with a skeletal muscle, the acetylcholine stimulates receptor sites that activate muscle cells to contract. If at a junction with smooth muscles such as those around the small intestine, the muscles will move rhythmically. If at a junction with a gland, the glandular cells will secrete. This is how impulses are transmitted from nerve cells to end organs.

Once the neurotransmitter acetylcholine acts on the receptor site, it is inactivated by the enzyme acetylcholinesterase. Stimulation of the target cell stops with removal of the neurotransmitter acetylcholine.

Nerve agents block the activity of acetylcholinesterase, so that it cannot function to destroy acetylcholine. As a result, the neurotransmitter acetylcholine accumulates and continues to stimulate receptor sites on the target nerve cell, muscle, or gland.

The target cells continue to be stimulated long after the original impulse was transmitted. If the affected nerve is stimulating a muscle, muscles continue to twitch in an uncontrolled and repetitive manner, until they go into a prolonged contraction and go limp. If the affected nerve is stimulating a gland, it will continue to secrete. Some results are excessive tearing, drooling, runny nose, sweating, and accumulation of secretions in the airways.

ROUTES OF EXPOSURE



Three main routes of exposure.

There are three main routes, or ways that a person can be exposed to a nerve agent:

- inhalation—breathing air that has been contaminated with nerve agent vapors
- direct contact—absorption through the skin or eyes
- ingestion—swallowing contaminated food or drink

Inhalation

Although the nerve agents are usually found in a liquid form, they are easily changed into vapors. These vapors mix freely with the air. If a person breathes the contaminated air, the nerve agent enters the body through the respiratory system.

Nerve agent entering the lungs may be absorbed rapidly into the blood stream and spread to other parts of the body because of the large surface area of the lung tissue and the number of blood vessels in the lungs. The chief cause of death from nerve agent exposure is respiratory failure. Because of the rapid absorption by tissues of the respiratory tract, the lethal dose from inhalation is smaller than a lethal dose by ingestion or direct contact exposure; that is, less agent is needed to kill by inhalation than by any other route.

Direct Contact

Direct contact occurs when the skin or eyes are touched with nerve agent vapor or liquid. Contamination can spread from one person to another if an uncontaminated person comes into direct contact with chemical agent on the skin, hair, or clothing of a contaminated person.

Nerve agents have no toxic effect on the outer skin layer; rather, the nerve agent is absorbed through the skin. Once penetration has occurred, the nerve agent is circulated to the nervous system. Concentrated vapor, or mist, can also penetrate skin tissue in the same way the liquid does.

All of the nerve agents (VX and G-agents) can be absorbed through the skin; however, agent VX tends to be absorbed much more completely because it is “highly persistent” and does not volatilize or degrade rapidly. The persistence of VX causes it to remain on the skin, thus allowing more absorption time. It penetrates slowly compared with GB and immediate decontamination is very important. This is why, during the decontamination process, the exposed person’s clothing must be removed completely.

The more watery G-agents have a tendency to evaporate quickly. Agent GB, in particular, tends to evaporate quickly rather than penetrate the skin. Cases of GB poisoning have occurred from skin exposure to liquid agent. Skin exposure to GB vapor can also result in poisoning, but only at concentrations higher than those that produce severe inhalation effects.

Absorbed through the skin, the nerve agent begins to affect the normal chemical neurotransmission process that occurs between the nerves and muscles or glands. On normal, intact skin, nerve agent must first pass through a layer of dead cells and the outer layer of the skin before reaching the blood stream and nerve cells found in deeper tissue layers. If a volatile G-agent is involved, evaporation of agent may occur before a significant dose can be absorbed. Skin abrasions caused by cuts, scratches, insect bites, freshly shaven skin, sunburn, rashes offer direct entry points for the nerve agent and make access to the blood stream and nervous system easier.

It is important to protect the eyes from exposure to vapors or aerosols. The eye is the most sensitive organ for nerve agent vapor effects. Threshold dose for miosis (constricting or pinpointing pupils) is a basis for both VX and GB exposure standards.

Ingestion

If an individual ingests contaminated food or drink, the nerve agent can enter the body through the digestive system. Incidental hand-to-mouth contact, putting objects in your mouth, and swallowing are all examples of potential sources of exposures by this route.

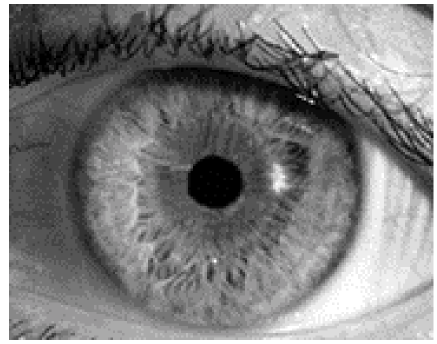
Once the nerve agent has entered the body by way of the digestive system, access to the blood stream can occur. Although the likelihood of an agent contaminating food or drink is extremely slim, you should be aware that it is possible for someone to become exposed through ingestion.

SIGNS AND SYMPTOMS OF NERVE AGENT EXPOSURE

Signs (e.g., drooling) are objective evidence of a medical condition or disease, while symptoms (e.g., headache) are subjective indicators of physical disturbance or disease. Symptoms usually have to be verbally or otherwise communicated by the person exposed. There are several physical signs to look for in determining if someone has been exposed to a nerve agent. Some signs are caused by local effects of the vapor on the organ (eye or skin) and may or may not correlate with the effects of the agent on the central nervous system. Other signs are the direct result of the chemical blocking effect of the nerve agent.

Note: Not all signs and symptoms may appear in every exposed individual.

Miosis


Constricted or pinpointed pupil.

Miosis (constricting or pinpointing of the pupil) is one of the initial effects of nerve agent vapor exposure. This sign is usually a direct effect of nerve agent vapor in the eye. Miosis can appear in one eye, but often appears in both eyes.

Vision Difficulties

If a person has had mild exposure, he or she may complain of general eye irritation or pain, describing the pain as "somewhere deep in my eye" or "somewhere deep in my head." The person may complain of dim or blurred vision. He or she may squint often in an attempt to clear up the blurred vision. You may notice that the exposed person blinks more often than usual; this is a sign that the eyes are affected. The person may also complain of sensation of pressure in the eyes.

Respiratory Trouble

Watch for these signs and symptoms as indicators that the agent may be contributing to respiratory failure

- difficulty in breathing;
- runny nose;
- coughing, frothy secretions, and drooling; or
- wheezing.

Difficulty in Breathing

The exposed person may show signs of labored breathing and may complain of a "tight chest" feeling. Remember that the muscles can be severely affected by the nerve agent's ability to overwork the muscle cells into exhaustion.

Increased Oral/Nasal Secretions

Another indication that the agent is interfering with respiratory function is an abundance of mucus secretions from the respiratory passages. The person may drool at the mouth and have a very runny nose.

Localized Sweating

If the nerve agent has affected nerves that are connected to sweat glands, the person may sweat profusely, particularly at the sites of agent contact. Again, this results from the overstimulation caused by nerve agent's interference with the normal function of nerves that control the sweat glands.

Nausea and Vomiting

If exposure was through the skin or by swallowing, gastrointestinal (GI) effects of nausea, vomiting and diarrhea may be the first effects to appear. These GI effects can also occur after moderate to severe inhalation exposure.

Abdominal Cramping

Increased activity of the muscles controlling the walls of the GI tract and intestines may lead to cramps or pain in the abdomen.

Involuntary Urination or Bowel Movements

Exposed individuals may lose control of the sphincter muscles that normally control the bladder and bowel. These involuntary urination or bowel movements are usually associated with convulsions.

Heartbeat Irregularities

Because the heart is a muscle, it is also susceptible to stimulation by the nerve agent. In persons exposed to nerve agent, heart rate changes from normal are common, as are heartbeat irregularities.

Generalized Weakness

Because the nerve agent also affects the portion of the nervous system that controls the skeletal muscles, the exposed person may have an overall feeling of weakness that increases with exertion.

Twitching or Muscle Spasms

If the affected nerve is connected to a muscle, the muscle action becomes uncontrollable and repetitive. You may notice this effect as twitching or muscle spasms. Spasms of local muscle groups, usually at the site of exposure, resemble what has been likened to "a bag of worms."

Convulsions and Coma

In severe cases, persons exposed to nerve agent may convulse, become comatose, and stop breathing.

Other signs and symptoms may result from early or mild exposure effects on the central nervous system (brain and spinal cord). These may result in

- headache;
- anxiety;
- restlessness;
- giddiness;
- irritability;
- problems concentrating, impaired judgement, and forgetfulness; or
- sleep disturbances.

Table 4 lists the signs and symptoms of nerve agent exposure following local exposure and absorption affecting the body in general (systemic) depending on dose.

Table 4. Signs and symptoms of nerve agent exposure

Site of action	Signs and symptoms
Following local exposure	
Pupils	Miosis (constricting or pinpointing), may be more apparent in one eye than the other
Eye lens muscles	Frontal headache; eye pain on focusing; blurred vision
Nasal mucous membranes	Runny nose; inflammation and congestion
Lungs	Tightness in chest; constriction of the airways; increased secretions; cough
Gastrointestinal tract	Occasional nausea and vomiting
Following systemic absorption (depending on dose)	
Lungs	Tightness in chest with prolonged wheezing; labored breathing; pain in chest; increased secretions; cough; bluish discoloration of skin; abnormal accumulation of fluid in the lungs
Gastrointestinal tract	Loss of appetite; nausea; vomiting; abdominal cramps; tightness beneath the breastbone and upper stomach with "heartburn" and belching; diarrhea; involuntary bowel movements
Sweat glands	Increased sweating
Salivary glands	Increased drooling
Tear glands	Increased tearing
Heart	Heart rate less than 50 beats
Pupils	Miosis sometimes unequal, later maximum miosis
Eye muscles	Blurring of vision; headache
Bladder	Frequent, involuntary urination
Striated muscle	Easily fatigued; mild weakness; muscular twitching; cramps; generalized weakness of respiratory muscles causing labored breathing and bluish discoloration of skin
Skin	Paleness because of elevation in blood pressure followed by low blood pressure

Table 4. Signs and symptoms of nerve agent exposure (continued)

Site of action	Signs and symptoms
Following systemic absorption (depending on dose)	
Central nervous system	*Immediate effects*: generalized weakness; depression of respiratory and circulatory systems; labored breathing; skin discoloration; low blood pressure; convulsions; loss of consciousness; coma
	Delayed effects: giddiness; tension; anxiety; jitteriness; restlessness; emotional instability; excessive dreaming; insomnia; nightmares; headaches; tremor; withdrawal and depression; bursts of slow waves of elevated voltage in EEG (especially on hyperventilation); drowsiness; difficulty concentrating; slowness of recall; slurred speech; staggering; muscular discoordination

Adapted from the *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, Department of the Army (FM8-285), Navy (NAVMED P-5041), Air Force (AFJMAN 44-149), and Commandant Marine Corp. (FMFM 11-11) Table 2-1, pg. 2-3, December 22, 1995.

FACTORS THAT AFFECT NERVE AGENT EXPOSURE SIGNS AND SYMPTOMS

Time Factor (Onset)

Although the signs and symptoms of nerve agent exposure often appear immediately, they may also be delayed. Some particular signs may appear much sooner than others. Reaction time, and whether or not the sign or symptom shows up at all, depends on several factors:

- type of agent;
- amount of agent to which the person has been exposed;
- dose (how much a person has absorbed);
- duration of the exposure;
- route of exposure (inhalation, direct contact, ingestion); and
- sensitivity of the person's system (depends on general state of health, age, gender, etc.).

However, as a general rule, the reaction time to a nerve agent is

- immediate if moderate to large amounts are inhaled, or
  if moderate to large amounts are spilled onto the skin.

- delayed if small amounts are involved, or
  if agent has been absorbed through the skin in a small localized area (takes time to absorb and take action).

Peak Effect

If the exposure results from breathing air with a high concentration of agent, effects can occur after a single breath. This "immediate" response occurs within seconds. After the exposed person has been removed from the contaminated environment, effects will likely peak within 15 to 20 minutes. Generally, you can be reasonably certain that, if the exposure was through air (only) and the time lapse has been approximately 20 minutes, the effects have maximized—they will not worsen after this time.

If the exposure route results from direct contact (droplet or liquid or vapor that touches the skin), absorption may continue for hours. This is likely to continue even after decontamination is completed because any agent that had penetrated too far to be removed by decontamination would proceed to the blood stream. In contrast to the results of breathing contaminated air (where the worst effects can be expected within 15 to 20 minutes), the effects of direct contact generally do not occur until 1 to 18 hours after exposure. Effects that occur many hours after exposure are usually non-lethal.

Signs and symptoms of nerve agent exposure vary depending on several different factors. Some people may exhibit only one or two symptoms, while others may experience several symptoms at the same time. In addition, the time at which these signs and symptoms begin to appear may differ from person to person. Remember, there are large differences in sensitivity between persons.

OTHER POSSIBLE CAUSES OF NERVE AGENT SIGNS AND SYMPTOMS

The signs and symptoms described may be caused by health problems other than exposure to nerve agent. Many of them may also be attributed to

- epilepsy,
- gastroenteritis,
- exposure to agricultural insecticides (organophosphates and carbamates),
- emphysema,
- strokes,
- head trauma,
- drug overdose,
- heat illnesses,
- allergies, or
- upper respiratory illnesses.

INITIAL FIRST AID TREATMENT

Treatment for a severe nerve agent exposure must be immediate and should be performed by properly trained and equipped personnel. Depending on the severity of the exposure, seconds can make the difference between life and death. The first aid treatment for an individual exposed to nerve agents is immediate removal from the source of exposure, decontamination, and antidote administration with airway management support as necessary.

The nerve agent must be neutralized and removed as soon as possible because the severity of effects is directly proportional to the absorbed dose. The preferred decontamination solution is undiluted, household bleach on exposed skin.

The initial treatment for nerve agent exposure comes as a two-part antidote. First, atropine is administered to block receptor sites from the stimulating action of the acetylcholine neurotransmitter. Then, 2-PAM chloride is administered to restore the acetylcholinesterase enzyme by breaking the enzyme-nerve agent bond, removing the nerve agent molecule, and restoring normal control of skeletal muscle control by relieving twitching and paralysis. The antidote is available from the Army or from commercial sources. Administration of the antidote must be in accordance with State laws and local protocols.

Convulsions are relieved by administration of diazepam.

CHAPTER 9. BLISTER AGENT EXPOSURE

- IDENTIFY THE SPECIFIC SIGNS AND SYMPTOMS OF SULFUR MUSTARD AGENT EXPOSURE
- IDENTIFY THE SPECIFIC SIGNS AND SYMPTOMS OF LEWISITE EXPOSURE

As mentioned earlier, blister agents are poisons that destroy individual cells in target tissues. The most noticeable effect these agents have is the blisters (or vesicles) they cause on exposed tissue. Note that the Army's inventory of chemical warfare agents includes two blister agents: sulfur mustard and Lewisite. Although Lewisite is in the blister agent family, there is very little of this chemical warfare agent remaining and it is all stored at Deseret Chemical Depot.

HOW BLISTER AGENTS WORK

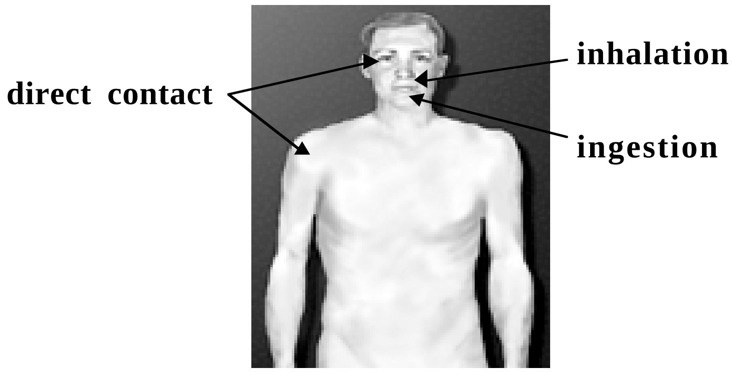
Blister agents were designed to inflict wartime casualties. These agents can affect any skin tissue, but are especially harsh to the more delicate tissues such as the soft membranes surrounding the eyes, the eye itself, lung tissue, and tissues of the mouth and throat. Sulfur mustard has its greatest effect and potency on warm, moist surfaces of the body. This would include any of the mucous membranes (eye, respiratory tract, and/or mouth), and also the armpits, groin, buttocks, creases of the knees and elbows, and folds of the neck. Both the liquid itself and the vapors generated from blister agents create an extreme hazard. The greater the absorbed dose, the greater the severity of skin and tissue damage.

Although cell membranes are damaged within minutes after exposure, the delayed reaction is what makes sulfur mustard agents insidious. There is little or no pain at the time of exposure. The development of chemical signs and symptoms such as burning, stinging, redness, or blisters is usually delayed between 2 and 24 hours, occasionally even up to 36 hours. Effects usually begin to appear between 4 and 8 hours after exposure. Lewisite differs from sulfur mustard in that pain is experienced immediately upon exposure.

ROUTES OF EXPOSURE

A person exposed to a blister agent should be decontaminated as soon as possible. Since blister agents are capable of causing cancer, it is doubly critical to decontaminate quickly.

In order to do this you must understand how the blister agent is capable of entering the body.



Three main routes of exposure.

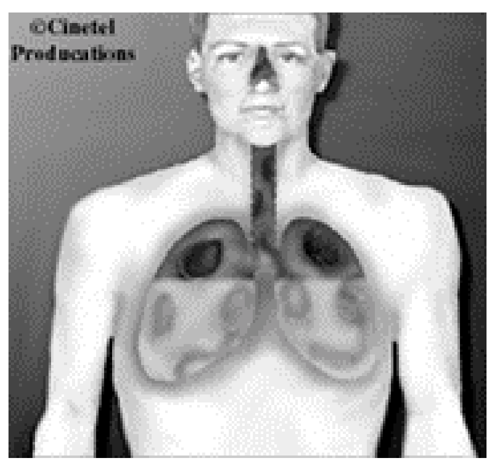
There are three main routes, or ways that a person can be exposed to a blister agent. They are

- inhalation—breathing air that has been contaminated by vapors or droplets of blister agents
- direct contact—skin, mucous membranes, and eyes
- ingestion—swallowing contaminated food or drink

Inhalation

Although the blister agents may be stored as liquids, they are easily changed into vapors that may be breathed. These vapors mix freely with the air. If a person inhales the contaminated air, the blister agent enters the body through the respiratory system.

Once inhaled, the blister agents also have direct access to the lining of the nose, the throat, the bronchial tubes, and lungs. These warm, moist membranes are particularly vulnerable to the effects of the blister agent. With prolonged exposure, the blister agent destroys the mucous membrane lining—just as skin blisters damage the outer layer of skin—causing internal inflammation and bleeding that may lead to later infection of the airways and lungs. Blister agents do most damage to the upper airways, but with a heavy exposure,



Blistered lungs and airways.

the air sacs in the lungs can be injured and fill with fluids.

Direct Contact

Direct contact can occur when any skin surface or the eye comes in contact with liquid agent, a surface on which the agent has been deposited or by exposure to the agent vapor. It is through this method that secondary contamination from one person to another is possible unless strict decontamination procedures have been followed.

Fluid from broken blisters is non-irritating and does not cause blistering upon contact with skin.

Warm, moist membranes are very susceptible to the effects of blister agents. This includes the lining around the eyelids and the inside of the mouth and nose. Since warmth and moisture increase the blister agent's effect, other body areas are particularly susceptible to severe blistering. Examples of these areas are between the toes, behind the knees, in the groin, the armpits, and behind the ears.

Ingestion

If a blister agent has been deposited on or in food items, drink, or anything that a person may place in the mouth (e.g., cigarettes), the agent can cause similar injury to the warm, moist tissues of the mouth, throat, and esophagus. Incidental hand-to-mouth contact and swallowing airborne contaminants are also examples of potential exposure routes.

Although the likelihood of the agent contaminating food or drink is small, you should be aware that it is possible for someone to become exposed through ingestion.

SULFUR MUSTARD

SIGNS AND SYMPTOMS OF SULFUR MUSTARD AGENT EXPOSURE

Although liquid deposition of agent or high concentrations of vapor are not expected off the installations, it is important to recognize the signs and symptoms of more severe exposure.

The severity of the symptoms and the rapidity with which they develop are greatly influenced by weather conditions as well as amount of agent absorbed. Hot, humid weather significantly increases the action of sulfur mustard.

Following sulfur mustard exposure, the onset of clinical signs and symptoms is characteristically delayed for a period of hours. However, there are several physical signs to look for in determining if someone has been exposed to a sulfur mustard agent.

Eye Irritation/Inflammation

The eyes are extremely susceptible to sulfur mustard vapors because of the sensitivity of the mucous membranes of the eyelid and surrounding tissue. Effects include tearing, itching, blinking, reddening of eye tissue, and a sensation of "grit" in the eye. These effects occur at lower doses more often than any other effect. For this reason, this particular set of signs and symptoms is the most sensitive indicator of a sulfur mustard agent exposure.

The eyelids may swell to the extent that they are completely closed. Burning pain can be severe and cause contraction of the muscles surrounding the eye. In severe cases, the cornea can become ulcerated. Exposed persons may be alarmed and think they are blind. However, it is usually only the swelling that obstructs vision and spasms that cause the eyelids to close. Neither of these effects is permanent.

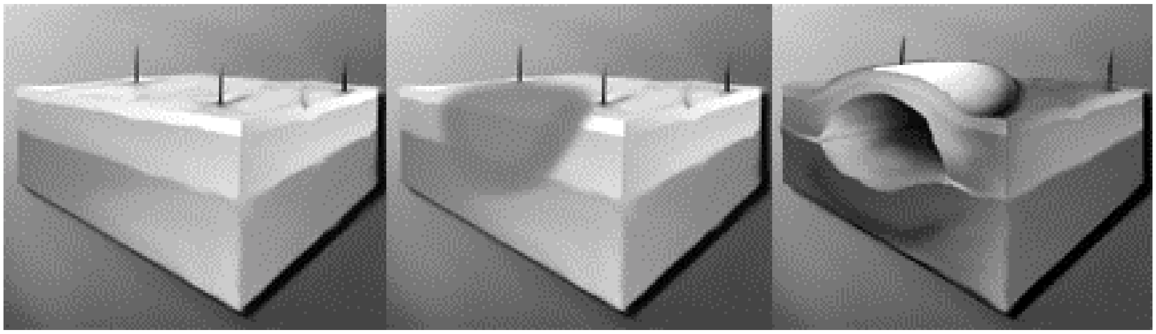
Photophobia

If the eyes are exposed to sulfur mustard vapors the person may experience photophobia (painful sensitivity to light). Light may also cause general discomfort, and not necessarily pain.

Reddening of Exposed Skin

One of the earliest signs of skin exposure is a rash or reddening that resembles sunburn. Itching, burning, and/or stinging pain often accompany skin redness. With sulfur mustard, skin redness typically occurs between 4 and 6 hours after exposure, but can start as early as 2 hours or as late as 24 hours after exposure.
Because the sulfur mustard agents are absorbed faster in warm, moist areas of the body, certain areas are more likely to be affected much quicker. Such body areas include the armpits, genital area, between fingers and toes, membranes surrounding the eyes, lungs, skin folds of the neck, and creases of the elbows and knees.

Blisters



Normal skin. **Reddening skin.** **Blistered skin.**

If not immediately decontaminated, or if exposure has been severe, the reddened skin develops fluid-filled blisters. These blisters, if crudely broken, could become infected.

The blisters may not be painful initially. However, pain and itching may occur not long after blisters develop, then subside, then reoccur a few days later as healing progresses.

Care must be taken to avoid introducing infection into the blister wounds. Because of the damage to the skin tissue and the suppressive action of sulfur mustard to the immune system, a person's ability to fight infection will be diminished. This same precaution is used for any type of massive surface injury (such as thermal burns) to the body.

Blisters may appear 2 hours after exposure; however, they often do not appear for at least 6 hours. In some cases, blisters may not appear for as long as 36 hours after exposure.

Inflammation of the Respiratory Tract

If inhaled, the sulfur mustard agent can be extremely damaging, although not necessarily fatal. It causes swelling and death of the mucous membranes of the airways, resulting in internal inflammation and blistering of the throat and lungs. Inflammation of the main airways to the lungs in the first 12 hours after sulfur mustard exposure is characteristic and can be identified by hoarseness, hacking non-productive cough, chest tightness, and increased respiratory rate.

Depending on the severity of the exposure, the inflammation can cause a substantial amount of fluid to build up in the lungs. The combined effect of fluids and inflammation can obstruct the respiratory tract. Sulfur mustard agents do most damage to the upper airways, but with a heavy exposure, the air sacs in the lungs can be injured.

First signs of respiratory tract damage from sulfur mustard usually appear within 2 hours after exposure but may be delayed for up to 36 hours. Severity of signs and symptoms may increase for up to 24 to 48 hours.

A mild exposure to the sulfur mustard agent can cause slight to moderate irritation of the lining of the nose and mouth. It has been likened to a "very sore throat feeling, even without swallowing" that extends from the mouth, nose, and all the way down the back of the throat. There may also be sneezing, laryngitis, often with loss of voice, and an irritating cough.

Gastrointestinal and Systemic Effects

Ingestion of food or water contaminated by liquid sulfur mustard produces nausea and vomiting, pain, diarrhea, and complete exhaustion. Sulfur mustard vapor does not dangerously contaminate food or water.

Severe exposures to sulfur mustard may cause systemic signs and symptoms such as the feeling of being ill, nausea, vomiting, and fever—at about the time the skin reddens. With severe exposures, particularly by extensive liquid contamination of the skin (which is not expected off-post), these effects may result in exhaustion. Exceptional cases of severe systemic sulfur mustard poisoning may also present central nervous system symptoms such as depression of brain activity, convulsions, and other effects such as heartbeat irregularities. Shock may occur.

Severe systemic effects do not occur with lesser sulfur mustard exposures. However, with amounts approaching a lethal dose, injury may result to the blood-producing tissues, such as bone marrow, lymph nodes, and spleen leading to suppression of a person's immune system.

Table 5 summarizes the signs and symptoms of sulfur mustard agent exposure.

Table 5. Signs and symptoms of sulfur mustard agent exposure

Site of action	Sign(s)/symptom(s)
Eye	Tearing; itching; blinking; reddening of eye tissue; “grit” sensation in the eye; swelling; burning pain; contraction of the muscles; cornea ulceration in severe cases; photophobia
Skin	Rash or reddening that resembles sunburn; itching, burning, and/or stinging pain; blisters
Respiratory tract	Irritation of nose, mouth, and throat; sneezing; blisters; swelling and death of mucous membranes; inflammation; hoarseness; hacking cough; chest tightness; increased respiratory rate; fluid build up and obstruction of respiratory tract in severe cases
Gastrointestinal tract	Nausea; vomiting; pain; diarrhea; complete exhaustion; systemic effects of feeling ill or fever
Central nervous system	Depression of brain activity; heartbeat irregularities; shock; convulsions
Blood-producing tissues	Injury to bone marrow, lymph nodes, spleen (systemic effects)

Adapted from the *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, Department of the Army (FM8-285), Navy (NAVMED P-5041), Air Force (AFJMAN 44-149), and Commandant Marine Corp. (FMFM 11-11), December 22, 1995.

FACTORS THAT AFFECT SULFUR MUSTARD AGENT SIGNS AND SYMPTOMS

Time Factor (Onset)

Although the signs and symptoms of sulfur mustard agent exposure are characteristically delayed (4 to 6 hours), they may appear within 1 to 2 hours if the person has been exposed to a large quantity or if the weather is hot and humid. Depending on these factors, some signs may appear much sooner than others. Just as with nerve agent exposure, the onset of symptoms depends on the

- type of agent;
- amount of agent to which the person has been exposed;
- dose (how much a person has absorbed);
- duration of the exposure;
- route of exposure (inhalation, direct contact, ingestion); and
- sensitivity of the person’s system (depends on general state of health, age, gender, etc.).

Inhalation of sulfur mustard agent causes a much quicker reaction than exposure through direct contact. This is because the agent is absorbed much faster in warm, moist areas, in this case the respiratory tract, and is not as easily removed once breathed. The soft membranes inside the nose, mouth, throat, and bronchial tubes are extremely susceptible to the harsh effects of the sulfur mustard agent vapor.

Peak Effect

If the exposure route is inhalation, the effects can occur after a few hours following exposure. Sneezing, coughing, and inflammation of the trachea and bronchi usually accompany the onset.

If the exposure route is by direct contact (droplet, liquid, or vapor which touches the skin or eye), the effects are usually delayed and absorption may continue for hours. This is likely to continue even after decontamination since the absorption may continue deep within the skin layer.

Some of the signs and symptoms described are very dependent on the dose received, the sensitivity of that individual, and the route of exposure.

OTHER POSSIBLE CAUSES OF SULFUR MUSTARD AGENT SIGNS AND SYMPTOMS

The signs and symptoms described as blister agent effects may be caused by health problems other than exposure to blister agent. They may also be attributed to

- hay fever (red eyes);
- burns—thermal, sun, or other chemicals (erythema and/or blisters);
- large amounts of tear-gas exposure (all signs/symptoms);
- poison ivy, poison oak, other contact allergies; or
- certain drugs.

INITIAL FIRST AID TREATMENT FOR SULFUR MUSTARD EXPOSURE

Decontamination treatment for a sulfur mustard agent exposure must be immediate. Unfortunately, there is no antidote for sulfur mustard agent poisoning. The only first aid treatment consists of immediate removal from the source of exposure and decontamination through washing and diluting. Airway management may be needed as signs and symptoms develop.

Treatment for Eye Contact

If the agent has gotten into the eyes, speed in decontamination is especially critical. Irreversible damage may be done to the eyes very quickly, even though the effects of sulfur mustard agent are not evident in the eyes for 1 to 3 hours or longer.

Flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages. Make sure hands and fingers used in this procedure are not contaminated with agent. If an exposed person is experiencing photophobia, dark or opaque glasses help shield the eyes from the light and provide relief.

Treatment for Skin Contact

When performing decontamination procedures for sulfur mustard agents, pay special attention to skin creases (groin, armpits, behind ears, between fingers, etc.). These are the areas where the agent is most likely to cause severe blistering. Irreversible damage may be done to the skin very quickly before signs and symptoms appear.

At the hospital, additional treatment for the blisters may be given, as determined by the attending physician. This may include administration of antibiotics (including application of topical antibiotics) and other treatments common for burn injuries. Calamine or other soothing lotions to relieve burning may be all that is needed if the only effect is skin reddening.

LEWISITE

SIGNS AND SYMPTOMS OF LEWISITE EXPOSURE

The key difference between the sulfur mustard agents and Lewisite is the onset of effects. Unlike sulfur mustard agents, Lewisite causes immediate pain upon skin or eye contact. When inhaled, Lewisite vapor causes immediate irritation of the upper respiratory tract and may cause sneezing. This is similar to sulfur mustard effects, except that, in the most severe cases, abnormal accumulation of fluid in the lungs and seepage of fluid between the layers of membrane lining the chest cavity may occur. Formations of mucous secretions are common and more likely after breathing Lewisite, as compared to sulfur mustard.

Liquid Lewisite, on the other hand, can severely damage the eye, with immediate stinging pain and twitching of the muscles around the eyes. Swelling of the inner surface of the eyelids and inflammation of the iris may cause the eye to close within 1 hour. Corneal damage may occur. Within hours, the swelling subsides. Mild inflammation of the eyelids may heal in a few days without specific treatment, but severe exposure may cause permanent injury or blindness.

Contact with liquid Lewisite produces more severe skin lesions than does sulfur mustard. Blistering over the entire exposed area follows skin reddening. There is also deeper injury to connective tissue and muscle, greater blood vessel damage, and more inflammation. Dead, gray skin will be noted within minutes of Lewisite liquid or vapor contact. The pain is immediate and becomes deep and aching, itching and irritation persist for a day, and blisters develop fully in one-half of that time. Lewisite has induced Bowen’s disease, a relatively slow-growing and usually nonfatal form of skin cancer.

Lewisite is also known to be a systemic poison to liver, gall bladder, bile ducts, and kidneys at sufficiently large doses. Lewisite does not cause damage to blood-producing tissues such a bone marrow, lymph node, or spleen.

Table 6 is a general summary of the signs and symptoms of Lewisite exposure.

Table 6. Signs and symptoms of Lewisite exposure

Site of action	Sign(s)/symptom(s)
Eye	Prompt redness; swelling; irritation; immediate burning sensation; may cause inflammation of the iris and injure the cornea. Liquid Lewisite will cause severe damage within minutes.
Nose	Immediate irritation; pain
Respiratory tract	Rapid irritation; hoarseness; inability to produce speech (“loss of voice”); cough; fever; accumulation of fluid in the lungs in severe cases; exudation of fluid from the blood or lymph
Skin	Stinging pain in 10 to 20 seconds after liquid contact; burning redness within 30 minutes; blisters within 24 to 48 hours; dead, gray skin visible within minutes after contact
Gastrointestinal tract	Diarrhea; nausea; vomiting; liver failure (systemic effects)
Cardiovascular system	Shock due to systemic effects; destruction of red blood cells; increased concentration of blood due to loss of fluid
Bladder	Kidney failure due to systemic effects

Adapted from the *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, Department of the Army (FM8-285), Navy (NAVMED P-5041), Air Force (AFJMAN 44-149), and Commandant Marine Corp. (FMFM 11-11), December 22, 1995.

INITIAL FIRST AID TREATMENT FOR LEWISITE EXPOSURE

Decontamination of the exposed person should occur immediately in order to avoid deep burns in all cases of liquid Lewisite exposure.

British Anti-Lewisite (BAL) ointment was developed by British toxicologists prior to World War II to be used as an antidote for Lewisite and arsenical poisoning. However, the antidote is not manufactured at this time.

CHAPTER 10. SOURCE DOCUMENTS AND REVIEW PUBLICATIONS

Many publications were reviewed in the development of this Study Guide, but the major sources are from the course materials used by the Army in the Medical Management of Chemical Exposures Course, the Centers for Disease Control Medical Management of Chemical Exposures Course, and other publications recommended to us by our reviewers.

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