Department of the Army
Pamphlet 385–61

Safety

# Toxic Chemical Agent Safety Standards

Headquarters
Department of the Army
Washington, DC
27 March 2002

UNCLASSIFIED

# *SUMMARY of CHANGE*

DA PAM 385–61
Toxic Chemical Agent Safety Standards

This change--

- Updates agency names and acronyms (throughout)

- Updates chemical agent monitoring requirements and procedures (chap 3).

- Provides latest Army chemical agent exposure standards (chap 3)

- Provides latest Army and OSHA safety standards in personal protective equipment (chaps 4 and 8).

- Introduces use of airborne exposure limit-worker population limits and maximum use concentrations (MUCs) to respiratory protection (chap 4).

- Provides latest Army and OSHA safety standards in chemical agent decontamination and disposal (chap 5).

- Clarifies requirements and use of standing operating procedures (chap 6).

- Updates ventilation requirements (chaps 6 and 8).

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# Toxic Chemical Agent Safety Standards

By Order of the Secretary of the Army:

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**History.** This printing publishes a revision of this publication. Because the publication has been extensively revised, the changed portions have not been highlighted.

**Summary.** This pamphlet establishes the Army safety program for all aspects of military toxic chemical agents. It provides new Department of the Army guidance on management of the toxic chemical agent safety program, as well as specific toxic chemical agent safety technical requirements.

**Applicability.** This pamphlet applies to the Active Army, the Army National Guard of the United States, and the U.S. Army Reserve. It applies to all Army civilian employees, and Army contractors (unless otherwise specified within contract clauses) with a responsibility for toxic chemical agent operations or a toxic chemical agent mission.

**Proponent and exception authority.** The proponent of this pamphlet is the Office of the Chief of Staff, Army. The Chief of Staff, Army has the authority to approve exceptions to this publication that are consistent with controlling law and regulation. The proponent may delegate this approval authority, in writing, to a division chief within the proponent agency in the grade of colonel or the civilian equivalent.

**Suggested Improvements.** Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended changes to Publications and Blank Forms) directly to Chief of Staff, ATTN: DACS-SF, 200 Army Pentagon, Washington, DC 20310-0200.

**Distribution.** This publication is available in electronic media only and is intended for command levels D and E for the Active Army, the Army National Guard of the United States, and the U.S. Army Reserve.

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# Chapter 1
# Introduction

## 1–1. Purpose

*a.* This pamphlet explains the minimum safety criteria and standards for use in processing, handling, storage, transportation, disposal, and decontamination of blister agents H, HD, L, and HT; and nerve agents GB, GA, and VX, including those levels of agents listed in AR 50–6, table 9–2. (See AR 385–61 for responsibilities and policies.)

*b.* Although there is also a concern with other agents such as BZ and GD, the small quantities of these agents in the inventory and their isolation at few locations have precluded detailed standards in this pamphlet. The general requirements of this pamphlet will be applied to GD and other experimental chemical agents (see glossary for definition) exhibiting similar toxicity to nerve and mustard agents.

*c.* All pertinent information necessary to safely conduct operations involving the latter agents will be addressed in safety submissions and related standing operating procedures (SOPs).

*d.* Airborne exposure limits (AEL) for agents are contained in AR 385–61 and DA Pams 40–8 and 40–173. Unless otherwise noted, "AEL" in this document refers to the 8-hour time-weighted average (TWA) for unmasked agent workers.

*e.* For research development test and evaluation (RDTE) solutions of chemical agents (as defined in AR 50–6, table 5–1) the provisions contained in this pamphlet may be deviated from with approval of the responsible installation/activity commander/director, or his designated representative. The provisions contained in this pamphlet should be used in conjunction with hazard analysis/standing operating procedures and good lab practices to ensure safe operations with RDTE solutions. Each installation/activity that conducts RDTE solution operations must have a program document that describes how operations will be conducted in a safe manner.

## 1–2. References

Required and related publications and prescribed and referenced forms are listed in appendix A.

## 1–3. Explanation of abbreviations and terms

Abbreviations and special terms used in this pamphlet are explained in the glossary.

## 1–4. Functions

*a.* The commander of each major Army command (MACOM), major subordinate command (MSC), installation, unit, or activity effectively manages the chemical agent safety program within his or her command and assures that all applicable safety requirements outlined herein are implemented and strictly enforced. In order to maintain an effective chemical agent safety program, it is important that commanders take the same aggressive leadership in chemical agent safety that is taken in other phases of command responsibility.

*b.* In discharging the command safety responsibility and AR 385–10, commanders appoint a safety manager who is occupationally qualified in accordance with Office of Personnel Management standards to manage the toxic chemical safety program.

*c.* The safety manager maintains a safety program for chemical agents according to AR 385–10, AR 385–61, and AR 385–64. The safety manager has direct access to the commander relating to all toxic chemical agent safety matters.

*d.* The quality assurance specialist (ammunition surveillance) who performs a chemical agent munitions inspection mission for the commander in conformance with AR 740–1 and SB 742–1 informs the safety manager of safety deviations or concerns observed during the conduct of these inspections.

## 1–5. Policy

Commanders with a chemical agent mission will require the use of methods, procedures, and equipment that accomplish operations in a safe manner and protect personnel involved in agent operations, the general public, and the environment.

## 1–6. Concept

This pamphlet applies to all active Army commands, agencies, organizations, installations, units, activities, and contractors with chemical agent responsibilities specified in their contracts. Installations and activities will follow the requirements and guidance contained in this pamphlet. This pamphlet takes precedence over the guidance contained in technical manuals (TMs), field manuals (FMs), supply bulletins (SBs), technical bulletins (TBs), DA pamphlets, or MACOM regulatory documents. Restrictions imposed by local governing agencies will be followed as required. Overseas commands will meet the provisions of this pamphlet or equivalent requirements of the host government.

## 1–7. Provisions

This pamphlet has mandatory provisions as well as preferred and acceptable methods of accomplishment.

*a.* The words “shall,” “will,” and “must”are used to state mandatory requirements. Deviation from these provisions requires a waiver or exemption per provisions of AR 385–61.

*b.* The word “should” indicates a nonmandatory desire or preferred method of accomplishment. Deviation from these provisions requires written authorization from the local commander.

*c.* The word “may” indicates an acceptable or suggested means of accomplishment.

# Chapter 2
# Agent Information

## 2–1. Overview

*a.* Chemical agents are not gases, although “poison gas” is a term colloquially used to refer to them. The first lethal chemical used in combat, in 1915, was the gas chlorine, and “gas” became the common term. Most agents in the Army chemical munitions stockpile are liquids that were intended to be dispersed either as droplets or vapors.

*b.* Chemical agents produce various physiological effects on the human body. They will produce a harmful physiological and/or psychological reaction when applied to the body externally, when inhaled, or when taken internally at sufficient doses. Most chemical agents cause a disruption of normal body functions, as described in this chapter.

*c.* The two significant types of known modern chemical agents are blister agents and nerve agents.

(1) Blister agents are persistent agents that act on the eyes, lungs, and skin and burn and blister the skin or any other part of the body they contact. The common names and chemical names of examples of blister agents are as follows:

*(a)* H—Levinstein mustard—70 percent bis(2–chloroethyl) sulfide, 30 percent polysulfides.

*(b)* HD—distilled mustard—bis(2–chloroethyl) sulfide.

*(c)* HT—mixture of chemical agents H—60 percent bis(2–chloroethyl) sulfide and T—40 percent bis(2–chloroethylthio) diethyl ether.

*(d)* L—Lewisite—dichloro (2–chlorovinyl) arsine.

(2) Nerve agents are organophosphorus compounds chemically related to pesticides and include the G and V agents. The G agents were developed in the 1930s and 1940s and attack primarily through the respiratory system; the V agents, developed in the early 1950s, act by absorption through the skin. G agents can also be absorbed through the skin and eyes, particularly if they have been mixed with a thickener that slows evaporation, keeping them in liquid form for a longer time. All nerve agents injure and kill by binding to cholinesterase, an enzyme of the human body that is essential for functioning of the nervous system; they produce a range of neurological disorders followed by paralysis and cardiovascular or respiratory failure. The common name and chemical name of examples of nerve agents are as follows:

*(a)* GA—tabun—ethyl N, N-dimethylphosphoramid-ocyanidate.

*(b)* GB—saran—superpolite methylphosphonofluoridate.

*(c)* GD—soman—pinacolyl methylphosphonofluoridate.

*(d)* VX—O-ethyl S—(2–diisopropylaminoethyl) methylphosphonothiolate.

## 2–2. Classification

Chemical agents are classified as class 6.1 poisons by the Department of Transportation (DOT) and belong to storage compatibility group K.

## 2–3. Chemical and physical properties

Table 2–1 provides basic chemical and physical properties of agents. Additional agent information may be found in FM 3–9 and chemical agent material safety data sheets (MSDS) that may be obtained from Chief, Safety/Surety/Security Office, U.S. Army Edgewood Chemical Biological Center, ATTN: AMSSB-RCB-RS, Aberdeen Proving Ground, MD 21010–5424 or from the Internet via the SBCCOM Web site.

## 2–4. Types of hazards

*a.* Hazards from mustard agents (H, HD, and HT) are through vapor contact with the eyes or respiratory tract and liquid contact with skin. The most common acute hazard is that of liquid contact with the skin. Mustard vapor may be absorbed readily through the respiratory tract and eyes, and, if ingested, through the gastrointestinal tract. The severity of the effects is dependent on the degree of liquid contamination and on the vapor concentration and associated exposure time. Mustard agents may persist as liquid contamination on nonporous surfaces for long periods because of their low volatilities. They can also wick into porous surfaces and emit vapor over a long period of time. Agents on contaminated surfaces can be transferred to personnel by direct contact.

*b.* The hazards from Lewisite (L) are similar to those of mustard agents. The most severe effect results from liquid contact with the eyes and skin. Injury to the respiratory tract because of vapor exposure is similar to that of mustard,

and in large amounts Lewisite causes pulmonary edema. Lewisite on the skin, as well as inhaled vapor, is absorbed and may cause systemic poisoning.

*c.* The hazard from G agents (GA, GB, and GD) is primarily that of vapor inhalation through the respiratory tract, although it may be absorbed through the eyes or skin. As a liquid, it is hazardous by skin or eye contact and by ingestion. It is highly toxic and quick acting. When dispersed as large droplets, GB is moderately persistent. It is nonpersistent when disseminated as a cloud of very fine particles or as a vapor.

*d.* The hazard from VX is primarily that of liquid absorption through the skin, although it may be readily absorbed as a vapor or aerosol through the respiratory tract and eyes and ingested through the gastrointestinal tract. VX is slow to evaporate and may persist as a liquid for several days.

## 2–5. Mechanism of action and physiological effects

*a. Cause of casualties.* Inadvertent skin contact with chemical agents and inhalation of agent vapors are the most common causes of casualties. The agent absorption rate is accelerated through unprotected cuts and abrasions.

(1) Mustard is an insidious vesicant agent and has been identified as carcinogenic and mutagenic. The agent's garlic-like odor quickly becomes unnoticeable after the first detection because the agent causes the olfactory nerves to become insensitive. This phenomenon is known as "olfactory fatigue." Another indication of the insidiousness of mustard is the possible absence of pain for a period of hours after vapor contact with the skin and for many minutes even after eye contact with the liquid. With regard to skin exposure, the presence of moisture or perspiration on the skin tends to increase the effect of exposure to this agent.

(2) Lewisite is a vesicant agent and is considered a suspect carcinogen. Exposure to Lewisite causes intense pain on contact. Exposure to the eyes, if not decontaminated immediately, will result in permanent injury or possible blindness within 1 minute of exposure. When inhaled in high concentrations, it may be fatal in as short a time as 10 minutes. Lewisite can cause sensitization and chronic lung impairment.

(3) G agents are anticholinesterase compounds. Their effects are referable to stimulation of the autonomic and central nervous systems resulting from the inhibition of the cholinesterase enzymes in the tissues and the resultant accumulation of acetylcholine at its various sites of action.

(4) VX is an anticholinesterase compound similar to GB in its mechanism of action and effects. Since VX has a low volatility, liquid droplets on the skin do not evaporate quickly, thereby facilitating effective percutaneous absorption. By this route, VX is approximately 10 times as toxic as GB. By the inhalation route, VX is estimated to be twice as toxic as GB.

*b. Signs and symptoms.*

(1) *Mustard.* The eye is the most vulnerable part of the body to mustard, either by liquid or vapor contact. Conjunctivitis (red eye) can occur following an exposure to a vapor concentration barely detectable by odor. Long exposures to low concentrations or short exposure to high concentrations can result in permanent eye damage. The initial effect after skin contact with either vapor or liquid is a reddening of the skin similar to sunburn. Depending on the severity of exposure, the reddening may progress to blistering and tissue destruction. The initial exposure is not accompanied by a sensation, but, as symptoms develop, there may be an itching or burning sensation that develops to reddening and then to blistering. Inhalation of mustard vapor or aerosol causes damage to the mucous membranes of the upper respiratory tract. Damage develops slowly and may not reach the maximum severity for several days following exposure. The symptoms are hoarseness, sore throat, and coughing. In the case of severe exposure, there is a predisposition to secondary infection such as bronchial pneumonia. Recovery from the effects of exposure to mustard is very slow. Very small repeated dosages are cumulative in their effect and even more serious because of their tendency toward sensitization. Exposure to vapors from mustard may, in the first instance, cause only minor symptoms such as red eye. Repeated exposures may produce severe respiratory symptoms. Mustard agent is a known mutagen and human carcinogen and may cause these adverse health effects in individuals exposed even to very small repeated dosages.

(2) *Lewisite.* The signs and symptoms of Lewisite are similar to those of mustard, but they occur more rapidly. As with mustard agents, the eye is vulnerable. Mild exposure to the eye produces reversible eye damage if decontaminated instantly; otherwise, more permanent injury or blindness is possible within 1 minute of exposure. Contact with the skin results in immediate stinging pain increasing in severity with time. Erythema (skin reddening) appears within 30 minutes after exposure, accompanied by pain with itching and irritation for 24 hours. Blisters appear within 12 hours after exposure with more pain, which is diminished after 2 to 3 days. Skin burns are much deeper than with HD. Tender and moist skin (mucous membrane or perspiration-covered skin), absorbs more Lewisite, and therefore it is more sensitive. Lewisite is irritating to nasal passages and produces a burning sensation followed by a profuse nasal secretion and violent sneezing. Prolonged exposure causes coughing and production of large quantities of froth mucus. Lewisite acts as a systemic poison, causing pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure.

(3) *G agents and VX.* The first indication of exposure to liquid G agents or VX agent may be a reaction at the point of contact (for example, localized sweating, muscular twitching, and pinpoint eye pupils (miosis) if liquid gets into the eye). For mild exposures, symptoms may not progress beyond the local reaction; however, if absorption is sufficient to

produce systemic poisoning, the following signs and symptoms, the number and severity of which will depend upon the degree of exposure, can be expected:

*(a)* If exposure is from aerosol or vapor, early signs and symptoms are pinpointing of eye pupils and dimness of vision (these symptoms may be absent entirely in cases of skin absorption), runny nose, and a tightness in the chest.

*(b)* If exposure is by skin contact, early signs and symptoms may be sweating and muscular twitching.

*(c)* Later signs and symptoms (indicating severe exposure) include nausea; possible vomiting, diarrhea, weakness, coma, and cessation of breathing. Death can result from both respiratory and skin exposure. These agents in vapor form are rapidly absorbed through the respiratory system, and death can occur in less than 10 minutes. Symptoms appear much more slowly when the dose is acquired by absorption through the skin; however, if the dose is large, the response can be very rapid. The intact skin acts as a barrier to these agents in the vapor state. However, the vapor may quickly pass through the eyes, and miosis may result from very low concentrations of vapor alone. The effects of repeated exposures can be cumulative and workers may experience severe cholinesterase (ChE) depressions from repeated exposure to low concentrations of agent. The rate of regeneration of ChE within the body is slow.

## 2–6. Airborne exposure limits (AEL)

*a.* Personnel working without protection from the inhalation of agent vapors in areas where an agent may be present will not be exposed to concentrations exceeding the AEL in AR 385–61, table 2–4. When known or suspected agent concentrations exceed these values, appropriate protective clothing will be worn as required by chapter 4 of this pamphlet. Agent monitoring requirements are detailed in chapter 3.

*b.* In cases where, by the nature of the operation, a release of agent is expected (such as in emergency destruction, training, or certain preventive maintenance operations), calculations will be made using approved methodology (see para 11–4) to assure that nonagent workers and the general population are protected, as required by AR 385–61, table 2–3.

*c.* Unless otherwise noted, AEL in this document refers to the 8-hour worker population limit AEL—time-weighted average (TWA) for unmasked agent workers.

## 2–7. Persistency

The persistency of chemical agents is categorized as nonpersistent (G-class nerve agents) and persistent (mustard (H) and Lewisite (L) blister agents, and V-class nerve agents (VX)). Table 2–1 shows the characteristics of chemical agents.

## 2–8. Stability of chemical agents

The stability of chemical agents is dependent on weather variables such as wind, temperature, temperature gradient, humidity, and precipitation. The magnitude of the effect of each variable depends upon the synoptic situation and is locally influenced by topography, vegetation, and soil and may also determine possible downwind hazards. Although the travel and diffusion of an agent cloud are not significantly affected by meteorological elements during the first 30 seconds, the dosages and the rate of dosage buildup are influenced by weather. At high windspeeds, the dosages are reduced during all time intervals. At high air temperatures, the rate of dosage buildup from volatile agents is faster, and total dosage may be obtained within 15 seconds.

*a. Agent cloud characteristics.* Chemical agents may appear as vapors, aerosols, and liquids.

(1) *Vaporous chemical agents.* If a chemical agent is disseminated as a vapor from a bursting-type munition, initially the cloud expands, grows cooler and heavier, and tends to retain its form. If the vapor density of the released agent is less than the vapor density of air, the cloud will rise quite rapidly, mix with the surrounding air, and dissipate. If the vapor density of the released agent is greater than the vapor density of air, the cloud will pancake, sink, and cling to the surface of the earth. Generally, during the first 30 seconds, the cloud growth will be independent of ambient meteorological conditions, although the rate of dosage buildup is affected by the existing weather. Shortly after release (30 seconds or so), an agent cloud will assume the temperature, direction, and speed of the surrounding air. The chemical cloud then will be subjected to forces that act to tear it apart and dilute its concentration. The heavier the agent, the longer the cloud will retain its integrity. Under stable atmospheric conditions (favorable temperature gradient and low windspeed), the chemical agent cloud will travel great distances with little decrease in its vapor concentration. As turbulence (mechanical and/or thermal) increases, the agent cloud will dissipate faster.

(2) *Aerosolized chemical agents.* An aerosol can be either a liquid or a solid substance consisting of finely divided particles suspended in the atmosphere. Airborne aerosols behave in much the same manner as vaporized agents. Initially, aerosol clouds will have a higher temperature than vapor clouds; this vapor may cause some initial rise of the cloud at the release point. Aerosol clouds are heavier than vapor clouds, and they tend to retain their form and settle back to earth. Because they are heavier than vapor clouds, they are affected to a lesser extent by turbulence. (However, as the aerosol cloud travels downwind, the larger, heavier particles will settle out, and many of the particles may be removed by impaction on surfaces.)

(3) *Liquid chemical agents.* Evaporation of liquid agent will cause the agent to form into vapor. Once evaporated, the agent vapor plume will have about the same temperature and vapor density as the ambient/surrounding air. The vapor concentration will depend on the volatility of the chemical agent and the temperature. The resultant chemical

vapor plume will exhibit essentially neutral buoyancy (that is, it will not have a tendency to either rise or sink). However, depending on surrounding terrain contours or obstacles (such as bindings), the vapor plume may "settle " into terrain or obstacle cavities in light or calm winds, especially near the source.

*b. Diffusion of a chemical cloud.*

(1) *Lateral spread.* When a chemical cloud is released into the air, it is blown from side to side by shifting air currents and mechanical turbulence. These currents cause a lateral spread as the cloud moves downwind. In steady winds, the spread of the cloud amounts to about 15 percent of the distance traveled, while under ordinary conditions the spread is about 20 percent of the distance from the source. In a fishtail wind (one frequently changing direction), the spread is much greater.

(2) *Drag effect.*

*(a) Turbulent drag effect.* Wind currents carry chemical clouds along the ground with a rolling motion, since the wind velocity increases rapidly from a negligible value near the ground to an appreciable one at gradient wind level (about 2,500 feet). This effect (called drag effect), together with the interference of vegetation and other ground objects, causes the base of the cloud to be retarded and to stretch out in length. When clouds are released on the ground, the drag effect causes lengthening of the cloud by about 10 percent of the distance traveled over grass, plowed land, or water and about 20 percent over gently rolling terrain covered with bushes, growing crops, or small patches of scattered timber. In heavy timber the drag effect is greatly increased.

*(b) Layering.* With the turbulence and light to moderate winds, the friction of the lower layers of air against the earth causes windspeeds to decrease gradually as the surface is approached. Under these conditions, a chemical cloud is carried along faster than it can diffuse downward. As a result, air near the ground on the forward edge of the cloud may not be contaminated while the air a few feet up is heavily contaminated. This condition (layering) becomes more pronounced and increases proportionately with the distance of the forward edge of the cloud from the source.

(3) *Vertical rise.* The vertical rise of a chemical cloud is dependent on weather variables such as temperature gradient and wind speed, and the difference in densities of the cloud and the surrounding air. The chemical cloud particles are not appreciably affected by the radiation of the sun because they are small.

## 2–9. Weather and terrain

*a. Weather.* Weather (particularly temperature, temperature gradient, windspeed, and direction) directly influences the effectiveness and persistency of an agent.

(1) *Temperature.* The evaporation of liquid chemical agents increases as the temperature rises.

(2) *Windspeed.* High winds increase the rate of evaporation of liquid chemical agents and dissipate chemical clouds more rapidly than low winds do.

(3) *Direction.* Wind and terrain control the travel of chemical clouds.

*b. Terrain.*

(1) *Contour.* Under stable conditions, chemical clouds tend to flow over rolling terrain around large hills and up and down valleys.

(2) *Trees and vegetation.* Agent clouds tend to pass around and over heavily wooded areas with little or no agent penetrating any depth into the woods.

## 2–10. Hydrolysis

Hydrolysis is the reaction of any chemical substance with water whereby decomposition of the substance occurs and one or more new substances are produced.

*a. Rate of hydrolysis.* The rate of hydrolysis is the rate at which the various chemical agents or compounds are decomposed by water. Rapid hydrolysis is also an important factor in lowering the duration of effectiveness of toxic chemical agents. For example, Lewisite is rapidly hydrolyzed, and therefore it has a shorter duration of effectiveness than HD, which hydrolyses very slowly at ordinary temperatures.

*b. Hydrolysis products.* Hydrolysis products are those new substances formed when a chemical agent or compound reacts with or is decomposed by water. In certain cases, hydrolysis does not completely destroy the toxicity of a chemical agent or compound (as in the case of Lewisite and most other chemical agents containing arsenic) because the hydrolysis product is also toxic.

## 2–11. Rate of detoxification

The rate of detoxification is the rate at which the body is able to counteract the effects of a poisonous substance. It is an important factor in determining the hazards of repeated exposure to low concentrations of toxic chemical agents. Continued exposure of personnel to low concentrations of HD may result in sensitivity to very low concentrations of HD. Some chemical agents are not detoxified at appreciable rates by the human body. For example, an exposure of 1 hour to HD followed within a few hours by another exposure of 1 hour has approximately the same effect as a single exposure of 2 hours duration. The disabling or lethal dosage in the case of such cumulative agents is proportional to the time factor within reasonable limits. GB, while having a cumulative toxic effect, also has a detoxification effect that is important. For example, the median lethal dosage of GB is approximately 70 mg-min/$m^3$ over periods of 30 seconds to

several minutes. However, if the concentration breathed is so high that 15 to 25 milligrams are received in one breath, this amount can be lethal because there is no time for any appreciable amount of detoxification to occur.

## 2–12. Rate of action

*a.* The rate of action of a chemical agent is the rate at which the body reacts to or is affected by that agent. There is a wide variation in the rate of reaction to the chemical agents, even to those of similar classification. For example, HD causes no immediate sensation on the skin and causes no noticeable effect for several hours (in a few cases, effects have been delayed for 10 to 12 days). Lewisite, on the contrary, produces an immediate burning sensation on the skin upon contact and blistering in about 12 hours. None of the blister agents are as delayed in their noticeable effects as HD.

*b.* Decontamination of blister agents must be accomplished within 2 minutes after contamination if serious effects are to be prevented. The nerve agents are characterized by the great rapidity with which they act. First-aid measures, such as administering antidotes, generally must be carried out within a few minutes after lethal dosages of these agents have been absorbed if death is to be averted.

## 2–13. Dosage

*a.* Vapor dosage is the concentration of a chemical agent in the atmosphere (C) multiplied by the time (t) the concentration remains, expressed as mg-min/$m^3$. Dosage is often referred to as *Ct*. The dosage received by a person depends upon how long he or she is exposed to the concentration. That is, the respiratory dosage in mg min/$m^3$ is equal to the time in minutes an individual is unmasked in an agent cloud multiplied by the concentration of the cloud. The skin dosage is equal to the time of exposure in minutes of an individual's unprotected skin multiplied by the concentration of the agent cloud. (This is generally understood as being the effect upon the whole body.) The physiological effectiveness of skin and respiratory aerosol dosages are influenced by particle size as well as time and concentration, since retention by the lungs and impingement upon the skin are functions of particle size. They are usually expressed in mg-min/$m^3$ for a particle size.

*b.* Liquid dosage is the weight of liquid agent received by a person on his or her skin and is usually expressed as dosage in milligrams of contaminant per kilogram of body weight (mg/kg).

*c.* After exposure to a chemical agent, an individual may show signs and symptoms that are less or more than expected for a given dosage (Ct), depending upon some of the following variables:

(1) How long the breath was held during short exposure.
(2) Speed with which mask was donned.
(3) Ability to fit mask and mask leakage factors.
(4) Whether the chemical agent was also absorbed through the skin.
(5) Whether the chemical agent stimulated the rate of breathing.
(6) Rate and depth of breathing of the individual at the time of exposure.
(7) Amount of physical exertion of the individual at the time of exposure.
(8) Rate of detoxification, especially if exposure was long.

*Note.* For tabulation purposes such variables are ignored, and the Ct values are assumed to measure the amount of chemical agent received by an individual breathing at a normal rate in a temperate climate with average humidity. These values provide a basis of comparison for the chemical agent.

**Table 2–1**
**Agent chemicals and physical properties**

| Agent | Boiling pt | Freezing pt | Flammability | Color | Odor | Vapor pressure |
|---|---|---|---|---|---|---|
| H, HD, Mustard | 217°C 423°F | 14. 5°C 58°F | Class III B(combustible liquid) | Clear through amber to dk brown | Garlic | 0.072 mm Hg at 20°C 68°F |
| HT mustard | No constant point above 228°C | 0.0 to 1. 3°C 32°F | NA | Clear to pale yellow | Garlic-like | 0.104 mm Hg at 25°C |
| L | 190° 374°F | NA | NA | Pure-colorless | Geranium like, pure-very little | 0.35 mm Hg at 25°C |
| GA | 274°C 476°F | -50°C | NA | Colorless to brown liquid | Faintly fruity pure-none | 0.07 mm Hg at 24°C |
| GB | 158°C 316°F | -56°C | Nonflammable | Colorless | Pure-none | 2. 9 mm Hg at 25°C 77°F |
| GD | 198°C 388°F | NA | NA | Pure-colorless amber or dark brown | Pure-fruity oil of camphor | 0.40 mm Hg at 25°C |

**Table 2–1**
**Agent chemicals and physical properties—Continued**

| Agent | Boiling pt | Freezing pt | Flammability | Color | Odor | Vapor pressure |
|---|---|---|---|---|---|---|
| GF | 80°C at 4. 0 torr | -30°C | NA | Clear | None | 0.07 mm Hg at 25°C |
| VX | 300°C 572°F | -39°C -38°F | Class III B combustible liquid | Clear to straw-colored | None | 0.0007 mm Hg at 25°C 77°F |

# Chapter 3
# Agent Monitoring Requirements

## 3–1. Detection methods and equipment

*a. Detector paper.*

(1) The VGH-ABC M8 chemical detector paper is a component of both the M256 and M18A2 detector kits and will detect liquid agent. It is also available as a separate item, national stock number (NSN) 6665–00–050–8529. It is an off-white paper that has been treated with a combination of dyes that produces a distinctive color change when in contact with liquid agent. When exposed to liquid agent, the paper turns to a deep-red color for mustard, scarlet for Lewisite, yellow for GB, and dark green for VX. The paper will not detect vapor or extremely small droplets of agent. For nerve agents, the detector ticket (See 3–1*g*, below.) may be used to confirm positive M8 paper tests.

(2) M9 chemical agent detector paper (NSN 6665–01–049–8982) is a separate stock fund item of issue. It detects small droplets (greater than 50 microns) of liquid agent. The paper is gray/green in color and turns red in contact with agent droplets or liquid. It does not distinguish between mustard or nerve agents.

*Note.* M8/M9 papers are subject to interference and should not be used as a sole verification of the presence of an agent.

*b. Blue band tube or white band tube.* The blue band tube (NSN 6665–00–856–8236) is a separate stock item that will detect mustard agent vapor at concentrations as low as 0.5 $mg/m^3$ and GB as low as 1.0 $mg/m^3$. The blue band tube will not detect VX. The sensitivity decreases with lowering temperature. Upon addition of reagent, the tube will turn to a purple-blue color in the presence of mustard vapor and yellow-orange or blue-green in the presence of GB vapors (depending upon the reagent used). Use of the blue band tube is preferred over the M256 detector kit sampler for mustard detection. White band tube (NSN 6665–00–702–7136) may also be used for detection of GB. (The expiration date on the white and blue band tubes may be disregarded when used with indole reagent solution for GB detection). The white band tube will not detect mustard or VX agents.

*c. M256 kit sampler*. The plastic detector component (NSN 6665– 01–016–8399) has all the reagents self-contained in finger crushable glass ampoules. In the presence of mustard agent, a distinctive purple-blue color change is obtained after proceeding according to instructions on use of the sampler, which are printed on the outside of the heat sealed protective envelope. In the absence of GB/VX, a distinctive blue color change is obtained. The M256 sampler will detect agent vapors at concentrations of 3.0 $mg/m^3$ for mustard, 14.0 $mg/m^3$ for Lewisite, 0.05 $mg/m^3$for GB, and 0.1 $mg/m^3$ for VX. The response time of the sampler increases as the temperature decreases. Gloves and protective mask are required when breaking the heater ampoules used for mustard detection. The M256A1 kit sampler will detect agent vapors at concentrations of 3.0 $mg/m^3$ for mustard, 14.0 $mg/m^3$ for Lewisite, 0.005 $mg/m^3$ for GB, and 0.02 $mg/m^3$ for VX.

*d. Absorption air sampling.* An absorption air-sampling system (commonly referred to as a bubbler) provides a reliable method for detecting low-level concentrations of agent vapors; however, this system has no capability for providing an alarm response when agent is present. The bubbler unit is usually a vessel packed with glass beads and filled with a scrubbing solution. The air sample is bubbled through the scrubbing solution, which absorbs the chemical agent from the air sample. After sampling for a predetermined time and flow rate, the unit is removed and sent to a chemical laboratory for processing to determine the presence, type, and quantity of agent in the sample. Using the proper analytical techniques, the system can detect average agent vapor concentrations of 0.003 $mg/m^3$for mustard and Lewisite, 0.0001 $mg/m^3$ for GA/GB, 0.0000 $mg/m^3$ for GD, and 0.00001 $mg/m^3$ for VX. Lower average concentrations can be detected by increasing the sampling time and/or the rate of the sampled air. When bubblers are used, samples should be analyzed as soon as possible after the sample is drawn. Samples may be stored (or shipped, if necessary; see para 10–5 for transportation controls) provided that strict quality controls are present over temperatures and length of storage. Since samples are subject to agent degradation (for example hydrolysis) when subject to high temperatures or long periods of storage, bubbler samples should be aspirated and stored at controlled temperature conditions, 21 degrees C (70 degrees F) or less, right up to the time they are analyzed (within 36 to 48 hours). If the length of time between sampling and analysis will exceed 48 hours, temperatures should be maintained at or below 2 degrees C (36 degrees F) to minimize degradation. Water-based samples should not be subjected to freezing temperatures.

*e. Depot Area Air Monitoring System (DAAMS).* DAAMS is a portable air-sampling unit that is designed to draw a controlled volume of air through a glass tube filled with a collection material (for example, Tenax GC). As the air is passed through the solid sorbent tube, agent is collected. After sampling for the predetermined period of time and flow rate, the tube is removed from the vacuum line and sent to a chemical laboratory for analysis (approximately 1-hour

process time) to determine the presence, type, and quantity of agent collected in samples. This technique will sample down to the AEL and is to provide low-level detection capability for GA, GB, HD, and VX, and Lewisite.

*Note.* The analytical method used for Lewisite air monitoring shall meet as a minimum the quality assurance requirements contained in the latest revision of the chemical agent standard analytical reference material (CASARM) quality assurance plan. More stringent quality assurance requirements are also acceptable.

*f. Automatic Continuous Air Monitoring System (ACAMS).* The ACAMS is an automatic air monitoring system with real-time, low-level capability that collects compounds present in the air on a solid sorbent trap, thermally desorbs them into a capillary column for separation, and then detects the agent with a flame photometric detector. The ACAMS is capable of detecting agents GB, VX and HD at low level (GB at 0.0001 $mg/m^3$, VX at 0.00001 $mg/m^3$, and HD at 0.003 $mg/m^3$) and gross levels (up to 100 $mg/m^3$ with the use of low-volume sampler). The ACAMS can detect an agent at concentrations as low as 0.00002 $mg/m^3$ for GB, 0.000002 $mg/m^3$ for VX, and 0.0006 $mg/m^3$for HD, but not in real-time mode. The ACAMS can detect agent present in the ambient air, furnace exhaust stacks, filter stacks, and highly contaminated areas. The ACAMS can also be used, and is available, for mobile monitoring operations. A local audible and visible alarm is given by the ACAMS in addition to the capability of sending an analog signal to a remote location. The response time for the ACAMS may vary from 3 to 5 minutes, depending on the agent being monitored; 2 minutes for gross levels, and 5 to 10 minutes for furnace exhaust-stack monitoring, depending on the agent.

*g. Detector ticket.* The detector ticket is a stock item that will detect nerve-agent vapor at concentrations as low as 0.1 $mg/m^3$ (GB) and 0.4 $mg/m^3$ (VX). It is included in the M18A2 kit (NSN 6665–00–903–4767) and the M30A1 refill kit (NSN 6665–00–909–3647). The sensitivity of the ticket decreases with lower temperature. Using a reagent (substrate), the square end of the ticket will turn blue in the absence of agent and will turn light red-orange or have no color change in the presence of agent. The ticket will not distinguish between GB and VX agent vapor or any other nerve agent. The detector ticket can be used for point source sampling, using the APE 2053 or aspirator bulb for confirmation of positive M8 paper tests (GB only), and for area air sampling, using the procedures similar to the card in the M256 kit. The detector ticket continues to detect an agent for 24 minutes without rewetting of the ticket and for up to 30 minutes provided the ticket is rewetted once during the 30-minute period. The extended sampling period is approved only for use in magazines or structures where exposure to sunlight or heat will not occur. When confirming positive M8 or M9 paper tests for VX, a negative detector ticket reading will not be considered to invalidate the positive detector paper test. A third paper test must be conducted using a different detector paper lot number.

*h. Real-time monitor (RTM).* RTM is a nonportable continuous air-sampling device normally used in operational facilities for the detection of low levels of nerve agent. The RTM will detect agent vapor concentrations of 0.0001 $mg/m^3$ (GB) and 0.00001 $mg/m^3$ (VX) and will provide an alarm response in 8 to 12 minutes.

*i. M8A1 and M22 detection alarms.* M8A1 and M22 alarms are portable/fixed alarms using the M43 and M43A1 detector units respectively. They are capable of detecting nerve-agent concentrations as low as 0.2 $mg/m^3$ (GB) and 0.4 $mg/m^3$(VX) with an alarm response of 2 to 3 minutes for the M43 and 30 seconds for the M43A1. The M43A1 has a much faster response time at higher concentrations. The M8A1 and M22 detection alarms are used to supplement other real time chemical agent monitoring systems and provide rapid alarm response to high-level concentrations.

*j. Demilitarization chemical agent concentrator (DCAC).* The M8 alarm system used with a DCAC unit can detect GB agent vapor concentrations of 0.001 $mg/m^3$ in 33 minutes and 0.2 $mg/m^3$ within 2 minutes (the DCAC cannot be used for VX monitoring except at the 0.4 $mg/m^3$ level provided by the basic M43 detector).

*k. Hydrogen flame photometric emission detector (HYFED).* The HYFED is a real-time monitoring device that can be configured for detecting agents GB and VX at a concentration of 0.001 $mg/m^3$, and mustard agents at concentrations of 0.003 $mg/m^3$, both in 1 to 2 minutes. The equipment can be equipped with an audible alarm response and a permanent record chart. Since a HYFED is actually monitoring phosphorous and sulfur (respectively, for nerve and mustards), it is highly susceptible to interference and is most useful in a laboratory.

*l. Chemical agent monitor (CAM).* The CAM is a lightweight, hand-held, gross-level vapor detector designed to respond to nerve and mustard agent vapors. It detects vapors of chemical agents by sensing molecular ions of specific mobilities (time in flight) and uses timing and microprocessor techniques to reject interferences. When the CAM detects the presence of a chemical agent vapor, a visual display will indicate the class of agent (depending on manual mode setting) and the relative concentration of agent. The CAM does not have an audible alarm. It has a real-time response capability of 1 minute for the detection of the following concentrations: 0.03 $mg/m^3$ (GB), 0.1 $mg/m^3$ (VX), and 0.1 $mg/m^3$ (mustard).

*m. Visual inspection.* A thorough visual inspection of accessible agent-filled munitions items and containers is a necessary and useful adjunct for detecting leaking agent. Special attention should be given to any wet or damp areas and painted surfaces since agent may cause blistering or peeling and discoloration of painted surfaces. All suspect liquids observed during the inspection should be tested with the M8 or M9 detector paper as a confirmatory measure. Agent leakage sometimes occurs at the juncture between the fuze or closing plug and projectile and then, owing to chemical reaction and evaporation, self-sealing of the leak may result. Inspecting personnel should be aware of this condition and recognize that any built-up area between the fuze or closing plug and projectile or presence of a dry residue may be an indication of agent leakage.

*n. Olfactory.* The fact that mustard has a recognizable odor at low concentrations is useful to augment conventional

monitoring methods. Personnel who detect the characteristic garlic odor of mustard must immediately mask and/or evacuate the area. Do not remain unprotected in the area after smelling mustard even if the odor disappears. Exposure to mustard vapors can impair the continued ability to smell its odor. Absence of odor must never be relied upon alone to indicate absence of agent.

*o. Air pumps.* Air pumps capable of achieving and maintaining the required air flow to utilize approved sampling tubes or media may be used during sampling. These air pumps must meet all other safety criteria for the place of intended use, such as intrinsically safe or explosion proof.

*p. Chloroform extraction.* Chloroform may be used as a solvent to remove potential surface contamination for laboratory analysis. However, it is not a substitute for air monitoring to establish a 3X level of decontamination. Chloroform is a suspected human carcinogen. Exposure will be minimized. Proper personal protective equipment will be used.

*q. Miniature continuous air monitor (MINICAMS).* MINICAMS is an automatic air monitoring system that collects compounds on a solid sorbent trap, thermally desorbs them into a capillary gas-chromatography column for separation, and detects the compounds with a flame-photometric detector. It is a lightweight, portable, real time, low-level monitor with alarm capability, designed to respond to 0.0001 $mg/m^3$ for GB in less than 5 minutes, 0.00001 $mg/m^3$ for VX in less than 15 minutes, and 0.003 $mg/m^3$ for mustard in less than 5 minutes.

*r. Real-time analytical platform (RTAP).* The RTAP combines a vehicle with a mounted HP 5890 dynatherm gas chromatograph with an automatic continuous environmental monitoring system that collects compounds on a solid sorbent trap, thermally desorbs them into a capillary gas chromatography column, and detects the compounds with a simultaneous phosphorous and sulfur, dual-headed flame photometric detector. The RTAP is a self-contained mobile platform that can be moved from site to site. The low-level monitor mounted in the RTAP is designed to respond to 0.0001 $mg/m^3$ for GB, 0.00003 $mg/m^3$ for GD, 0.00001 $mg/m^3$ for VX, and 0.003 $mg/m^3$ for mustard in less than 15 minutes with alarm capability. The RTAP is especially useful in onsite clearance of igloos and other suspect agent contamination sites.

*s. M22 automatic chemical agent alarm.* The M22 is an "off–the–shelf " automatic chemical agent alarm system capable of detecting and identifying standard blister and nerve agents. The M22 system is man–portable, operates independently after system startup, and provides an audible and visual alarm. The M22 system also provides communications interface for automatic battlefield warning and reporting, operable on and in vehicles, and operable in a collective protection environment and is compatible with the MICAD. The M22 system is capable of providing simultaneous, real–time detection and warning of nerve and blister agent concentrations of 0.04 $mg/m^3$ (VX) with a response time of 90 seconds, 0.1 $mg/m^3$ (GA/GB/GD) with a response time of 30 seconds, and 2.0 $mg/m^3$ (HD/L) with a response time of 2 minutes.

*t. Other methods.* Detection methods other than those listed above may be used provided sensitivity and reliability have been demonstrated and documented. Approval of such detection methods by HQDA, ATTN: DACS-SF, WASH DC 20310–0200 is required.

### 3–2. Detection equipment capabilities

*a.* Capabilities, sensitivities, and response times for detector equipment listed in paragraph 3–1 are shown in table 3–1.

*b.* Gross-level detectors are those detection devices that can provide a response within 3 minutes for high agent concentrations (above AEL). Examples include blue band tubes, detector tickets, and M8 alarms. Although a gross-level configured ACAMS can also provide rapid response, it will not provide AEL sensitivity in this configuration.

*c.* Low-level detectors are those detection devices that can provide detection capability and/or alarm for concentrations of 0.003 $mg/m^3$ for mustard, 0.0001 $mg/m^3$ for GA/GB, and 0.00001 $mg/m^3$ for VX. Examples include the bubbler, DAAMS and ACAMS for nerve and mustard, and RTMs for nerve agents only.

*d.* A gross-level alarm is a device (used in conjunction with a gross-level monitor or detector) that produces an audible sound when the appropriate level of detection above the AEL is detected. The M8/M8A1 detector/alarm is an example.

*e.* A low-level alarm is a device (used in conjunction with a low-level monitor or detector) that produces an audible sound when a predetermined level of detection below the AEL is obtained. The ACAMS, MINICAMS, and RTAP are examples.

### 3–3. Monitoring support requirements

*a. Certification.* Use of the air-sampling devices described in paragraph 3–1 will require special training of personnel to operate and maintain those devices. Personnel must be certified by the local authority for the operation and maintenance of agent monitoring systems.

*b. Calibration.* Air monitoring equipment and methods must be calibrated before use. Calibration requirements are found in the chemical agent standard analytical reference material (CASARM) quality assurance plan. (See paragraph 3–4 below.)

*c. Specific monitoring.* Detailed information on the use and maintenance of specific monitoring or air-sampling

equipment may be obtained from the Chief, Safety/Surety/Security Office, U.S. Army, Edgewood Chemical Biological Center, ATTN:AMSSB-RCB-RS, Aberdeen Proving Ground, MD 21010–5424.

### 3–4. Quality control of monitoring methods

A quality control (QC) plan will be established for all monitoring systems. Guidelines for the preparation of the QC plan are found in the CASARM quality assurance plan developed by the U.S. Army Edgewood Chemical Biological Research Research, Development and Engineering Center (ECBC).

*a.* QC procedures approved by the U.S. ArmySoldier and Biological Chemical Command (SBCCOM), CASARM Quality Assurance Office, will be established for monitoring methods and procedures to assure the system is functioning within its designed specifications.

*b.* A copy of the CASARM quality assurance plan can be obtained from the CASARM Quality Assurance Office, Commander, SBCCOM, ATTN: AMSSB-REN-C (QAK), Aberdeen Proving Ground, MD 21010–5424.

### 3–5. Detection requirements

Monitoring of agent areas is outlined in this section. (The following requirements do not pertain to laboratory operations where approved engineering controls have been incorporated. See chapter 8 of this pamphlet for laboratory requirements.) Monitoring equipment and results will be used to determine the level of protective clothing:

*a.* Where personnel are allowed to work unprotected, a continuous real-time low-level monitor with alarm will be used to assure that unprotected personnel are not exposed to agent concentrations in excess of AELs contained in AR 385–61, table 2–3.

*b.* Prior to entry each day into areas containing chemical agents or agent contamination, remote air monitoring must be performed to determine the level of protective clothing required.

*c.* For outdoor storage and operational areas, monitoring requirements must be contained in the installation/activity monitoring plan (see para 3–9). Initial monitoring may be performed while wearing level-C protective clothing.

*d.* For 3X decontaminated areas or facilities, entry monitoring is not required.

*e.* Air monitoring must be supplemented by visual observations for conditions that may indicate leakage. The frequency and scope of observations should be identified in the SOP.

*f.* Monitoring during operations is as follows:

(1) Monitoring with continuous, real-time devices with alarm capabilities will be conducted according to an approved monitoring plan (para 3–9).

(2) Air monitoring must be supplemented by visual observations for conditions that may indicate leakage. The frequency and scope of observations should be identified in the SOP.

### 3–6. Leaking containers or munitions

*a.* When agent leakage is detected, engineering controls such as filters will be used (to the extent practicable) to control the release of agent vapors and reduce agent concentrations in storage facilities. Installations or activities with storage facilities will determine the number of engineering controls (for example, through using risk analysis to find filters required to support the mission). The risk analysis should consider the number of leaker lots stored and the history of leakers in storage.

*b.* Upon detection, handling of container leaks will be as follows:

(1) Personnel in appropriate protective clothing (dependent on monitoring results) will containerize the leaking item in accordance with requirements outlined in SB 742–1 (if a munitions) or repair the item to stop the leak for a container or process equipment (see para 6–6).

(2) During chemical demilitarization facility operations, items discovered to be leaking (in the unpack area) will be expeditiously processed for demilitarization by personnel in appropriate levels of personal protective clothing and equipment. If the leaker can not be isolated, the entire on-hand quantity (in the unpack area) will be processed by personnel in appropriate levels of personal protective clothing and equipment until no munitions remain or until monitoring results verify that agent levels above the AEL do not exist.

*c.* Decontamination of confirmed liquid agent and containerization of liquid leakers must be performed in level-A protective clothing unless a risk assessment proves a safer level of protection for a specific operation.

*d.* Before unprotected personnel are permitted to go into the facility or area, the area will be decontaminated and the atmosphere remonitored to verify that concentrations of agent above the AEL do not exist.

### 3–7. Recordkeeping

*a.* Information needed for medical records of personnel will be collected, evaluated, and maintained according to DA Pam 40–8 and DA Pam 40–173.

*b.* Detailed records of the results of monitoring conducted in support of operations, (for example, ACAMS records, bubbler and DAAMS analysis results, and so forth) will be collected each day monitoring is conducted for all chemical agent operations. Monitoring records will include—

(1) The date, sample number, duration, location, and results of each sample taken.

(2) A description of the sampling and analytical methods used (or reference to publications in the open literature describing those methods).

(3) Type of protective clothing and equipment used.

(4) A roster of personnel entering the building/area. The roster will have unequivocal identifying information (for example, social security number) for individuals entering agent areas.

*c.* The official responsible for maintaining the monitoring records must be designated by the installation or activity commander, and he or she will have personnel available who are qualified to interpret and correlate the results. A summary of the rosters documenting individual agent area entrance egress level of personal clothing and equipment (PCE) worn and the records of air-monitoring measurements will be retained in accordance with section 1020(d), part 1910, title 29, Code of Federal Regulations (29 CFR 1910.1020(d)).

*d.* Employees will have access to atmosphere sampling results, recommendations, and records. Former employees or their designated representatives will also have access to such records.

### 3–8. Detector/monitor tubing

Tygon or rubber tubing will not be used on the sample inlet to a detector (for example, bubbler). Teflon (preferred), glass, or stainless steel tubing is acceptable. Total tubing length will be kept as short as possible but in no case will the length be such that the flow rate is reduced below that required by the detector for accurate sampling. Heat tracing of sampling lines is authorized to enhance sampling accuracy.

### 3–9. Monitoring plan

*a.* A monitoring plan will be developed for all toxic chemical agent facilities and approved by the installation/activity commander/program manager. Safety managers will review and concur on all monitoring plans.

(1) The monitoring plan will be in writing. Each installation shall determine and document the priority order for development of all monitoring plans. Monitoring plans will be written and implemented for all toxic chemical agent operations, as specified below:

*(a)* Fifty percent of operating areas within one year of the date of this pamphlet and AR 385–61.

*(b)* One hundred percent of operating areas within two years of the date of this pamphlet and AR 385–61.

(2) It must be based on good industrial hygiene monitoring principles.

(3) Development of the plan will be a coordinated effort involving, as a minimum, representatives from the safety office, surety office, industrial hygiene office, environmental office, and the toxic chemical agent laboratory.

(4) The monitoring plan should contain the following elements:

*(a)* Diagram of the operational site (OS) or storage facility (SF).

*(b)* Agent and munitions involved.

*(c)* Agent monitors to be used.

*(d)* Placement of sample points based on characteristics of agent and munitions, airflow patterns, and monitoring equipment being used.

*(e)* Kind of sampling lines used, to include: length, material made from, and if sampling lines are heat traced or not.

*(f)* Provisions for low-level personnel monitoring during operations must be included.

*(g)* Identification of work stations where agent leakage is considered possible.

(5) Monitoring tubing will be fixed and be heat traced if required.

*b.* Safety submissions submitted for approval will include monitoring concepts.

*c.* It is recognized that agent vapors that may exist in an operational or storage structure will not be uniformly distributed. (This is particularly true for VX and HD agents owing to their relatively low vapor pressure). In order to assure that the air samples taken in a given structure reflect a true representative sample of that environment, the positioning of the sampling points is based on airflows within the storage structure where operations are performed and on characteristics of the agent involved. Development of the monitoring plan will be in accordance with paragraph 3–9*a* , above.

*d.* The storage conditions or configurations in each storage facility differ; therefore, placement of the sampling point in each facility may be different.

*e.* Personnel involved with agent monitoring operations are to be knowledgeable of fundamental procedures of air sampling so the sampling devices will be positioned at the appropriate locations during operations.

**Table 3–1**
**Detector sensitivity and response/processing time sensitivity (mg/m$^3$)**

| Equipment | Lewisite | Mustard | GB | VX | Response time[1] |
|---|---|---|---|---|---|
| Detector paper (M8/M9) | | Positive or negative only | | | Immediately |
| Detector ticket | N/A | N/A | 0.1 | 0.4 | 3 min |
| Blue band tube | N/A | 0.5 | 1.0 | N/A | 2 min |
| Yellow band tube | 10.0 | N/A | N/A | N/A | 1 min |
| White band tube | N/A | N/A | 1. 0 | N/A | 2 min |
| M256 kit | 14. 0 | 3. 0 | --- | --- | 13 min |
| | --- | --- | 0.05 | 0.1 | 15 min |
| M256A1 | 14. 0 | 3. 0 | --- | --- | 13 min |
| | --- | --- | 0.005 | 0.02 | 16 min |
| Bubbler | 0.005 | 0.003 | 0.0001 | 0.00001 | 2 to 4 hrs |
| | 0.003 | --- | --- | --- | 8 hrs |
| DAAMS | N/A | 0.003 | 0.0001 | 0.00001 | 1 hr |
| ACAMS | N/A | 0.003 | 0.0001 | 0.00001 | 3 to 5 min |
| RTM | N/A | N/A | 0.0001 | 0.00001 | 8 to 12 min |
| DCAC | N/A | N/A | 0.001 | --- | 33 min |
| | --- | --- | 0.2 | 0.4 | 2 to 3 min |
| M8/M43 | N/A | N/A | 0.2 | 0.4 | 3 min |
| M8A1/M43A1 | N/A | N/A | 0.2 | 0.4 | 30 sec |
| CAM | N/A | 0.1 | 0.03 | 0.1 | 1 min |
| HYFED | N/A | 0.003 | 0.001 | 0.001 | 1 to 2 min |
| MINICAMS | N/A | 0.003 | 0.0001 | --- | 5 min |
| | --- | --- | --- | 0.00001 | ≤15 min |
| RTAP | N/A | 0.003 | 0.0001 | 0.00001 | ≤15 min |

Notes:
[1] Response times may vary at installations.

# Chapter 4
# Personnel Protective Clothing and Equipment

## 4–1. General philosophy and levels of protection

*a. Protective clothing and equipment.* The use of personal PCE is the least desirable method of complying with AELs (see AR 385-61, paras 2–5 and 2–6 and table 2–3). Efforts will be made to reduce dependence upon PCE in agent operating environments through the increased use of engineering and administrative controls such as ventilation, isolation, remote operations and monitoring, and elimination of all nonessential entries into agent areas. Risk assessments will reflect that these alternatives have been explored.

*b. Operational constraints when using PCE.* The use of protective clothing can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. For any given situation, equipment and clothing should be selected that provides an adequate level of protection. However, specifying too high a level of protective clothing or too low a level of protective clothing can be hazardous and should be avoided where possible.

*c. Protection levels.* The following are definitions of levels of protection for chemical workers:

(1) *Level A.* Positive-pressure, full-facepiece, self-contained breathing apparatus (SCBA), or positive-pressure supplied-air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH); totally encapsulating (vapor-tight) chemical protective suit; coveralls (optional); gloves, outer, chemical resistant; gloves, inner; boots, chemical resistant, steel toe, and shank.

(2) *Level B.* NIOSH-approved, positive-pressure, full-facepiece, self-contained breathing apparatus (SCBA); suit, hood; gloves, outer, chemical resistant; gloves, inner; boots, outer, chemical resistant, steel toe and shank; coveralls.

Or, NIOSH-approved, positive-pressure, full-facepiece, self-contained breathing apparatus (SCBA), or positive-pressure, supplied-air respirator with escape SCBA (NIOSH-approved); hooded, chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one- or two-piece chemical-splash suit; disposable chemical-resistant overalls); gloves, outer, chemical resistant; gloves, inner; boots, outer, chemical resistant, steel toe and shank; coveralls (optional); boot covers, outer, chemical resistant (optional); hard hat (optional); face shield (optional).

(3) *Level C.* Full-face, air-purifying respirators (NIOSH-approved or military mask); hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; sleeved chemical-resistant apron; disposable chemical-resistant overalls); gloves, outer, chemical resistant; gloves, inner; boots, outer, chemical resistant, steel toe and shank; coveralls (optional); boot covers, outer, chemical resistant (optional); hard hat (optional); face shield (optional).

(4) *Level D.* NIOSH-approved or military mask slung or readily available; coveralls, fatigues, or equivalent government-issued clothing (laboratories may use a lab coat); boots/shoes, chemical resistant, steel toe and shank (optional); boots, outer, chemical resistant (optional); safety glasses or chemical splash goggles (optional); gloves (optional); hard hat (optional); face shield (optional).

*d. Non-chemical workers.* Non-chemical workers can wear street clothes with a slung mask in lieu of level D.

*e. Combinations of PCE.* Based on local risk assessment deviations from the requirements stated in paragraph 4-2, combinations of PCE may be used to provide more proper and appropriate levels of protection.

### 4–2. Determination of protection required

Selection of protective clothing is a complex process, which should take into consideration a variety of factors, including hazard identification, routes of exposure (inhalation, skin absorption, ingestion, and injection) and the performance of the materials in providing a barrier to these hazards. Other factors in this selection process are matching protective clothing to work requirements and task-specific conditions, task duration, and heat stress. These factors shall be considered in the risk assessment or hazard analysis for every agent operation.

*a. Level A.* Level A is selected when the greatest level of skin, respiratory, and eye protection is required. Level A protection shall be used when:

(1) The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system on the basis of either the measured high concentrations of atmospheric vapors, gases, or particulate; or the high potential of the site operations and work functions for splash, immersion, or exposure to unexpected vapors, gases, or particulate of materials harmful to skin or capable of being absorbed through the skin in harmful doses.

(2) Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible at hazardous levels.

(3) Operations are conducted in confined, poorly ventilated areas, and the absence of conditions requiring level A have not yet been determined.

*b. Level B.* Level B is selected when the type and atmospheric concentration is known, and the highest level of respiratory protection is necessary, but a lesser level of skin protection is needed. Level B protection shall be used when the type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection.

*c. Level C.* Level C, or military mask, is selected when the concentration(s) and type(s) of airborne substance(s) are known, and the criteria for using air-purifying respirators are met (as set forth in 29 CFR 1910.134(d), or AR 385-61, table 2-1). Level C protection shall be used when the following conditions are met:

(1) The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin.

(2) The types of air contaminants have been identified, concentrations have been measured, and an air-purifying respirator that can remove the contaminants is available.

(3) All criteria for the use of air-purifying respirators or military masks are met.

*d. Level D.* Level D protection shall be used when:

(1) The atmosphere contains no known hazard.

(2) Work functions reasonably preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

*e. Respiratory selection decision logic.* Figure 4–1 can be used to identify suitable classes of respirators for protection in various situations. This chart must be used only if all applicable respiratory program requirements have been met, and it must be used in conjunction with a job hazard analysis. Supporting industrial hygiene personnel can assist in selection of suitable respirators.

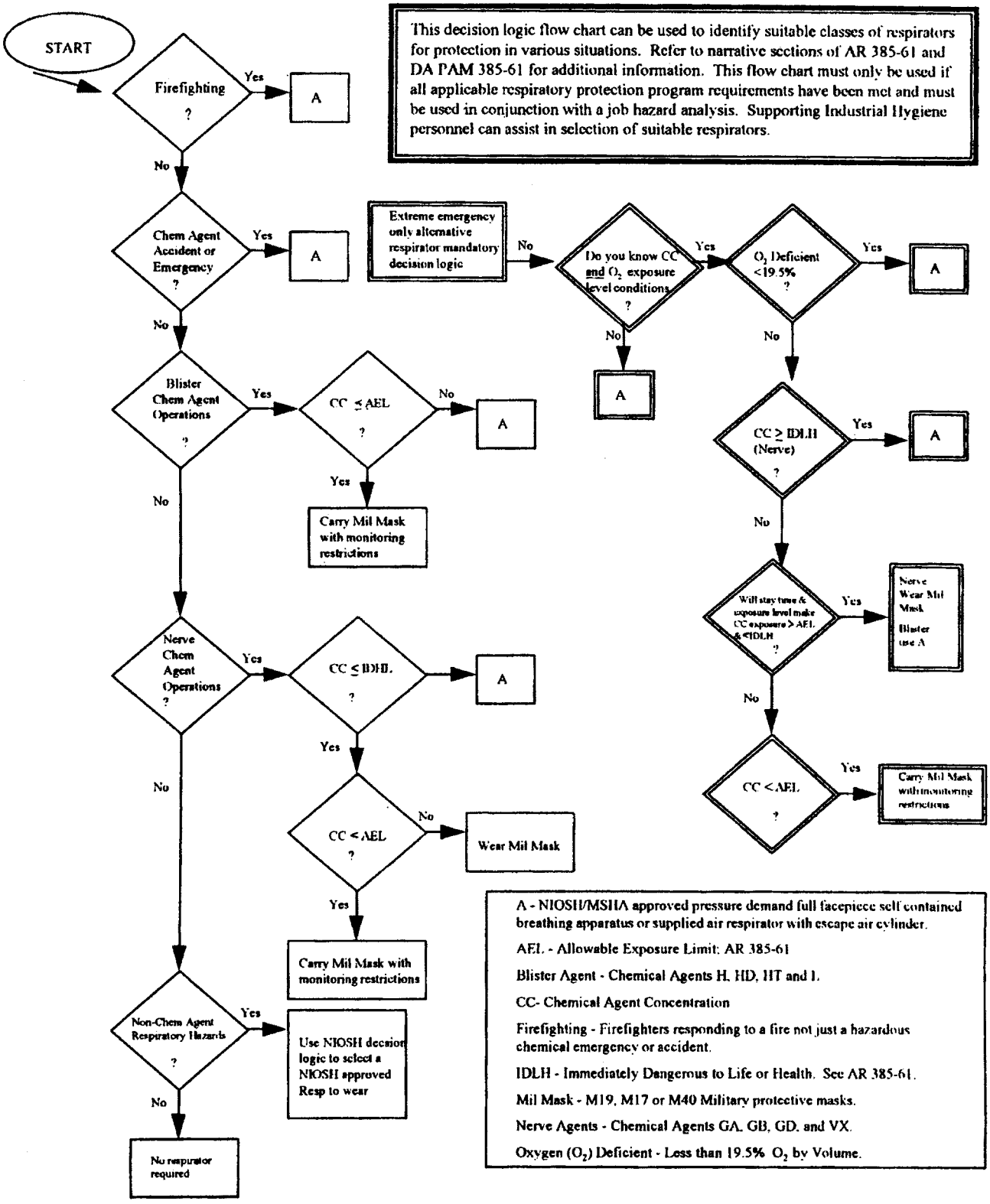



**Figure 4–1. Chemical agent protective decision logic**

## 4–3. Heat-stress plan

*a.* A heat-stress plan for chemical protective clothing will be developed for all toxic chemical agent installation/activities. Installation/activity safety managers and the local medical authority will review and concur in all heat-stress plans—

(1) The heat-stress plan will be in writing.

(2) It must be based on good industrial hygiene and medical principles.

(3) Development of the plan will be a coordinated effort involving, at a minimum, representatives from the safety office, industrial hygiene office, local medical authority, applicable employees, and their supervisors.

*b.* The heat-stress plan should contain the following elements:

(1) Training requirements, which should include—

*(a)* Heat-stress hazards (for example, heat syncope, heat exhaustion, heat stroke, and so forth).

*(b)* Proper usage of chemical protective clothing (for example, maximum stay times, and so forth).

*(c)* Signs and symptoms (so that buddies can access fellow workers).

*(d)* Importance of hydration.

*(e)* First-aid procedures.

*(f)* Effects of medications and drugs, to include over-the-counter items.

(2) Precautions and/or preventive measures, such as—

*(a)* Medical clearances.

*(b)* Personnel monitoring results (for example, worker temperature, maximum heart rates and continuous work times, rehydration rates, and duration of cooling periods).

*(c)* Determination of stay times.

(3) Responsibilities and monitoring logs. The log should contain:

*(a)* Level of protective clothing.

*(b)* Personnel monitoring results (for example, employee pulse rate and body core temperature, or equivalent, before and after work in a heat-stress environment). Personnel should be monitored periodically during operations, as stated in the hazard analysis.

*(c)* Activity level (light, moderate, heavy) and activity duration.

*(d)* Observed heat-stress symptoms.

(4) Heat-stress symptom relief measures.

(5) Emergency procedures.

## 4–4. Special requirements

*a. Requirements pertaining to Army protective clothing ensembles.* The time it takes a chemical to permeate through a protective material is the "breakthrough time." An increase in temperature generally decreases the breakthrough time. The breakthrough time must exceed the duration of use.

(1) The duration of use for the 30-mil demilitarization protective ensemble (DPE) in a mustard or Lewisite environment shall not exceed 2 hours.

(2) If the ambient temperature is 80 degrees Fahrenheit or less, the duration of use for the 20-mil DPE in a mustard or Lewisite environment shall not exceed 1 hour.

(3) If the ambient temperature is more than 80, but not more than 90 degrees Fahrenheit, the duration of use for the 20-mil DPE in a mustard or Lewisite environment shall not exceed 45 minutes.

(4) If the ambient temperature is 100 degrees Fahrenheit or less, the duration of use for the 20-mil DPE in a GB environment shall not exceed 45 minutes.

(5) If the ambient temperature is 120 degrees Fahrenheit or less, the duration of use for the 20-mil DPE in a VX environment shall not exceed 60 minutes.

(6) If the ambient temperature is 120 degrees Fahrenheit or less, the duration of use for the 30-mil DPE in a mustard environment shall not exceed 45 minutes.

(7) The time it takes a chemical to saturate an adsorptive filter is the breakthrough time. The breakthrough time must exceed the duration of use. The duration of use for the M17- or M40-series mask canister/filter shall not exceed 2 hours in an atmosphere in which the chemical agent concentration exceeds the AEL. Any M17- or M40-series mask canister/filter shall be replaced after use in an atmosphere in which the chemical agent concentration exceeds the AEL.

(8) Chemicals penetrate through zippers, seams, or imperfections in protective material. The wrist and ankle cuffs of the modified M3 butyl rubber suit shall be taped to the gloves and boots in situations requiring level B protection. Duct tape or a tape that has been tested and approved for butyl may be used.

*b. Restrictions pertaining to any protective clothing ensemble used in Army operations.*

(1) Butyl rubber burns and does not possess self-extinguishing properties. Butyl rubber protective clothing must not contact an open flame or any object that would ignite the clothing. Smoking is prohibited in the vicinity of or while wearing butyl rubber protective clothing items.

(2) If poorly conductive (insulating) materials prevent the gradual discharge of static electricity, the static electricity accumulates until it sparks. Surgical gloves and other 7-mil standard gloves shall not be worn in operations requiring electrical conductivity (including handling M55 rockets outside their shipping and firing tubes, operations in which exposed explosives or propellants are present, and operations in which the hazard analysis indicates electrostatic initiation is possible).

(3) Corrective glasses or goggles may interfere with the sealing edge of a respirator's facepiece. Systems have been developed for mounting corrective lenses inside a respirator's facepiece. Optical inserts are required in accordance with DA Pam 40-8 and DA Pam 40-173.

*c. Corrective glasses and goggles.* Contractors and off-installation personnel whose visits are transient in nature (for example, chemical agent inspectors, safety inspectors, treaty verification team members, and environmental inspectors) do not require optical inserts if they can evacuate the area safely with assistance from other authorized personnel.

*d. Spectacle kits.* Spectacle kits must be the exact types approved by NIOSH for use with that particular manufacturer's facepiece. More than one set of optical inserts may be necessary if, for example, optical inserts are returned with the mask for cleaning and sanitizing.

*e. Contact lenses.* Personnel involved in agent operations shall not wear contact lenses. Visitors and casuals who would normally don a mask for escape may wear contact lenses.

*f. Special fitting.* Requests for specially fitted butyl rubber protective clothing will be submitted to Commander, U.S. Army Natick Research and Development Command, ATTN: AMDNA-VCC, Kansas Street, Natick, MA 01760, DSN 955–2207, with detailed measurements.

## 4–5. Care of protective clothing and equipment

*a.* Personal protective clothing and equipment, chemical agent monitoring and detection equipment, and other equipment associated with chemical agent operations shall be used, inspected, tested, maintained, repaired, and calibrated according to the appropriate TMs, FMs, and manufacturer's instructions. Users of this equipment will be instructed in the proper use, inspection, testing, maintenance, repair, and calibration requirements.

*b.* Each installation/activity will establish a separate area where protective clothing will be laundered, inspected, tested, and issued. Prior to laundering, all protective clothing worn in unknown or contaminated areas will be monitored in accordance with paragraph 4-5*d*(4) below prior to delivery to the laundry.

*c.* When personal protective clothing (PPC) is used in chemical agent areas that were monitored and known to be at or below the AEL, monitoring of clothing may not be necessary. Before the decision is made not to monitor, the limitations of the air monitoring system(s), the worker's activities, and chemical agent involved must be considered.

*d.* Requirements for decontamination and laundering of protective clothing will be as follows:

(1) Reusable commercial protective clothing (CPC) will be laundered and tested in accordance with manufacturer recommendations. CPC that is contaminated will be handled as follows:

*(a)* If the CPC has been worn in a chemical agent vapor environment, it will be decontaminated using the appropriate solution (depending on type of agent), flushed with water, and monitored to the AEL. If results are negative, CPC may be sent to the laundry. If results are positive, the CPC will be further decontaminated and again tested as above.

*(b)* If the CPC has been contaminated with liquid chemical agent, it will be decontaminated using the appropriate solution (depending on type of agent), flushed with water, and monitored to the AEL. If results are negative, CPC will be disposed of. If results are positive, the CPC will be further decontaminated and again tested as above.

(2) Military protective clothing and equipment will be laundered and tested in accordance with the appropriate technical manuals (TMs), technical bulletins (TBs), and so forth.

(3) Protective clothing may be reworn after liquid contamination if the DA Safety Office has granted approval based on evaluation of test data.

(4) Monitoring of decontaminated clothing shall be performed as follows: The clothing will placed in a container and held for at least 4 hours at a location providing a temperature equivalent to ambient temperatures of worksite and laundry, but a minimum temperature of approximately 21 degrees Celsius (C) (70 degrees Fahrenheit (F)). The atmosphere inside the container will be tested for contamination with a low-level detector to verify agent concentrations are below the AEL before the clothing may be sent to the laundry facility. If agent concentrations are detected above the AEL, the clothing will be further decontaminated and again tested as above.

*e.* Each wearer is to ensure, by visual inspection, serviceability of PPC before use. Unserviceable protective clothing items must be clearly marked so as to not be mistaken for serviceable items. Serviceable protective clothing is not to be worn as a general utility item.

*f.* All PPC that has been issued must be laundered, inspected, and tested quarterly. Unissued PPC in standby status must be inspected and tested semi-annually. Masks, coveralls, hoods, aprons, and so forth may be marked by affixing flexible plastic tags or similar devices (bar code labels, for example) to the item. The marking should both identify the

item and provide means to track the recertification test date in accordance with the applicable TM. The marking method must be able to withstand decontamination and sanitizing procedures and must not damage the clothing.

*g.* Protective clothing worn in known contaminated areas and monitored to assure that agent vapors do not exceed AEL will not be reused until laundered. The laundry facility will accomplish thorough cleaning, inspection, and repair (if required). Impermeable protective clothing (excluding masks) will be soaked in hot soapy water with an alkalinity of pH 8 to pH 9 at a temperature of 79 degrees to 85 degrees C (175 degrees to 185 degrees F) for at least 1 hour without agitation. The clothing will then be rinsed with fresh water, air dried, and hung in a ventilated area (for aeration) for a 24-hour period. Liquid detergents can be used for laundering if they contain water-soluble, water-based materials. Detergents containing petroleum products or that are petroleum based may cause damage to butyl material and should not be used for cleaning or laundering. Military protective clothing that has been contaminated will be handled as specified in paragraph 4-5*d*(4).

## 4–6. Respiratory protection program

In operations where respiratory protection is required, there will be a program for selection, use, inspection, training, fit testing, and maintenance that complies with AR 11-34 and TB Med. 502. A maximum use concentration (MUC) is used to determine the upper concentration limits an air-purifying respirator can be safely used for a particular chemical agent. The respirator MUC for a given chemical agent is the assigned protection factor (APF) for the respirator multiplied by the exposure limit (AEL—worker population limit) for the chemical agent in question. If, after the APF is multiplied by the AEL—worker population limit, the product exceeds the IDLH value for the chemical agent in question, then the IDLH value shall be the maximum use concentration. Otherwise, the calculated MUC shall be used. In all cases, the most stringent or protective value will be used as the MUC. Table 2-2, AR 385-61, lists the MUC for the chemical agents.

*a. Maintenance and care of military respirators.*

(1) A facility will be established at each installation for the issue, testing, and organizational maintenance of serviceable respiratory protective equipment.

(2) Canister and filter replacements will be in accordance with the requirements of the latest TMs and SBs for the M17, and M40 protective masks. In addition to the replacement requirements for canisters or filter elements given in the appropriate TMs and SBs, the following replacement requirements will also apply:

*(a)* At least annually, with the annual cycle starting when the canister/filter is removed from the original sealed package.

*(b)* Whenever the mask becomes contaminated with liquid agent.

*(c)* As necessary to ensure the canister/filter is not used for more than 2 hours in an area known to be above the AEL.

*(d)* As prescribed by special directives for M13-series filter elements (M17-series masks) and the C2 canister (M40-series masks).

*b. Storage.* Military protective masks should be stored in the carriers provided and hung by the shoulder strap or D-ring on the carrier. Protective masks in carriers may also be stored separately in bins in an upright position. Nothing should be stored on top of the masks when they are stored in bins.

*c. Individual care.* Each individual is responsible to maintain his or her own mask. This includes a monthly detailed visual inspection. Defects will be immediately reported to the supervisor.

*d. Fit testing.*

(1) All respirator wearers using a tight-fitting facepiece respirator shall pass an appropriate qualitative fit test (QLFT) or quantitative fit test (QNFT).

(2) Fit test procedures are as follows:

*(a) Isoamyl acetate.* Test procedures for isoamyl acetate are found in section 134, part 1919, title 29, Code of Federal Regulations, appendix A, paragraph B(b) (29 CFR 1910.134).

*(b) Irritant fume.* Test procedures for irritant fume are found in 29 CFR 1910.134, appendix A, paragraph B(c).

*(c) Quantitative fit testing.* Test procedures can be found in the latest revision of the M41 operators manual for the Protective Assessment Test System. Quantitative fit testing must be used for the M40-series mask.

*e. Mask wearing procedures and leak testing.* Donning and doffing procedures for the M17- and M40-series protective masks can be found in TM 3–4240–279–10 and TM 3–4240–346–10, respectively.

## 4–7. Approved military PCE

*a. Fully encapsulating suit.*

(1) Demilitarization protective equipment (DPE), 20 and 30 mil, totally encapsulating positive pressure, air supplied.

(2) STEPO—self-contained toxicological environmental protective outfit, totally encapsulated with airline tether or self-contained air supply.

*b. Protective suits.*

(1) TAP (M3) butyl rubber ensemble with coveralls (suit is not positive pressure).

(2) MOPP IV (for use in tactical and military training environments).

(3) M3 suit with M30 hood and SCBA, pressure-demand, self-contained breathing apparatus and full-face respirator.

*c. Mask.* M17- and M40-series.

*d. Hoods.* TAP (M3A1 for M40 mask SP, M6A2 for M17 mask), M30 hood, quick doff (M40A1).

*e. Apron.* TAP (M2).

*f. Innerware.*

(1) GB/VX—coveralls, fatigues, or equivalent Government-issue clothing (with drawers and undershirt).

(2) Mustard and Lewisite—impregnated gloves, impregnated socks, impregnated underwear or impregnated protective liner, to include shirt and trousers or chemical protective undergarment (CPU) with socks and gloves. Coveralls, fatigues, or equivalent Government-issue clothing or unimpreganted underwear may be worn in addition.

*g. Microclimate controls.* Cooling vests or suits.

*h. Outer boots.* Butyl with safety toe, TAP (M2A1) NSN 8430-00-820-7295/7306.

*i. Gloves.*

(1) Outer butyl, TAP (M3, M4, gloveset) MIL Spec MIL-G12223 or 7 and 14 mil tested under an acceptable quality level (AQL) or as per ANSI Z1. 4-1993.

(2) Inner surgical or nonstandard.

*(a)* GB/VX—surgical or other equivalent nonstandard gloves will be worn underneath for protection when doffing TAP clothing.

*(b)* Mustard—surgical or other equivalent nonstandard gloves are optional.

### 4–8. Commercially available protective clothing and equipment

Note that commercially manufactured suits and masks may also be used if approved using the commercial protective clothing or mask matrices. To obtain approvals and a copy of the requirements, contact the U.S. Army Edgewood Chemical Biological Center, ATTN: AMSSB-RCB-RS, Aberdeen Proving Ground, MD 21010-5424.

## Chapter 5
## Decontamination and Disposal

### 5–1. Decontamination

The decontamination of personnel and items (for example, equipment and facilities) requires that procedures be established to ensure proper personnel training and accomplishment of desired results.

*a.* When rooms within buildings, equipment, tools, or other items or materials come into contact with liquid agent, they will be marked, tagged, or segregated to indicate the degree of decontamination undergone.

*b.* Items or materials that are known, as a result of air monitoring, or reasonably believed to present a chemical agent contact or vapor hazard will be marked to identify their level of decontamination. That items or materials have been in the presence of agent vapor does not automatically result in the item or materials being contaminated with chemical agent. Vapor exposure may warrant a marking indicating the item or materials have not been contaminated (see symbol "0" zero).

*c.* The following guidelines apply only to items or materials that have a solid physical state:

(1) An agent symbol with a single X indicates the item has been partially decontaminated of the indicated agent. Further decontamination processes are required before the item is moved or any maintenance or repair is performed without the use of chemical protective clothing and equipment. This degree generally shall be applied to the item as it stands used and subjected only to routine cleaning after use.

(2) An agent symbol with three Xs ("XXX") indicates that the item has been surface decontaminated by locally approved procedures, has been bagged or contained in an agent-tight barrier (plastic bags may be used if they have been tested and found to be effective for the purpose) of sufficient volume to permit sample air to be withdrawn while minimizing dilution with incoming air, and/or appropriate tests/ monitoring have verified that concentrations above 0.0001 $mg/m^3$ for agents GA/GB, 0.00001 $mg/m^3$ for agent VX, 0.003 $mg/m^3$ for H or L, or 0.00003 $mg/m^3$ for agent GD (unmasked worker AEL values for other covered chemicals) do not exist. Monitoring is not required for completely decontaminated and disassembled parts that are shaped simply (no crevices, threads, or the like) and are made of essentially impervious materials (such as simple lab glassware and steel gears).

(3) An agent symbol with five Xs ("XXXXX") indicates an item has been decontaminated completely of the indicated agent and may be released for general use or sold to the general public in accordance with all applicable federal, state, and local regulations. An item is decontaminated completely when the item has been subjected to procedures that are known to completely degrade the agent molecule, or when analyses, submitted through MACOM and DA channels for approval by the DDESB, have shown that the total quantity of agent is less than the minimal health effects dosage as determined by The Surgeon General. 5X condition must be certified by the commander or

designated representative. One approved method is heating the item to 538 degrees C (1,000 degrees F) for 15 minutes. This is considered sufficient to destroy chemical agent molecules.

(4) An agent symbol with "0"(zero) indicates an item, although located in an area with liquid agent and/or agent vapor, has not been contaminated (for example, it does not present an agent contact or vapor hazard).

(5) When situations, such as metallurgical investigations, require testing at locations outside the installation, the item will be disassembled and exposed to moderately high temperatures long enough to decompose agent to compounds of lesser toxicity. A temperature of 177 degrees C (350 degrees F) for 4 hours is considered sufficient to decompose agent. Samples will be taken to assure vapor concentrations do not exceed 0.0001 $mg/m^3$ for agents GA/GB, 0.00001 $mg/m^3$ for agent VX, 0.003 $mg/m^3$ for H or L, or 0.00003 $mg/m^3$ for agent GD. After test data is obtained, material will be decontaminated to 5X levels for release from Government control or placed in approved storage as 3X status. Such testing will be accomplished only at Government installations and under an SOP concurred in by the installation responsible for the item.

*d.* To identify decontaminated equipment, materials, and facilities, DD Form 2271 (or equivalent) and physical marking will be used. Items designated as 3X, which are stored in secure areas, need not be marked as long as surrounding fences or entrances to buildings in which the items are stored are locked and adequately marked. Locally approved weather-resistant tags may be attached to 3X items that are stored outside. All tags will be numbered, and the tag number will be recorded on DD Form 2271.

*e.* Decontamination of personnel, equipment, and facilities will be done as follows—

(1) For equipment decontamination (metal or other nonporous materials), appropriate tests will be conducted to assign the equipment to a level of decontamination described in paragraph 5–1*c*, above.

*(a)* X items must be handled or stored as contaminated, using adequate engineering control measures and/or protective clothing.

*(b)* 3X items may be handled or operated by agent-related personnel without restriction, except that the items may only be heated or disassembled in an area having appropriate engineering controls, to include ventilation. Maintenance or disassembly of such items will be accomplished by personnel knowledgeable in agent symptomatology and agent characteristics, and in facilities equipped with appropriate safeguards to control potential hazards associated with handling 3X items. 3X equipment may be transported under Government bill of lading or by commercial carrier, such as UPS or Federal Express, provided that—

(2) The material is shipped "Signature Secure".

(3) The exterior of the shipping container is clearly marked, "CONTAINS XXX MATERIAL, TO BE OPENED BY AUTHORIZED PERSONNEL ONLY".

(4) Certification of decontamination is provided by the shipper and accompanies the shipment. The certification should be enclosed in an envelope located on the outside of each package shipped.

*(a)* Items decontaminated to 3X level may not be released from Government control unless all Federal, State, and local provisions have been met and approval is granted by the MACOM commander. The shipper will maintain an audit trail of the documents. Nonrelated personnel should not be allowed routine access to 3X items.

*(b)* 5X and 0 items may be handled, operated, or released from Government control in accordance with Federal, State, and local regulations.

*(c)* Clean conditional material may be handled under controlled conditions when suitable precautions are taken for decomposition products. Material will not be released from Government control until decontaminated to the 5X level, except in the case of shipment by regulated carrier in accordance with applicable DOT requirements for general cargo.

(5) When facilities are decontaminated, they must be certified to the 3X level of decontamination before the release of agent operating facilities or storage facilities for Army operations of a nonrelated nature. Monitoring will be conducted with an ambient temperature of 16 degrees C (60 degrees F) or above, with the area closed, and for at least three 8-hour sample periods. Sampling periods may be consecutive or nonconsecutive. Monitoring will be consistent with the installation/activity-approved monitoring plan. All equipment that has been in contact with an agent will be removed. An assessment must be performed to ensure that the future use of the facilities is appropriate for the level of decontamination certification. The installation commander will ascertain suitability of reuse.

(6) Combustible waste contaminated with agents will be disposed of by burning in a controlled emission incinerator. If the waste has not been decontaminated to 3X levels prior to incineration this material is required to be incinerated in equipment that is designed to assure destruction of all toxic agent and control emission of gaseous products to ensure compliance with air pollution control standards and applicable Federal, State, and local environmental regulations.

(7) When decontaminating the protective clothing while it is being worn, care must be taken to prevent application of the decontaminant over the protective mask air intake. Special attention should be paid to the folded areas of the sleeves and leg cuffs of the M3 TAP suit and cuffs of the M2 butyl apron.

(8) Eye and skin decontamination will be accomplished in accordance with paragraph 7–8 of this pamphlet.

*f.* Decontaminating agents procedures are as follows:

(1) Decontaminating agents that are acceptable for decontaminating equipment or spills include, but are not limited to, the following—

*(a)* Super tropical bleach (STB) must be used as a slurry. In the dry state, STB reacts violently with liquid mustard,

producing toxic vapors and possibly sufficient heat to cause flame. STB should be immediately and thoroughly rinsed from surfaces after decontamination to preclude fire and limit corrosion.

*(b)* HTH must be used as a solution. In the dry state HTH reacts violently with liquid mustard, producing toxic vapors and possibly sufficient heat to cause flame.

*(c)* Commercial liquid bleach (nominal 5 percent solution of sodium hypochlorite).

*(d)* A 10 percent sodium hydroxide or sodium carbonate for agent GB. Sodium hydroxide will not be used as a decontaminant on agent-filled aluminum munitions or containers such as the Weteye bomb or the exposed warhead (M56) of a M55 rocket. Sodium hydroxide reacts with aluminum, generating heat and hydrogen gas and causing deterioration of the aluminum. When mixing a sodium hydroxide solution, always add the sodium hydroxide to the water to prevent spattering from the heat of reaction.

(2) Additional issues for selection, maintenance, and use of decontaminating agents include the following:

*(a)* Supplies of chemical decontaminating materials that are adequate to meet the needs of each installation or activity assigned a chemical mission must be maintained at locations immediately available to each operation. Selection of the decontaminant, based on the nature and extent of contamination involved, will be made in accordance with requirements outlined herein.

*(b)* Because of damaging effects to butyl rubber, DS2 is not an appropriate decontaminant for use at chemical agent installations, except as approved by the local safety office for small and controlled quantities such as might be used in laboratories or tests. (See safety precautions, FM 3–5.)

*(c)* The chlorine-based decontaminants mentioned below must be checked upon receipt and at least annually, in accordance with quality assurance procedures, to ensure deterioration has not occurred. The minimum acceptable chlorine content for STB is 10 percent, 30 percent for HTH, and 3 percent for sodium hypochlorite solution. Sampling procedures should be in accordance with MIL STD 105E. Analysis should follow procedures referenced in specifications for the decontaminant involved. Testing requirements above apply to decontaminants stored in original, closed containers. If decontaminants are kept in open containers or receptacles, they need to be checked or rotated at least once a month.

(3) Waste material from the use of decontaminating agents will be managed in accordance with applicable Federal, State, local, or host nation standards regarding the management and disposal of hazardous wastes.

*g.* Decontamination equipment procedures are as follows:

(1) *Mustards, Lewisite, and VX.* Equipment provided for decontamination of mustard, Lewisite, or VX spills or leaks from facilities and equipment will be filled with the required amount of water prior to operations, and a predetermined amount of STB or HTH will be stored at the same location as the decontaminating equipment for mixing of the water-bleach slurry upon notification of an agent leak or spill. The slurry mix will not be held in the M12A1 apparatus for more than 4 hours to avoid corrosion and plugging of equipment components. After each use, the equipment must be drained and flushed with clear water before returning it to a standby condition.

*Note.* WARNING. Ethylene glycol (antifreeze) will not be used to prevent freezing when chlorinating compounds STB or HTH are being used as the decontaminating agents. This combination (STB/antifreeze or HTH/antifreeze) liberates heat and gas in an exothermic reaction, which would increase pressure to the rupture point in a closed system such as a M12A1 decontaminating apparatus.

Additional information for the M12A1 decontaminating apparatus is contained in the TM 3–4230–209–10.

(2) *GB.* Equipment provided for decontamination of GB spills or leaks will be precharged (or capable of being charged within 40 minutes) with a 10 percent sodium hydroxide (caustic soda) solution and be ready for use at all times when such operations are in progress. Equipment utilized for caustic soda solutions should be constructed of steel or stainless steel (never aluminum). The M12A1 decontaminating apparatus storage tank may remain filled with a caustic soda solution for extended periods of time (for example, 2 to 3 months), provided that it is protected against freezing, and the pump unit is thoroughly flushed after each use, as described in the appropriate technical manuals. During periods of cold weather, ethylene glycol (without additives) may be added to the caustic soda solution to prevent freezing. For those situations involving only contamination, in which the likelihood for hazardous release outside the immediate operating or storage area does not exist, a sodium carbonate solution heated to 70 degrees F may be used (when temperatures are above freezing) for decontamination. Examples of appropriate situations include contaminated laboratory equipment or personal protective equipment and leaks detected during routine surveillance of storage operations.

(3) *Training.* Each installation will be responsible for training designated personnel to operate this equipment in event of an emergency. This equipment need not be manned with operating personnel until decontamination is required.

(4) *Maintenance.* Operating supervisors will be responsible for verifying the serviceability of decontaminating equipment by inspecting the equipment prior to starting operation and periodically thereafter.

(5) *Positioning of equipment.* Decontamination equipment will be positioned according to the following criteria:

*(a)* A single piece of equipment may be used to provide coverage to multiple operations performed in the same general area, providing that the potential for major spillage is remote (for example, storage leak testing, shipping, inspection, and minor maintenance).

*(b)* A single piece of equipment (or a source of decontaminating solution) will be provided for each operation where the potential for massive spillage exists; for example, renovation, modification, demilitarization, and agent transfer in sufficient amount to cope with the spill potential involved.

(6) *Decontamination pans.* When agent contamination is found, step-in decontamination pans, containing a 10–percent HTH solution or other suitable decontaminating solutions, should be placed at exits from agent operating areas requiring the wearing of butyl boots. Household bleach (5 percent solution of sodium hypochlorite) may be used for decontamination during exits from agent operations.

(7) *Protection of spills.* Plastic sheets will be available at the operational site to cover spills until the decontamination equipment arrives at the spill location. If an agent spill occurs in an area that is ventilated through charcoal filters, the use of the plastic sheets or bags is not required.

## 5–2. Disposal

*a. Disposal in general.* One method of disposal of agent is by incineration using specially designed incinerators. However, other methods are being considered for various stockpile agents. Regardless of the decontaminating method used, any decontaminated waste will be disposed of in accordance with appropriate provisions of Federal, State, and/or local Resource Conservation Recovery Act (RCRA) or other applicable laws or regulations. Procedures for such disposal will be approved by the installation environmental coordinator. When soil is contaminated by liquid agent in outdoor work/storage sites it will be decontaminated and the surface layer removed to a depth where the AEL is not exceeded. The removed soil will be processed in accordance with Federal, State, and/or local laws and regulations. Emergency disposal operations may be conducted free of the prior approval restrictions imposed by Public Laws 91–120, 91–121, 91–441, and this pamphlet.

*b. Detonation.* Routine detonation of items containing or contaminated with agents above 3X levels is prohibited. This does not limit emergency destruction of such items in accordance with AR 75–15 and Public Laws 91–121 and 91–441. For detonation operations the following apply:

(1) Appropriate decontamination equipment will be available.

(2) Downwind, low-level monitoring of the destruction site will be accomplished before, during, and after destruction. The number and location of samplers will be based on the downwind hazard prediction for the total quantity of agent possible to be contained in the item being destroyed.

(3) A hazard analysis will be conducted with appropriate safety zones established.

(4) Monitoring of the destruction site, soil, or surface is required to verify absence of residual contamination.

(5) Explosive safety standards required by AR 385–64 will apply.

*c. Burial.* Material, equipment, and clothing that has been decontaminated to at least the 3X level may be buried, with specific approval from the MACOM, only in a landfill that has been approved by the Environmental Protection Agency (EPA) or is under an authorized state RCRA program for hazardous waste disposal. Other existing locations—where agent-filled munitions and agent contaminated items or material have been previously buried—will be appropriately marked with permanent signs. Measures will be taken to prohibit unauthorized personnel from entering the area. Records identifying the type and quantity of items buried will be permanently maintained, and the burial site will be noted on installation master drawings. Such land may not be excessed.

*d. Prohibitions.* Open-pit burning or burying of items containing or contaminated with chemical agents, in any quantity, is prohibited, except as in 5–2*c*, above. No agent will be disposed of unless the agent has been detoxified or made harmless to humans and the environment, except where emergency disposal is necessary to safeguard human life.

*e. Chemical neutralization.*

(1) Where containment facilities are available, chemical neutralization of agent may be used. Each installation will determine the capability to neutralize agent safely and establish local limits on chemical neutralization. The neutralization process will be conducted in ventilated areas with a filtration system used to remove traces of agent from the effluent air. The thoroughness of the neutralization process will be verified by laboratory analyses to assure that agent concentration above the emergency drinking water standards in TB Med 577 does not exist, and that the results are documented. All Federal, State, and local provisions and standards must be complied with.

(2) Where containment facilities are not available, chemical neutralization will not be used, (except when detoxification is required under valid emergency conditions, including as a result of an accident). If emergency disposal is required without detoxification of the agent, procedures will be reported as required by Public Law 91–441.

*f. Incineration.* Incineration will be accomplished using an EPA- or State-approved permitted emission incinerator, appropriate engineering controls, and continuous monitoring to assure emissions are within source emission limits (allowable stack concentrations) in table 2–4 of AR 385–61. For incineration of 3X material, engineering controls and continuous monitoring may not be required if initial and periodic monitoring of effluent indicates that the levels are acceptable.

*g. Storage.* Storage of wastes resulting from operations specified herein will be in accordance with Federal, State, and local RCRA regulations. All materials storage procedures will be approved by the installation environmental coordinator.

*h. Former chemical agent installations (AR 50-6).* Termination of the chemical agent mission does not abrogate the

responsibility of an installation to maintain a safety program commensurate with the remaining mission. Until such time as ruling of agent-free status is issued (AR 50–6), a chemical safety plan that describes the specific safety requirements for operations in and near the decontaminated facilities will be in effect.

## Chapter 6
## Safety Criteria for Agent Activities

### 6–1. The cardinal principle

The cardinal principle to be observed in any location or operation involving explosives, ammunition, or toxic chemical agents is to limit the potential exposure to a minimum number of personnel, for a minimum period of time, and to a minimum amount of the hazardous material consistent with safe and efficient operations.

### 6–2. Risk management and assessment

*a.* The U.S. Army five-step risk management process is integrated into all chemical operations.

*b.* Steps one and two of the five-step risk management process consist of the risk assessment approach. This approach provides a valid method of eliminating/reducing the unique hazards associated with agent operations. For this reason, installation commanders will adopt a risk assessment approach in accordance with their written system safety engineering and management program. The risk assessment developed as a result of the identification of a unique hazard, and the safety and occupational health standards contained in AR 385–61 and this pamphlet will be used to develop procedures for each agent operation.

### 6–3. Standing operating procedures

*a.* Chemical agent SOPs are not required to be in a specific format, but they must address, as a minimum, the following elements:

(1) Protective clothing.
(2) Monitoring.
(3) Tools and equipment.
(4) Operating steps or procedures.
(5) Emergency response.
(6) Decontamination information.
(7) Operational hazards.

*b.* A hazards analysis will be conducted for all operations involving chemical agents or whenever there is a change in production, process, or control measures that could result in an increase in vapor or liquid concentrations of chemical agents. A written record of the hazard analysis will be made and retained with the record copy of the SOP. Analysis must include description of the operation, locations identified within the operation, effects of hazards on the operation, risk assessment code, and recommended actions to reduce the hazards. Hazard analyses should consider previous incidents that had a likely potential for adverse consequences in the workplace. Consequences of failure of engineering and administrative controls must also be addressed. A written plan outlining employee participation in the development and implementation of the hazard analysis and in development of other process safety management elements is required. Employees and their representatives will have access to the information developed. Applicable portions of section 119, part 1910, title 29, of theCode of Federal Regulations (29 CFR 1910.119) will be applied. All hazard analyses and SOPs will be reviewed and concurred in by the activity/installation safety manager.

*c.* SOPs will be prepared in advance of operations and be in sufficient detail to outline the necessary safety and operational requirements, including inspection of all facilities and equipment involved. Copies of the applicable SOP will be available at the worksite for personnel information, guidance, and compliance. SOPs will be certified for their accuracy at least annually by their proponent. Self- and buddy-aid procedures may be included or the location of those procedures referenced. SOPs will address those elements detailed in AR 385–61 (para 2–4*e*).

*d.* Personnel limits will allow for necessary supervision and for reinforcing requirements contained in the SOP. Supervisors will be responsible for monitoring all the areas and enforcing requirements outlined in the SOP. Explosive limits will be included for all operations in which explosives are involved. Concurrent, unrelated work in an area of operation (worksite) that involves toxic chemical agent or agent munitions is prohibited.

### 6–4. Change-house facilities/areas

Facilities must be provided for showering and changing clothes. This may be a designated area or a change-house. The following criteria apply to the location, design, and operation of change-house facilities:

*a.* Change-houses servicing a chemical area will be located at the maximum practicable distance from the storage or operating area; however, as a minimum, the separation distance for related explosives operations will be unbarricaded intraline distance based on the maximum quantity of explosives that would be involved at the controlling location.

*b.* Change-houses servicing chemical areas will be separated from those servicing other areas. This separation may be accomplished by the use of a separating wall if the building is sited at the appropriate inhabited building distances from each area it serves.

*c.* Change-houses servicing chemical areas will have, as a minimum, the following facility design requirements:

(1) Building air flow will be from the nontoxic or clean area toward the potentially contaminated areas.

(2) The building layout will provide clearly defined and separate areas (by walls, physical barriers, or other positive tangible means) for segregating clean and potentially contaminated areas.

(3) An area or room will be provided for decontamination and removal of contaminated, potentially contaminated, or soiled protective clothing. Receptacles with tight-fitting covers or plastic bags will be provided for collecting such clothing destined for thorough processing at the cleaning facility. Where practicable, external openings should be provided in the facility for removal of such clothing.

*d.* Change-houses/areas may be provided as an integral part of the operating building. In such cases the following provisions apply in addition to those specified in paragraph 6–4*c*, above:

(1) The building design (for example, floor slope, drainage, air flow, and so forth) will preclude agent migration into the change-house/area.

(2) A means of direct egress (that is, one that does not pass through agent operating areas) to the exterior of the building or outside the no-effects zone for the given operation will be provided for personnel.

(3) Change-house/area must be separated from explosives hazards by a wall/barrier that provides protection equivalent to that provided by unbarricaded intraline distance (UBID) if either of the following applies:

*(a)* Personnel other than those directly associated with the operation use the facility.

*(b)* The facility operates on a multiple-shift basis.

*e.* For operations in the field and in operating buildings without an integral change-house/area, provisions must be made for decontamination and removal of contaminated or potentially contaminated protective clothing at or adjacent to the worksite. Provisions for collecting such clothing for processing at the laundry facility will be provided as specified in paragraph *c*(3), above. Agent-contaminated protective clothing will not normally be worn or transported to change-houses/areas.

*f.* Change-houses/areas should include adequate toilet and shower facilities for all personnel involved in chemical agent operations.

*g.* Utilization of chemical change-houses/areas will be controlled by locally approved regulations.

## 6–5. Operational agent facilities

AR 385–16 (System Safety Engineering and Management) is a useful regulation for ensuring facility system safety in design, construction, and modification of agent operations, facilities, and equipment. The following safety features will be included in the design and construction of operating agent facilities and equipment:

*a.* The exhaust ventilation system will be designed so that toxic agents or other chemical compounds in amounts harmful to humans or the environment are not discharged to the atmosphere. To achieve this, it is necessary to incinerate, to filter, or to scrub with a neutralizing solution all exhaust air from such areas before it is discharged. If agent contamination is not reasonably expected, an alternative to filtering or scrubbing is to monitor the exhaust stack effluent to prevent continued release of agent vapors. Exhaust stacks will comply with the latest guidelines contained in the American Conference of Governmental Industrial Hygienists (ACGIH) industrial ventilation manual. When a single filter or scrubber is employed, a gas life indicator or another suitable method to predict filter life will be used to allow filter change out before allowable source emission levels are exceeded. When high concentrations of agent are involved and breakthrough of agent can be expected, preprocessing through a series of scrubbers or use of redundant (series) filters shall be employed. Where ventilation is a sole or primary method of personnel protection, backup emergency power (automatic start generator) or other fail-safe systems should be installed to prevent a release of agent in the event of an unplanned power outage. Exhaust ventilation system effectiveness will be measured (air velocity, static pressure, vacuum, and so forth) at least every 6 months or prior to initiation of operations when any changes in production, process, or control are made. New construction will meet all applicable DOD and Army regulations (for example, Corps of Engineers and National Guard design specifications, and so forth), appropriate national consensus standards (for example, the criteria of the American Conference of Governmental Industrial Hygienist (ACGIH), the National Fire Protection Association (NFPA), and American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)). The U.S. Army Center for Health Promotion and Preventive Medicine, Industrial Hygiene Program, Aberdeen Proving Ground, Maryland 21010–5424 is a good source of information for assistance in application of facility construction criteria and concept development and design review services because specific construction criteria must be adapted to protect the health of workers and the surrounding communities in chemical-agent situations.

*b.* In order to reduce the number of personnel that could be exposed to agent, each facility will be designated to function with as few personnel as possible and with hazardous areas isolated from safe areas.

*c.* The area where munitions are filled, closed, punched, drilled, or drained must be maintained under negative pressure during agent operations and for as long as agent levels would exceed the level in AR 385–61, table 2–3, without the negative-pressure or ventilation system in operation.

*d.* To further decrease the possibility of exposure to agent, the facility must be designed so that equipment and munitions will require only minimum handling by operational personnel.

*e.* There will be a method of coordinating activities in the hazardous area with those in the nonhazardous area. This may be an electronic communication system, a system of observation windows, or other equivalent methods.

*f.* Exits must be sufficient in size and number to permit rapid evacuation of all personnel in the event of fire, explosions, or spills.

*g.* In manufacturing plant types of operations, in laboratories that utilize large quantities of agent (1 liter or more), and in places where agent emergency showers are located, floor drains will be installed. All drains that could possibly receive agent will be provided with liquid seals (traps), and they should be connected to a sump or collection tank where liquid can be sampled for agent analysis and further neutralized if agent is present. Waste must be retained within the facility sump until tests confirm that the agent has been completely neutralized by a process that has been verified by laboratory analysis to reduce agent levels below drinking water standard. (See also para 5–2*e*(1).) Vents from holding tanks and drain lines must be filtered to preclude agent leakage. Testing is not required for facilities specifically approved for the destruction of chemical agent.

*h.* Wherever floor drains are provided, all floors will slant toward drains at an incline sufficient to provide surface drainage.

*i.* A supply of decontaminating agents, and equipment for applying them, must be immediately available for routine decontamination procedures and emergencies. Since most construction materials absorb agents to some extent, decontamination must be prompt and thorough.

*j.* Lightning protection is required only on operating buildings, magazines, or igloos in which agent-filled items with explosive components are manufactured, filled, stored, or otherwise processed.

*k.* The electrical system will be designed so that major pieces of equipment can be energized or de-energized either directly or remotely. In any operation where a power failure would give rise to a hazardous situation, an auxiliary electrical power source or a fail-safe system will be used.

*l.* Construction materials such as wood or other porous materials that absorb agent are difficult to decontaminate and should not be used in the construction of buildings where agent is to be stored, handled, or processed. Nonporous steel, glassbrick, or reinforced concrete are approved materials. Stainless steel and enameled steel are good materials for doors, cabinets, and furniture in agent areas. Existing facilities constructed of porous materials may be used provided the porous materials are sealed with approved epoxy paint such as MIL-C–22750 and use of the facility is approved by the MACOM. Wood or other porous materials may be used in temporary structures (for example, cubicles, and so forth) provided the porous materials are sealed with epoxy paint, use of the temporary structure is approved by the local commander, and decontamination and disposal plans are formulated.

*m.* When an agent facility is designed, the buildings and/or equipment will be arranged according to the sequence of operations. Such an arrangement will make it possible to keep the handling of agents at a minimum, and it will minimize the necessity for transferring of agents through nonagent areas. On the basis of the prevailing winds in the area, the manufacturing buildings, operational areas, or storage areas will be located downwind from administrative buildings, public highways, and inhabited buildings, insofar as practicable.

*n.* Fire protection will be provided as required by AR 420–90, DA Pam 385–64, chapter 3, and local requirements.

*o.* Eyewash fountains and safety showers that meet OSHA requirements must be readily accessible to all work stations in operating buildings. Portable showers and eyewash equipment should be provided in outside or remote operating areas. The portable eyewash fountains should not be used in place of the permanent one within agent facilities. The installation will take all necessary measures to ensure portable showers and eye washes used in outside agent operations do not freeze up and become inoperable during cold weather conditions and that tempered water is used.

*p.* Air-supply systems used to provide breathing and cooling air for air-supplied protective suits will be tested to ensure that they conform to or exceed the requirements for grade-D air. The specifications are included in ANSI CGA–7. 1 (latest revision), Commodity Specification for Air, and CGA Pam G–7.1, Commodity Specification for Air, available from the Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202. Air can be supplied by compressor systems, motor-blower units, or compressed breathing air cylinders.

*q.* An audible area alarm should be installed to provide an immediate warning to all personnel in the vicinity of the operational facility and within the 1–percent lethality distance based on the maximum credible event (MCE) (paras 11–3 and 11–4) in the event of a known or suspected agent release.

*r.* Local exhaust ventilation is the most effective and preferred method of controlling agent vapor; however, dilution ventilation may be required for specific conditions where local exhaust ventilation is not practical. In general, ventilation airflow should be from clean areas to areas of increasing potential or actual contamination. Each filter bank comprising the ventilation system will be provided with a means to measure differential pressure across each bank of filters. Airflow gauges or alarms should be used to verify proper ventilation conditions. Regardless of the type of ventilation system used, the design should be based on recommended practices published in the latest edition of *Industrial Ventilation*, available from the American Conference of Governmental Industrial Hygienists, Inc., 1330 Kemper Meadow Drive, Suite 600, Cincinnati, OH 45240–1634. The U.S. Army Center for Health Promotion and

Preventive Medicine, Industrial Hygiene Program, Aberdeen Proving Ground, Maryland 21010–5422 is a good source of information for assistance in application of facility construction criteria, concept development, and design review services because specific construction criteria must be adapted to protect the health of workers and the surrounding communities in chemical agent situations. Agent work areas will be provided with an appropriate ventilation system to—

(1) Collect and exhaust agent vapors from the work area.

(2) Provide mixing of air, which is essential for monitoring work areas with agent detection devices.

(3) Provide a negative pressure within the work area to eliminate escape of agent vapors.

*s.* Gloveboxes used for containment of chemical agent will provide the following:

(1) Pressure within gloveboxes will be a minimum of 1/4 inch of water gauge below that of surrounding areas.

(2) Makeup air or inert gas should be allowed into the glovebox to prevent stagnation and buildup of agent concentrations. The makeup sources will be protected by filters, backflow dampers, or other means.

(3) Temporary openings into a glovebox (such as during glove replacement) must maintain an inward flow of at least 90 linear feet per minute (fpm) if agent is contained in the glovebox.

(4) If a glovebox has large or permanent open areas, it should be considered a ventilation hood and subject to criteria in paragraph 8–3*b* of this pamphlet.

(5) If a toxic agent operation will involve pressurized vessels within the glovebox, that glovebox will be capable of containing the maximum credible pressure release from the vessels and will be leak-tested prior to each operation.

*t.* In the event explosives are present, all applicable safety rules for handling such items will be followed.

*u.* Additional guidance is in appendix E.

## 6–6. Criteria for containment of operations

*a.* Certain operations involving filling of munitions, renovation, maintenance, and demilitarization of agent-filled munitions assembled with explosive components may be inherently more hazardous than other operations. Appropriate containment is necessary for the protection of the employees performing such work and for the protection of other employees at the installation who are not associated with the work as well as the general public. Personnel responsible for planning, designing, and accomplishing the operations must assure that adequate safety is provided by incorporating the appropriate type of hazard containment. The various circumstances and facilities that may be encountered at such operations prevent publication of specific detailed containment requirements for each agent, each ammunition, and each operation. Nevertheless, the general principles of hazard containment are addressed in this section and will be normally incorporated in operations such as manufacture, disassembly, demilitarization, and disposal.

*b.* No containment is required for operations associated with storage activities. Examples of such operations include shipping, storing, inventory, receiving, rewarehousing, minor maintenance, surveillance inspection, repair, and encapsulation. Minor maintenance of agent munitions is any function involving preservation and packing that does not involve any internal component. Emergency transfer in the event of agent leakage is also permitted without containment. These activities normally present an acceptable degree of safety, except in the event of an agent leaker, and then the increased hazard is only to those operating personnel in close proximity to the leaker. In the event of a leaker, the use of personal protective clothing and equipment is mandatory to protect operating personnel during decontamination procedures, repair, encapsulation, or agent transfer from the leaking ammunition or container. Operations requiring no containment when accomplished by normal methods include the following:

(1) Removal of increments, primers, and ignition cartridges from mortar ammunition.

(2) Drilling of set screws and stake marks when positive stops are provided to limit the drilling depth in order to preclude contact with the explosives and prevent agent release.

(3) Removal, installation, and/or replacement of fuzewell plugs, supplementary charges, bursters, and so forth, after the burster well has been sampled within vapor containment and found to be free of agent.

*Note.* CAUTION. If components are stuck and require abnormal methods to remove, paragraph 6–6*c*(1), below, applies.

*c.* The two types of containment are total containment and vapor containment. With both types of containment, the containment structure or facility will be equipped with a means of entrapping or detoxifying the evaporated or aerosolized chemical agent. This is accomplished through the use of filters, scrubbers, incinerators, or other appropriate means. The types of containment are described as follows:

(1) *Total containment.* Total containment will be provided by equipment or facility of a tested design that assures sufficient capacity and strength to contain all combustion and detonation gases, fragments, and agent from the largest explosion that could occur based upon the propagation characteristics of the ammunition.

(2) *Vapor containment.* Vapor containment will be provided by facilities or equipment of a tested design that will prevent the release of detectable quantities of agent by the use of one or more of the following: negative pressure, controlled pressure, single- or multiple-walled enclosures. Designs for such vapor containment are usually tailored to the operation involved. Examples are hoods, gloveboxes, cabinets, rooms, buildings, and double-walled pipes.

*d.* The selection of the type of containment is dependent upon the nature of the operation involved. Types of containment for various operations are total containment and vapor containment, Total containment is required for

those operations involving ammunition that contains explosive components and toxic agents whenever the operation may subject the explosive components to a potential initiating stimulus. Vapor containment is required for those operations involving intentional release of toxic agents in bulk or in ammunition containing both toxic agent and explosive components wherein the operations do not subject the explosive components to a potential initiating stimulus. Examples of disassembly, demilitarization, and disposal operations that normally require total or vapor containment are listed in (1) and (2) below. For situations not specifically listed, adherence to the aforementioned principles will provide the necessary guidance for proper selection of the required type of containment.

(1) Operations requiring total containment include—

*(a)* Machine tool operations; for example, cutting, sawing, drilling, punching, and shearing of ammunition if the operation requires the cutting tool to remove or displace metal before or after contact with the explosives.

*(b)* Situations in which the ammunition arming and functioning environments can be duplicated by the sequence of operations or process machinery.

*(c)* Disassembly of armed or possible armed ammunition, except for application of explosive ordnance disposal (EOD) render safe procedures by trained EOD personnel.

*(d)* Disassembly of explosive components from ammunition where there is significant evidence of damage, exudation of explosives, corrosion, or deterioration, unless testing, analysis, or evaluation determines that total containment is not required.

*(e)* Disassembly of explosive components from ammunition where undue force is required to accomplish the disassembly. For example, tools used for disassembly must not apply significantly greater leverage, torque, extraction, or compression force than those required for the assembly. Undue force is any force that could cause any deformation of the munitions item (other than minor surface deformation) or could reasonably be expected to cause any explosive component of the explosive train to be damaged and/or initiated.

(2) Operations requiring vapor containment include—

*(a)* Machine tool operations (for example, punching, drilling, or sawing only for the purpose of removing agent from ammunition, providing the equipment is designed to preclude contact of its cutting tool with explosives).

*(b)* Burster well removal after removal of explosives components.

*(c)* Transfer of agent from bulk storage tanks, 1-ton containers, or ammunition into holding tanks, chemical detoxification reactors, incinerators, or similar processing equipment that may be found in a production, demilitarization, or disposal operating line.

*(d)* Other than normal surveillance inspections, removal of fuzes, lifting plugs, or other components that result in access to areas of munitions where agent may be present.

*Note.* CAUTION: In the event bursters or other explosives components are stuck and require abnormal methods for removal, the requirements in paragraph *c*(1), above will be followed or the agent will be removed (drill, drain, and detoxify) and the burster destroyed by demolition methods.

*(e)* Cleaning and derusting burster wells by hand or with hand-operated power tools.

*(f)* Opening containerized leaking munitions.

## 6–7. Leaking munitions and containers

*a.* Before starting operations, all agent-filled munitions and containers will be monitored for agent or contamination and every precaution will be taken to assure that agent exposure will not occur during operations. In the event a leaker or contaminated item is discovered during the monitoring operations or in subsequent operations, the immediate area will be evacuated. Except for leaker removal and decontamination activities, re-entry into the area will not be permitted until appropriate corrective actions have been accomplished:

(1) The area monitored to assure completion of decontamination.

(2) The area certified to be below the AEL specified in AR 385–61, table 2–3.

*b.* Upon discovery and confirmation of a leaking item, the crew will exit the location and notify the central control point. Prior to reentry, the area will be monitored to determine the level of protective clothing required. If no real-time low-level continuous monitoring with alarm capability is available, entry will be conducted in level A or equivalent. Steps will be taken to reduce the levels of agent contamination until such time as containerization or demilitarization processing can be resumed. Leaking munitions in a chemical agent disposal facility should be processed in accordance with established chemical demilitarization SOPs. Leaking munitions in a storage or transport situation will be containerized in accordance with SB 742–1.

## 6–8. Required chemical safety submissions

*a.* Site plans, hazard-zone calculations, and safety submissions for all proposed lethal and incapacitating chemical agents and munitions operations will be submitted as specified in AR 385–64. Safety approval of site plans will be obtained prior to the initiation of final design. Approval of final safety submissions will be obtained prior to contractual obligation for construction or the initiation of Army construction work. Routine surveillance operations conducted

according to SB 742–1 are excluded. All required chemical safety submissions must have the concurrence of the activity/installation safety manager.

*b.* Hazard-zone calculations (required for site plan approval) will be based on a realistic MCE that has a reasonable probability of occurring. When explosive components are present, the MCE will be based on the maximum credible effects given the detonation of the most disruptive explosive component. The MCE for site plan approvals will be based on operations conducted. MCEs will be derived using requirements in AR 385–61, chapter 2.

*c.* Site plans, hazard-zone calculations, and safety submissions will be prepared or formally endorsed by the installation safety director to assure that appropriate safety standards and necessary precautions are incorporated.

*d.* Submissions must contain sufficient copies of enclosures so that the original and one copy reach U.S. Army Technical Center for Explosive Safety (USATCES), ATTN: SIOAC-ES, 1 C Tree Road, McAlester, OK 74501–9053. In order to facilitate thorough review and obtain final approval, the following minimum information is required:

(1) For site approval—

*(a)* A narrative giving sufficient information concerning the mission and function of the various components of the operation for reviewers to have a general understanding of the project. Narrative will include an exact definition of operations to be conducted. It should be noted that the site is only approved for those operations listed and any other operations would require an additional submission. This is necessary because the MCE could change with changing operations, resulting in a different 1-percent lethality distance.

*(b)* Hazard-zone calculations prepared by the submitting installation clearly stating the MCE (see AR 385–61) with all supporting assumptions and rationale and containing 1-percent lethality distances calculated in accordance with DDESB Technical Paper No. 10. The use of the AMC Handbook for Chemical Hazard Prediction, or an approved computer program consistent with DDESB Technical Paper No. 10, should be used to facilitate calculations.

*(c)* Appropriately scaled drawings (1 inch equals 400 feet) showing the 1-percent lethality distance established by the hazard-zone calculations. Drawings should also show information indicating explosive classes and limits of neighboring explosive facilities and 1-percent lethality distances for neighboring chemical facilities.

*(d)* Information required by AR 385–64.

*(e)* If building configurations such as the use of collective filtering systems are used in determining the MCE, a general description of the system and systems specifications will be furnished.

*(f)* Evacuation procedures for personnel located within the public access exclusion distance. (See chap 11.)

(2) For safety submission and final safety approval, all of the above information required, and the following additional information, as a minimum, should be submitted: general plan views of buildings or the site, as appropriate, showing location of first-aid equipment; emergency showers; hot line; personnel decontamination line; filter systems; mask area; level A protection areas; equipment testing and approvals, as appropriate; communications systems; ventilation systems, and specifications; wind speed indicators; command post; television monitors; security guards; fencing; and other items as appropriate. Information previously submitted with a site plan need not be resubmitted unless changed; however, the source of the information should be explicitly referenced.

*e.* Site plans, safety submissions, and amendments to existing site plans and safety submissions are not required to be submitted for approval as specified in AR 385–64 when—

(1) A modification to an existing agent facility or agent operation does not increase the chemical agent hazard (that is, 1-percent lethality distance).

(2) Modification or rehabilitation of an existing nonagent facility for agent operations presents no greater agent hazard than existing chemical agent operations in the near vicinity. Such modifications shall be analyzed by the local installation/activity and documented.

## 6–9. Equipment and tools

*a.* Portable equipment and hand tools used in the manufacture, assembly, disassembly, handling, testing, or disposal of agents or munitions must be identified by a permanent marking system that cannot be removed through further use in agent operations, decontamination, or maintenance. Storage of such items should be segregated from items that have not been used in agent operations. Marking is not required for laboratory tools, equipment, glassware, and so forth, unless contaminated with agent. Contaminated laboratory equipment will remain marked until thoroughly decontaminated.

*b.* Records will be maintained listing all equipment that has been involved in agent operations and is being placed in standby status, removed and saved for future operations, or being converted to use in nonagent operations. Records need not be maintained for laboratory equipment unless contaminated with agent. Such records will identify the contaminating agent, the decontamination process used, and the methods and results of analysis used to confirm the decontamination process. This equipment will continue to be controlled until decontaminated, as described in paragraph 5–1*e* of this pamphlet.

*c.* Small items of equipment, such as instrumentation, which have been internally contaminated, will be disassembled and necessary work performed in a negative pressure enclosure; for example, hood or glove box whenever

maintenance is required. M8 alarm does not require negative ventilation when working on the interior components. This item incorporates features within its design to preclude interior contamination.

### 6–10. Special operational provisions for emergency preparedness

*a.* A central control point that is informed of all agent operations will be established for coordination of emergencies. This control point is not required to be the center for CAI control; however, the center may be used when it is more advantageous to the installation.

*b.* The work area will be clearly defined and access limited to only authorized personnel who have received appropriate safety training or are accompanied by someone who has been trained.

*c.* Work not necessary to the operations will not be performed in the areas of agent operations. Laboratories should have areas set aside for nonagent operations.

*d.* Adequate operable detection equipment and materials must be maintained at all work areas. Wind-direction indicators must be provided at all areas and located so they are readily visible to personnel in the areas.

*e.* Telephones, radios, or other means of communication for advising the operational control point of emergencies must be available at the worksites. Radios must be approved by local safety offices before they are used in operations involving explosives with electric firing or detonating devices.

*f.* Decontamination and first-aid equipment will be positioned at all agent operating sites. It is not necessary to man this type of equipment with nonoperating personnel. Designated personnel will be trained to operate this equipment in the event of an emergency. A Government vehicle or ambulance support, suitable for use as a patient transport vehicle, will be readily available at the job site whenever operations are in progress.

*g.* For field operations, each crew will have one individual designated as the safety person to assure that the above equipment is available and properly positioned, monitor communications equipment, assist personnel in donning protective clothing, and check for its proper fit, maintain records of entry and exit time, monitor stay times in TAP, assure protective clothing is properly decontaminated and doffed, and so forth.

*h.* A minimum of two people knowledgeable in agent exposure symptomatology, self/buddy aid, and treatment must be present during agent operations. They will remain in visual contact with each other at all times or within the immediate access area when communication is provided and observation by operational control personnel is possible.

*i.* All personnel working with agent will be given an off-duty hour telephone number to which suspected exposures can be reported.

*j.* Workers will report any illness to the supervisor prior to start of daily operations or before leaving the job if the illness occurs during working hours.

*k.* Any agent exposure, suspected exposure, agent spill or release, or other abnormal situation that may result in personnel injury must be reported to supervisory personnel immediately after emergency action is taken. Personnel with possible agent exposures will report for medical evaluation as soon as possible. All potentially exposed or exposed personnel who have been exposed to nerve agent will have a cholinesterase level drawn that day prior to release from duty.

*l.* Hot-line operation recommendations can be found in DA Pam 50–6.

### 6–11. Pre-operational safety survey

*a.* A pre-operational safety survey will be conducted by the MACOM or MACOM designee when site plans and safety submissions of proposed or renewed chemical agent operations are required by AR 385–64 and AR 385–61.

*b.* The pre-operational survey will—

(1) Assure, as a minimum, that all provisions of the site plan and safety submission and Army regulations are complied with.

(2) Include a simulated run conducted by operational personnel using dummy/inert material and associated protective clothing/equipment.

(3) Assure operator proficiency is demonstrated through SOP compliance.

*c.* After the simulated run and final SOP approval, live operations may be initiated under close supervision at controlled production rates and build to desired production rates. Safety personnel will certify facilities, equipment, training, and procedures according to the provisions in this pamphlet.

*d.* Operational personnel will perform a dry run in the presence of their first-line supervisor prior to restart of any toxic chemical operation that has not been conducted in the last 90 days. Installation/activity safety personnel will use the above procedures to ensure the operation will be conducted in a safe manner.

## Chapter 7
## Personnel Protective Practices

### 7–1. Checking safety equipment

The supervisor will be responsible for ensuring that safety equipment is checked and ready for use. Users will inspect the equipment before each use in accordance with appropriate regulations.

### 7–2. Training personnel

*a.* Supervisors will ensure that the training outlined in this pamphlet is accomplished. Safety, industrial hygiene, and medical personnel (if medical information/issues are involved) will provide technical assistance.

*b.* All personnel who work with or have some association with chemical agents and munitions or have a potential for exposure will receive enough training to enable them to work safely and to understand the significance of agent exposures. (This would apply to maintenance workers, clerical workers, firefighters, security guards, toxic chemical handlers, surveillance personnel, and so forth.) Prior to being assigned to operations or in support of operations, as a minimum, personnel will demonstrate proficiency in—

(1) Knowledge of operating procedures, to include safety requirements.
(2) Recognition of hazards involved in the operation.
(3) Recognition of signs and symptoms of agent exposure.
(4) Administration of first aid and self/buddy aid.
(5) Knowledge of personnel decontaminating procedures.
(6) Execution of emergency procedures.
(7) The donning and doffing of protective clothing and equipment (for example, SCBA).

*c.* An ongoing program of instruction will include—

(1) Techniques of wearing, adjusting, inspecting, and caring for personal protective masks and clothing.
(2) Use of nerve first-aid kit.
(3) Recognition of signs and symptoms of agent exposure.
(4) Cardiopulmonary resuscitation (CPR), self/buddy aid.
(5) Emergency procedures.
(6) Decontamination procedures.

*d.* Refresher instruction will be repeated at least annually. The installation/activity medical authority will review and approve the content of self/buddy aid and CPR training and the personnel who conduct the training.

*e.* Dry runs of operational and emergency procedures are encouraged.

*f.* In addition to the above training, fire protection personnel will also be made familiar with fire, explosion, and reactivity hazard data, physical/chemical data, emergency disposal procedures, and so forth.

### 7–3. Safeguarding of personnel

The following measures will be observed by personnel who work in contaminated or suspected contaminated areas, or where handling or contact with agent-filled items is involved. (For laboratories, see chap 8.)

*a.* All clothing, including shoes, will be changed at the beginning and end of the work shift upon arrival at a change house.

*b.* Open sores or wounds will be evaluated by the medical personnel and covered with an impermeable dressing prior to admittance to the area.

*c.* Each worker will shower thoroughly (using plenty of soap) with special attention given to hair, face, neck, and hands before leaving at the end of the work day.

*d.* Eating, drinking, chewing, and smoking within agent operating areas is permitted only in specifically designated locations. These locations will be in an area separated from the agent operating areas. Engineering controls and agent monitors will be used to assure that agent air concentrations do not exceed the AEL specified in AR 385–61, table 2–3. Requirements for engineering controls or agent monitors will be addressed in a risk analysis. A single covered container of water or other suitable liquid replenishment and disposable cups may be located not less than 100 feet upwind from an outdoor operating site. Individual personal containers of drinking water are not authorized. Conditions under which eating, drinking, chewing, and smoking may occur will be specified in the SOP.

*e.* Supplies of decontaminating solution and emergency showers for personnel decontamination will be available at storage and operational areas when operations are in progress.

*f.* Areas where liquid agent has been spilled will be clearly identified and controlled to prevent inadvertent access by unauthorized personnel.

*g.* Personnel who have been in areas of possible chemical agent exposure (normally, personnel downwind of an agent release or personnel who were in areas of known agent contamination) will remain at the installation for at least 30 minutes after leaving the area. They will then be observed for signs of agent exposure, and agent-related symptoms

by the supervisor or his designated representative before departing the installation. If signs of possible exposure are noted the worker will be referred immediately to the medical facility.

### 7–4. Medical examination

Preplacement, periodic, and termination physical examinations will be performed on all employees assigned to agent operations. The scope of examination, frequency of periodic re-exams and retention of physical examination records will follow the guidance published in DA Pam 40–8 and DA Pam 40–173. Medical personnel will also ensure that chemical agent personnel issued respirators receive medical clearance to use a respirator as part of the respiratory protection program. Personnel who have physical conditions or diseases that would be aggravated by exposure to agent or that could be unduly hazardous to themselves or others will not be employed in agent operations per AR 40–5, DA Pam 40–8, and DA Pam 40–173.

### 7–5. Key medical personnel

*a.* The installation or activity commander will ensure the appropriate Army medical department activity (MEDDAC) or U.S. Army Medical Center (MEDCEN) commander provides for medical support to chemical agent operations. Key medical personnel, military or civilian, should have received specialized medical training, such as the medical management of chemical and biological casualties course taught by the USA Medical Research Institute of Chemical Defense or the toxic chemical training for medical support personnel course and occupational health courses provided by USACHPPM. Personnel who have not received this training will receive it prior to or as soon as possible after their arrival for duty. Installation or activity commanders will coordinate the scheduling of this training with the supporting MEDDAC/MEDCEN commander.

*b.* The command-designated safety and occupational health manager is responsible for obtaining, as required, support from Army Medical Department (AMEDD) industrial hygiene consultative services. Industrial hygiene services can include:

(1) Personal monitoring for medical record and occupational health support (for example, ventilation control assessments).

(2) Assistance to chemical agent operations supervisors (for example, review of monitoring plans).

(3) Engineering control concept, design input, design, and blueprint review.

(4) Training (for example, heat-stress monitoring)

(5) Baseline potential exposure surveys for operations involving potential military and industrial chemical, biological, or physical hazards.

(6) Document development and review related to the occupational health aspects of chemical agent operations (for example, SOPs, local criteria, or standards).

(7) Selection of personal protective equipment (PPE).

(8) Industrial hygiene representation on committees, inspection teams, and so forth.

(9) Support to contractor officer representatives for oversight of contract-related industrial hygiene issues.

*c.* The installation or activity commander will advise the supporting installation medical authority of any new, unusual, or particularly hazardous activities that may require preliminary planning for support.

*d.* When medical support is provided by non-MEDDAC personnel, the support required medical training will be reviewed and approved by the MACOM surgeon for adequacy.

### 7–6. Emergency response equipment

*a.* The following emergency response equipment and supplies will be immediately available at any site or facility where operations are conducted that involve agent items. Trained personnel will also be available to use this equipment.

(1) A Government vehicle or ambulance support to serve as a patient transport vehicle.

(2) A communication system to summon aid.

*b.* Agent first-aid kit should be available and contain the following:

(1) Appropriate decontaminating materials in sufficient quantities.

(2) Clean water for personnel decontaminating purposes.

(3) Three MARK I nerve-agent antidote kits per person for nerve-agent operations (may be carried by the individual), along with instructions.

*c.* MARK I kit injectors must not be stored in the proximity of organic solvents, even when sealed in polyethylene bags because the vapors can cause the auto-injector to malfunction. Also, the injectors must be protected from freezing because the injector may not function properly while frozen.

*d.* The physician in charge of each clinic in support of the chemical agent mission may elect to provide each individual employee with only one MARK I kit with two additional atropine injectors.

*e.* The following additional equipment as a minimum will be available for use in case of an emergency. Quantities will be sufficient for the operation being performed as determined by local medical personnel.

(1) Fresh water for flushing eyes.
(2) 5 percent sodium hypochlorite solution (commercial bleach).
(3) Cloth, sponges, or gauze.
(4) Additional MK I kits for nerve-agent operations.

### 7–7. Emergency medical identification

*a.* Individuals (employed by installations or activities assigned an agent mission) who may be exposed during the performance of operations involving agents should be furnished a medical alert card. A medical alert identification bracelet may be furnished to employees upon request by the employee or as determined to be required by the installation medical officer.

*b.* Personnel will be requested to wear or have the identification on their person during off-duty hours.

*c.* The identification bracelet, if furnished, and card will show the following information: "FOR EMERGENCY MEDICAL INFORMATION CALL (INSTALLATION MEDICAL OFFICER TELEPHONE NUMBER). U.S. GOVERNMENT SERIAL NUMBER. (PERSONNEL IDENTIFICATION NUMBER). This person works with and may have been exposed to (type of agents by physiological action). Other special medical characteristics (list of allergies, special conditions, and so forth). "

*d.* Local procurement of emergency medical identification is authorized under provisions outlined in AR 385–10.

*e.* Each installation or activity assigned an agent mission will establish a system to ensure appropriate response during nonduty hours for emergency medical information, advice, or assistance.

### 7–8. Self/buddy-aid procedures

*a. General requirements.* Although a prime consideration in rendering assistance to an individual who has been exposed to vesicant (mustard) agent is immediate removal to an uncontaminated area, the risk of leaving liquid vesicant in the eye is so much greater than the risk of exposure to vesicant vapors during the short period of decontamination, that eye decontamination must be done despite the presence of vapor.

(1) Exposure to GB poses primarily an immediate vapor hazard and individuals will be removed immediately to an uncontaminated area. VX is more of a percutaneous hazard; therefore, primary consideration will be given to removal of the liquid agent from the skin before removal of the individual to an uncontaminated area or atmosphere.

(2) Decontamination of personnel exposed to liquid mustard or nerve agents should be done as quickly as possible by following the procedures in paragraphs 7–8*b* and *c*, below.

(3) Use of the M258/M258A1/M291 decontamination kit or commercial household liquid bleach (5 percent solution sodium hypochlorite) will aid in neutralizing liquid contaminants on protective masks, hoods, butyl rubber gloves, other personal equipment, and skin surfaces. Care should be taken to keep solutions out of eyes, mouth, injuries, or wounds. Flush with water if solution enters eyes, mouth, or wounds.

(4) During handling and decontamination of casualty cases, personnel will give consideration to their own safety, take necessary precautions, and wear prescribed protective clothing and equipment to avoid becoming exposed to agent.

*b. Mustard and Lewisite exposure.*

(1) *Eye and mucous membrane contamination.* Speed in decontaminating the eyes is absolutely essential. The procedure is very effective for mustard in the first few seconds after exposure, but it is of very little value in preventing eye damage if the decontamination is delayed for 1 or 2 minutes after exposure. Remove person from the liquid source, 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. Transfer the patient to the medical facility.

(2) *Skin contamination.* Remove person from agent source immediately. Flush skin and clothes with 5 percent sodium hypochlorite solution within 1 minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent sodium hypochlorite solution (mustard) or 10 percent sodium carbonate solution (Lewisite), then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to a medical facility. (If thickened agent is involved, remove by scraping with something dull such as a plasterer's trowel.)

*c. Nerve-agent exposure.* After removal from the contaminated area, the casualty will be decontaminated by washing the contaminated areas with nominal 5 percent solution sodium hypochlorite and flushing with clean water. The mask is left on the victim until decontamination has been completed unless it has been determined that areas of the face were contaminated and the mask must be removed to facilitate decontamination. After decontamination, the contaminated clothing is removed and skin contamination washed away. If possible, decontamination is completed before the casualty is taken to the aid station or medical facility. Because of the rapid effects of nerve agents, it is extremely important that decontamination of personnel not be delayed by attempting to blot off excessive agent prior to decontamination with sodium hypochlorite. Only clear water will be used when flushing the eyes or mouth. Skin surfaces contaminated with bleach should be thoroughly flushed with water to prevent skin irritation from the bleach.

*d. Nerve emergency treatment.* An individual who has received a known nerve-agent exposure or who exhibits definite signs or symptoms of nerve-agent exposure will be given an intramuscular injection immediately with MK I kit auto-injectors.

(1) Some of the early symptoms of a vapor exposure to nerve agent may be rhinorrhea (runny nose) and/or tightness in the chest with shortness of breath (bronchial constriction).

(2) Some of the early symptoms of percutaneous exposure may be local muscular twitching or sweating at the area of exposure followed by nausea or vomiting.

(3) Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken immediately to the medical treatment facility for observation.

(4) Injections using the MK I kit injectors (or atropine only if directed by the local physician) may be repeated at 5- to 20-minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given.

(5) Administer, in rapid succession, all three MK I kit injectors (or atropine if directed by the local physician) in the case of severe signs of agent exposure.

*e. CPR.* If indicated, CPR should be started immediately. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when the facial area has been contaminated unless the facial skin surfaces are first decontaminated by following the procedures described in 7–8*a* through 7–8*c*, above.

*f. Certification.* All personnel providing self/buddy aid and CPR must receive appropriate training and certification. All training must be reviewed and approved by the responsible installation/activity medical authority.

# Chapter 8
# Laboratory Safety

## 8–1. Overview of common laboratory safety guidelines

*a.* Agent operations and storage accomplished in a laboratory, as defined in the glossary, are subject to the guidance in this chapter. Other guidance in this pamphlet applies only where referenced. All toxic chemical agent laboratories will, as a minimum, meet the requirements contained in the section 1450, part 1910, title 29, Code of Federal Regulations (29 CFR 1910.1450). The risk assessment approach is a valid method of eliminating/reducing the unique hazards associated with research and development laboratory operations. For this reason, installation/activity commanders/directors will adopt a risk assessment approach in accordance with their written system safety engineering and management program plan (appendix G). The risk assessment developed as a result of the identification of a unique hazard and the requirements of AR 385–61, and this pamphlet will drive the safety and occupational health standards for each research and development laboratory operation.

*b.* Chapters 1, 2, 3, 4, 7, 10, and 11 apply to agent laboratories in their entirety. Paragraphs 5–1; 5–2*e*(1); 6–2; 6–3; 6–5*a*, *g*, *k*, *l*, *o*, *r*, and *s*; 6–8; 6–9; and 6–11 also apply. The following paragraphs do not apply: 3–5, 3–6, and 7–3.

*c.* Within a laboratory, containment of agent liquid and vapors is required at all times. When agent must be removed from the containment provided by the laboratory engineering controls, the following restrictions apply:

(1) For quantities of one milliliter or less of chemical agent, one of the following is required:

*(a)* A double-containment system.

*(b)* A single-containment system with a protective mask worn.

(2) For quantities in excess of one milliliter of chemical agent, a double-containment system is required.

*d.* A single-containment system must totally contain agent liquid and vapor. Examples include glass bottles sealed with gaskets or parafilm tape, syringes with needle caps, septum bottles, sealed ampoules, and capped liquid impingers (bubblers).

*e.* A double containment system must provide total primary containment as above and, in the event of leakage or breakage of the primary containment, must totally contain agent liquid and substantially contain agent vapors. Examples of secondary containment include, but are not limited to, metal cans with friction-fit lids containing absorbent material and sealed syringe carriers.

*f.* Operations not in accordance with the containment requirements in paragraph c above are not considered laboratory operations and are subject to the remaining controls contained in this pamphlet. Operations in real-time analysis platforms (RTAPs) and fixed-site, real-time monitoring operations are not considered laboratory operations, and therefore they are exempt from the requirements in chapter 3 and facility requirements in this pamphlet. Only RDTE solution, calibration, and precision and accuracy operations are permitted in RTAPs and fixed-site, real-time monitoring operations. Hazard analyses/SOPs must be developed to ensure that the risks associated with these operations are minimized.

*g.* Unattended overnight storage of agents will be in ventilation hoods or gloveboxes and requires double containment of agent. For operations in which the disassembly of equipment would result in increased hazards (for example, agent generators, agent synthesis, and Q-testers), the double containment requirement is advisory and requires a waiver.

*h.* Bubbler and DAAMS analyses may be conducted outside of a ventilation hood provided the samples were taken from an area where significant contamination is not expected. Samples that were taken from areas with known or expected positive contamination (according to results of gross indicators such as blue band tubes or M256 detector kit) will be analyzed in a hood or glovebox unless appropriate serial dilutions have been made. Bubblers will be transported in double containment.

*i.* Nonrelated operations involving different agents should not be performed concurrently in the same room unless agents are separated by engineering controls (for example, separate laboratory hoods).

*j.* Good housekeeping will be maintained.

*k.* SOPs for hazardous operations should contain a daily checklist to be used at the beginning of each day's operation to assure presence or function of nerve first-aid kit supplies, decontamination materials, ventilation systems, warning signs, warning labels, uncluttered work area, protective clothing, and so forth.

## 8–2. RDTE solutions

*a.* Operations that involve G agents, V agents, Lewisite, or mustard agents diluted below the drinking water standards in TB MED 577 are not subject to the provisions of this pamphlet. Local restrictions should be implemented as necessary.

*b.* For storage or operations involving RDTE solutions of agent, as defined in the glossary, the following may be applied:

(1) RDTE solutions may be stored in single containment within a refrigerator or freezer. The refrigerator or freezer will have a high temperature alarm to warn of malfunction and will meet appropriate electrical requirements for flammable materials if used.

(2) Engineering controls used for storage and operations with RDTE solutions are not required to have backup emergency power.

(3) Protective measures, equipment, and procedures should be determined through hazard analysis of each operation.

## 8–3. Ventilation

*a. Laboratories.*

(1) Laboratories will be equipped with either laboratory-type ventilation hoods or gloveboxes to provide the engineering control necessary to contain agent during operations. Hood and glovebox materials should be agent resistant and easy to decontaminate. Hoods and gloveboxes will be provided with catch trays, basins, or other means of spill containment of suitable size for agent operations.

(2) Ventilation systems will be designed so that air flow is away from the operator and toward the potential source of agent. Air pressure within the laboratory will be maintained below that of surrounding areas and entry corridor.

(3) A record noting filter replacement dates for each air filtering system will be maintained. Ventilation requirements in paragraphs 6–5*a* and 6–5*r* apply to ventilation systems in laboratories.

(4) A scheduled preventive maintenance program should be established to provide continued assurance of adequate ventilation performance.

(5) Ventilation exhaust will not be recirculated or used as makeup air for areas occupied by unprotected personnel. Makeup air diffusers will not be located so as to cause turbulence at the laboratory hood face.

(6) Ventilation hoods or gloveboxes used for overnight storage of agent should not be used for any agent operation except transfers from storage and related dilutions unless only 100 ml or less of a single category of agent (for example, nerve agents versus vesicant agents) is stored therein; or unless agent is stored in a vault or refrigerator. Charged agent generators may be used in the same hood in which they are stored if no other agent is stored in that hood; or if other agent is stored in a vault or refrigerator.

(7) Where ventilation is a sole or prime method of personnel protection, backup emergency power (automatic start generator) or other fail-safe systems should be installed to prevent exposure in the event of an unplanned power outage.

*b. Laboratory hood.*

(1) A laboratory hood in which agent operations are conducted will provide an average face velocity of 100 plus-or-minus 20 linear feet per minute (lfpm) through the working opening. A traverse of one measurement per square foot (approximately) should be used to compute the average face velocity. No single point velocity may deviate from the average face velocity by more than 20 percent.

*(a)* Laboratory hoods in which agent operations are conducted will contain challenge test aerosols (visible smoke) with the sash in the maximum open position. No visible smoke will escape from the hood while the sash is lowered from the fully opened to the fully closed position and raised from the fully closed to the fully opened position.

*(b)* Measurements will be made every 6 months or when the system has undergone major repairs or the airflow into or through the hood has been significantly affected (for example, by putting an apparatus into the hood, placing a large piece of equipment next to sides of hood, and so forth). Sash stops may be used to define the maximum sash position opening. Hoods used only for storage of double-contained agents (no operations) are not subject to upper limits on airflow when the hood sash is lowered and locked for security. Previously existing (pre-1984) laboratory hoods

designed and approved at 150 plus-or-minus 30 lfpm may continue to be used until they can be modified to the above criteria, provided containment is verified by smoke tests or other appropriate methods.

*(c)* When existing hoods are replaced in a room or a facility, the ability of the ventilation system to maintain the room or facility at a negative pressure must be verified. Adjustment or renovation to the system may be required. Consult with the installations's industrial hygienist for design guidelines.

(2) When ventilation hood exhaust systems contain filters that have been used for agent operations, and the working area of the hood no longer contains agent or agent-contaminated material, the ventilation system must maintain an inward airflow through the hood, as verified by smoke tests or other visual means. The minimum face velocities cited above, however, are not required. If the filter system is isolated from the hood (for example, back-flow dampers, and blind flanges), this subparagraph does not apply.

(3) The design exhaust volume of the hood should provide excess initial capacity.

(4) New hood installations should make maximum use of proven technologies such as bypass construction, multiple baffles, and other enhancements to provide optimal containment of chemical agent vapors and mists. The U.S. Army CHPPM, Industrial Hygiene Program, APG, MD 21010–5422 is a good source of information for assistance in laboratory hood construction criteria, concept development, and design review services.

(5) Effluent air from laboratory hood systems must not contain concentrations of agent in excess of the source emission limit contained in AR 385–61, table 2–3. If the quantity of agent being used or the type of operation is such that this amount may be discharged into the atmosphere, the discharge of the ventilation system must be equipped with chemical-type filters or other air treatment systems to reduce the agent in the effluent to an acceptable level.

(6) Existing hood ventilation systems will be equipped with an audible alarm device that will give a warning should the ventilation system fail because of power failure, mechanical malfunction, or if the average face velocity falls below 80 lfpm. For new construction, hoods will be provided with both visible and audible alarm devices. Visible alarms will be located so that they can be readily seen by personnel while working at the exhaust hood. For storage hoods, the visual alarm should be visible from outside the room containing the hood. Alarms should be periodically function-tested, as a minimum every 6 months.

(7) Each laboratory room will have a means of assessing approximate hood face velocity prior to beginning operations each day. A hanging vane velometer is considered sufficiently accurate.

(8) No agent or agent-contaminated equipment will be allowed within 20 centimeters of the hood face unless a hazard analysis demonstrates that worker safety will not be compromised. In such case, the commander may authorize a local waiver to the 20-cm requirement. Any reconfiguration of the agent or equipment location will require an update of the hazard analysis, verification of the hood, and revision of the waiver. The 20-cm zone should be designated by paint or tape.

*c. Glovebox.* Glovebox requirements for the laboratory will be consistent with those in paragraph 6–5*s*, this pamphlet.

## 8–4. Agent monitoring

During the first 5 days of new agent operations, monitoring at the AEL will be conducted to verify the adequacy of engineering controls. Remonitoring will be conducted for one operating day quarterly, following significant changes in the operation or following any significant damage or repairs to the ventilation system. If the only change in the operation is to an agent of lower volatility, remonitoring is not required.

## 8–5. Loss of engineering controls

*a.* Monitoring, protective clothing, and decontamination procedures, in accordance with chapters 3 (except para 3–5), 4, and 5 must be accomplished when the following exists.

(1) Agent release outside of containment.

(2) Ventilation failure of hood with uncontained agent.

(3) Ventilation failure of a hood with contained agent and lasting longer than 24 hours.

*b.* If there is a loss of ventilation in a hood with contained agent (double or single containment) not exceeding 24 hours, then a protective mask will be worn until ventilation has been restored and the laboratory has been monitored to the AEL.

*c.* For the following conditions, entry in level D with visual observation for tampering, leakage, or ventilation failure is acceptable:

(1) Normal entry with no apparent problems.

(2) Following restoration of ventilation in a hood containing only double-contained agent, provided the ventilation loss did not exceed 24 hours.

*d.* Prior to removal from engineering controls, agent containers will be sampled for surface liquid contamination with M8 paper.

*e.* When setting up alarms, gas chromatographs, or other agent monitoring equipment, whether for protective monitoring or process/experiment monitoring, it is necessary to ensure that the sampling device does not draw air out of a potentially contaminated location and exhaust it outside of engineering controls. Many sampling devices have

sample line regulators or sample transport pumps that cause more sample volume than is required to be delivered to the monitoring device. This excess, which is then bypassed or exhausted, must remain within engineering controls. Where sample lines containing agent extend outside engineering controls, double-walled lines or equivalent redundancy will be used.

### 8–6. Protective clothing and equipment

*a.* Approved protective masks will be issued to all personnel who are routinely assigned to agent operations. Training in the use of the masks will be provided. A properly fitted mask with instruction in its use, and how to react in the event of an emergency, will be provided to all transients entering areas in which chemical agent is being used or stored. The mask must be readily available to each individual in the room in which agent is being used or stored.

*b.* Personal protective clothing necessary to protect personnel during operation and for use in case of emergency will be kept readily available. Clothing sizes will be appropriate for the personnel who might need to wear them. PCE utilized in laboratory operations will be marked and maintained in an accountability program.

*c.* Protective gloves worn in laboratory operations will meet the testing requirements in accordance with the provisions of chapter 4.

*d.* Surgical gloves may be used without testing only if the total quantity of agent accessible is less than l milliliter; a time limit of 5 minutes from the beginning of access to uncontained agent is established; an individual wearing approved gloves (nonsurgical) is dedicated to watch and to provide immediate emergency response for spills, accidents, or agent contact with gloves; and a hazard analysis is performed and used in accordance with an approved SOP. Users of surgical gloves must wear two pairs simultaneously, wash hands with soap and water immediately after any use, and avoid sources of ignition.

*e.* The wearing of protective gloves is intended to preclude any contact of skin with agent. No glove may be used that will not preclude such contact in the event of an actual spill. In addition, the glove must provide reasonable protection against unrecognized contamination. For types of gloves authorized for use, the following procedures are considered reasonable:

(1) *Standard gloves (M3, M4, and gloveset gloves).*

*(a)* Prohibit operations with intentional liquid contamination of the gloves.

*(b)* If liquid agent contamination occurs, decontaminate immediately and continue operation. Upon completion, decontaminate again, remove gloves, place in plastic bag, and remove from hood. Treat as decontaminated (X) clothing until the gloves have been monitored. Gloves subject to liquid contamination will be disposed of.

*(c)* If no known liquid contamination occurs, the gloves may be decontaminated, removed, and left inside the hood by the edge. They may be reused in a similar fashion until the end of the day when they will be decontaminated, bagged, removed from the hood, and set aside for later monitoring and laundering or destruction.

*(d)* All butyl rubber gloves used in laboratory operations that require laundering and testing will be included in the installation PCE accountability program for control and processing as prescribed in TM 10–8415–210–13&P.

(2) *Nonstandard gloves.*

*(a)* Prohibit operations with high probability of liquid contamination of the gloves. Use time is measured as elapsed clock time from initial access to potential contamination.

*(b)* Restrict the use and duration, as required by the type of acceptance testing performed. Gloves will be marked to indicate restrictions that apply.

*(c)* If liquid contaminated, decontaminate immediately, discontinue operation if it can be done safely, remove gloves and place in plastic bag or other container, and remove from hood as contaminated waste. Wash hands promptly and thoroughly with soap and water.

*f.* All personnel handling agent containers will wear, as a minimum, level D protective clothing with gloves. Supervisors and visitors may wear street clothes or lab coats. Protective gloves will be worn by all personnel accessing agent operating areas (for example, hoods) whenever agent is present in the hood.

(1) Ungloved entry is permitted under the following conditions:

*(a)* Agent has not been placed within hood confines.

*(b)* Decontamination status for hood (at least 3X) is known.

*(c)* Handling of potentially contaminated items/equipment is not conducted.

(2) Removal of protective gloves from hood without decontamination is limited to the following conditions:

*(a)* Contact with agent, primary agent containers, or potentially contaminated items or equipment has not occurred.

*(b)* Gloves are not potentially contaminated as a result of experimental procedures being conducted.

*(c)* If no known liquid contamination occurs, the gloves may be decontaminated, removed, and left inside the hood by the edge. They may be reused in a similar fashion until the end of the day or until use time is expired (whichever is first) when they will be decontaminated, bagged, removed from the hood, and set aside for later monitoring and laundering.

## 8–7. Facility requirements

*a.* All entrances to laboratory rooms in which agent is present will be posted with signs warning personnel of the presence and type of agent within the room and any special entrance requirements.

*b.* Floors, work surfaces, and walls will have surfaces that resist agent absorption and can be readily decontaminated.

*c.* Emergency deluge-showers and eye-wash fountains will be readily accessible to all work situations within the laboratory.

*d.* Entry to the laboratory will be restricted to authorized personnel. This restriction can be indicated by signs or enforced by locks. The laboratory or individual rooms or storage/work hoods containing agent must be capable of being locked during nonwork periods and will be locked when unoccupied. All methods employed for locking systems should be consistent with the life safety code (NFPA 101) requirements for hazardous areas and appropriate security measures.

*e.* Where in-line canister-type filters are utilized for filtering effluents from laboratory apparatus, a filter-use record will be maintained. The date or conditions when replacement is due will be noted.

*f.* Means of egress must be continuously maintained free of all obstructions or impediments to allow full instant use in case of a fire, agent release, or other emergency. Means of egress must not exit into an area of greater hazard. For new construction, one means of egress must be directly to the outside.

*g.* Compressed gas cylinders not necessary for current laboratory requirements will be stored in a safely arranged location outside the laboratory in accordance with AR 700–68 (Storage and Handling of Compressed Gases and Gas Liquids in Cylinders).

*h.* Facilities must be available for washing hands and arms prior to leaving the agent area.

*i.* Permanent office equipment facilities (including desks) should not be maintained within an agent laboratory room. Desks for notetaking, logs, or recordkeeping are acceptable if directly related to the agent operations in that laboratory.

*j.* Check-valves, vacuum breakers, charcoal filters, and similar means should be used to avoid inadvertent transfer of agents to uncontaminated areas and equipment.

## 8–8. Personnel practices

*a.* All agents will be stored in a restricted laboratory, locked hood, or other facility to which access can be positively controlled.

*b.* Prior to assignment to such work, personnel who work with agents will be trained in the use and handling of toxic agents; in the donning, wearing, and doffing of protective clothing; in the use of decontaminating materials; and in procedures to be followed in the event of a spill or exposure.

*c.* When conducting agent activities, only personnel necessary to the operation will be permitted in the laboratory work area. However, a minimum of two qualified persons will be present.

*d.* Procedures will be established to ensure that the installation firefighting personnel and the security force are aware, and will be notified, of the presence and type of agent and room in which it is located in order to adequately respond to emergency situations.

*e.* Storage compatibility group standards (AR 385–64) do not apply to RDTE stocks of 1 liter or less. A reasonable effort should be made to group agents of like physiological effects together, but generation of additional storage locations is not required to accomplish this.

*f.* Mechanical pipetting aids will be used for all pipetting of agents or agent solutions.

*g.* The storage or consumption of food or beverages; the storage or application of cosmetics; the smoking or storage of smoking materials, tobacco products or other products for chewing; or the chewing of such product in all laboratory agent areas, is prohibited. Laboratory glassware will not be used to prepare or consume food or beverages.

*h.* Agent first-aid kits will be maintained in each laboratory operating or storage room in accordance with paragraph 7–6.

*i.* Each inner container and the outer container of chemical agents and agent candidates must be labeled with its agent and/or code name to properly identify the contents. The label will have a red border and will have dimensions of at least 4 1/2 by 5 1/2 inches, when container size permits. As necessary, the dimensions of labels for small inner containers may be as small as approximately one-fourth of those stated above. Those inner containers too small for complete information, as above, must have name or code name of agent clearly marked and may refer to remainder of information by locally determined system. The color of inner and outer container labels, as well as information thereon, will be identical. Labels will contain the following information:

(1) TOXIC CHEMICAL (in bold red letters).

(2) The original issue quantity of agent in the container stated in metric terms and the concentration if diluted. This quantity should be updated, as required, when a formal inventory is conducted.

(3) The operating activity responsible for storage and the numbers of the building and room where the material is stored.

(4) The name and telephone number of the custodian of the material.

(5) The date when the material was first placed in storage.

(6) Special instructions or notes regarding use or removal of the contents.

(7) Some method of identification of the person who prepared the solution or agent quantity.

### 8–9. Decontamination

*a.* A supply of decontaminating material appropriate and adequate for the type and quantity of agent present and equipment for its use, if required, will be immediately available in the laboratory.

*b.* Detoxification of agent in a laboratory hood or glovebox is limited to a maximum of 50 grams of agent at any one time unless approval for a greater amount is given in the site plan and safety submission.

*c.* The amount of contamination received by an article is a function of its absorption characteristic, the presence of liquid or vapor agent, the time inside the hood where it is placed, and the type of agent.

(1) Material and equipment exposed to liquid agent must be considered contaminated and must be controlled (decontaminated or contained) and identified (labeled) prior to removal from the hood.

(2) Porous material and equipment that has remained in the hood for one week or longer, or has been exposed to significant vapor contamination, should be considered potentially contaminated and treated as in (1) above.

(3) Glassware, such as bubblers that have not been exposed to liquid contamination, may be removed from a hood.

*d.* Checking by analytical methods for residual contamination, after detoxification of agent, is not necessary if the agent is known to be in solution using proven methods. These methods will consider appropriate decontaminants are used in calculated excessive amounts, the time allowed for reaction exceeds many half-lives, and no interference (slowed reactions, low temperatures) or other complications are reasonably expected. Solutions that meet this criteria may be considered decontaminated and need not be stored in an approved lab hood.

*e.* Laboratory animals injected with or ingesting agent are not considered contaminated unless massive doses relative to the animals' mass are given. Other exposed animals require decontamination and disposal by incineration.

### 8–10. Chemical hygiene plan

*a.* Each toxic chemical laboratory will develop and implement a chemical laboratory hygiene plan in accordance with 29 CFR 1910.1450, if applicable. This plan will be reviewed and concurred in by the activity/installation safety manager and industrial hygienist.

*b.* All laboratories will keep an inventory of hazardous chemicals and material safety data sheets on hazardous chemicals within the laboratory; the supervisor will ensure laboratory personnel are trained in accordance with section 1200, part 1919, title 29, Code of Federal Regulations (29 CFR 1919.1200) (Hazardous Communication Standard). The standard requires that all storage containers within the laboratory be appropriately labeled as to content.

*c.* Chemicals likely to have dangerous reactions on contact with each other will be stored separately in placarded areas in accordance with an approved compatibility system, such as that found in the Hazardous Materials Information System (HMIS) or other acceptable laboratory guidelines. Tracking of laboratory chemicals should ensure that unused, outdated, or excess materials will be disposed of in accordance with appropriate federal, state, and local hazardous waste regulations. The installation environmental coordinator should be consulted prior to disposal of hazardous chemicals.

## Chapter 9
## Storage

### 9–1. Storage requirements

*a.* SOPs implementing the requirements of this pamphlet will be established locally, reviewed by the safety office immediately prior to command group review, and approved by the commander or his designated representative on the command staff. Emphasis is to be given to the following storage philosophy:

(1) Agent-filled munitions containing explosives will be stored in igloo-type magazines.

(2) Except for mustard- and Lewisite-filled ton containers, agent-filled munitions that do not contain explosives will be stored in igloos or other approved storage structures specifically approved by the MACOM. Mustard- and Lewisite-filled ton containers may be stored outdoors.

(3) Magazines or structures used for the storage of agent-filled items or containers will be in a specifically designated area.

(4) Structures used for the storage of agent-filled items will have floors and floor surfacing that can be decontaminated. Bulk agent containers stored outdoors will be placed on steel dunnage (wood dunnage may be used as a temporary measure, then positioned over crushed stone, gravel, or porous earth surfaces to minimize atmospheric contamination in event of leakage. Sites should be selected that are not in proximity to surface water sources and are not located over underground water sources that could become contaminated. Direct drainage to a body of water is prohibited. Provision will also be made to assure compliance with applicable water pollution regulations.

(5) Ton containers of bulk agents will be stored in a horizontal position.

(6) Security forces and visitors are not required to wear protective masks while patrolling outside of the mustard agent storage limited area. In the event it is necessary for security forces to patrol within an outdoor mustard storage yard, they will don appropriate protective masks, as determined by hazard analysis.

(7) The ends of ton containers should be kept painted and free from rust to enhance the visual detection of agent leakage at the valves and plugs. Mustard, Lewisite, GB, and VX agents have a solvent action on most paints that causes peeling, dissolution, blistering, and discoloring in the vicinity of the leakage. To facilitate inspection for leakage, shipping bonnets will not be installed on ton containers in storage.

(8) Stacks, groups, or areas of outdoor storage are not quantity limited.

(9) Outdoor storage areas within the chemical area should be separated from magazines or areas containing explosives components by the appropriate minimum magazine distance based on the quantities of explosives.

(10) Munitions or storage containers having different agent fills must be stored separately from each other.

*b.* Only the minimum number of personnel (but not fewer than two people), consistent with safe and efficient operations, will be permitted at the operational site. The following rules will be observed:

(1) Leaking munitions and containers will be handled only by authorized personnel who have been instructed and are qualified in the appropriate procedures to be used.

(2) If detected in a storage or transport situation, leaking munitions will be encapsulated in specially provided containers, in accordance with procedures contained in SB 742–1, until final disposition; if detected in a chemical demilitarization facility unpack area, they will be entered into the demilitarization process expeditiously. At those installations where magazine space within the chemical area is available, the encapsulated leaker will be stored in a separate magazine. When a separate magazine is not available within the chemical area, the encapsulated leaker should be appropriately identified and retained in the same magazine with similar serviceable munitions, but separated to the greatest extent possible. Encapsulated munitions will not be opened within a magazine in which other serviceable munitions are stored.

(3) Material contaminated with chemical agent may be transported from one location to another. The material must be encapsulated so that the concentration of agent on the outside of the encapsulating material does not exceed the AEL in AR 385–61, table 2–3.

## 9–2. Chemical agent and ammunition hazard symbols

*a.* Locations where chemical agents and munitions are stored, handled, used, and processed require the use of chemical hazard symbols. These symbols shall be used by themselves or in conjunction with fire symbols, as appropriate.

*b.* The chemical hazard symbols are illustrated in figure 9–1. Supplemental chemical hazard symbols, illustrated in figure 9–2, are circular in shape and yellow with black letters.

*c.* When the chemical hazard symbol ordering the wearing of full protective clothing (see symbol 1 of fig 9–1) is colored with red rim and figure, the symbol indicates the presence of highly toxic chemical agents that may cause death or serious damage to body functions. The following full protective clothing, identified as set 1 in figure 9–1, will be used: DA-approved NIOSH/MSHA SCBA, impermeable suit, impermeable hood, impermeable boots, undergarments, coveralls, protective footwear, and impermeable gloves.

*d.* The supplemental chemical hazards symbols described in figure 9–2 shall be used with other symbols as required to identify chemical agents having special chemical hazards.

*e.* Unless precluded by operational security considerations, chemical hazard symbols (as described in figures 9–1 and 9–2) will be used to identify areas designated for the storage of agents. Posting of hazard markers will comply with the following:

(1) When a magazine area is used exclusively for storing only one type of chemical agent or agent-filled munitions, the entrance to the storage area may be identified with hazard symbols indicating the type of agent stored in place of posting hazard symbols on each magazine or storage pad.

(2) When an entire row of magazines or storage pads within a storage area is used exclusively for storing only one type of chemical agent or agent-filled munitions, access road entrances servicing that row of magazines or pads may be posted with hazard symbols identifying the chemical agent stored, in place of posting hazard symbols on each magazine or storage pad.

(3) When a magazine area or outdoor site is used for storing different types of chemical agents or agent-filled munitions, each magazine or storage pad will be posted with a hazard symbol to properly identify each chemical agent stored.

(4) Facilities used for agent manufacturing, filling, processing, and so forth will be identified by posting the appropriate agent hazard symbols at entrances into the area and on each separate building when more than one building is involved.

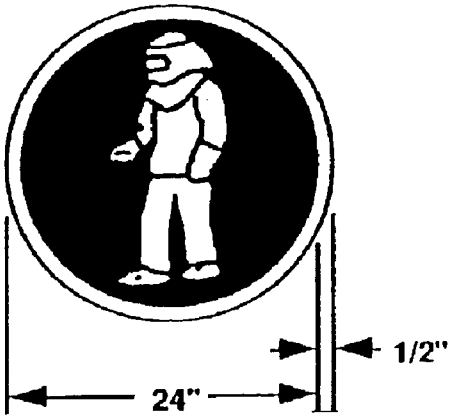
(5) Where topography and/or vegetation would prevent personnel from seeing a chemical hazard marker until arrival at a storage site, a master list will be maintained that indicates igloo location, fire division symbol, and chemical agent

type, if applicable. This list will be kept current and available to emergency forces; for example, guard forces, fire departmenst, chemical accident and incident response and assistance (CAIRA) teams, and so forth.

(6) In addition to the above, fire division symbols described in AR 385–64 must be posted on igloo magazine and outdoor storage sites when such facilities are used for storage of fire division symbols 1 through 4 chemical munitions. When a magazine block contains ammunition or explosives on only one fire division, fire symbols are not required for individual magazines. A fire symbol at each point of entry to the block is sufficient.

*f.* Wooded areas within, or immediately adjacent to, the border of chemical exclusion areas can significantly reduce the 1-percent lethality distances to both on-post, nonrelated inhabited buildings and offpost inhabited buildings. Except for maintaining the required fire break around each magazine and the security clear zone around the perimeter of chemical exclusion areas, cutting or harvesting of trees is prohibited within the 1-percent lethality distance unless specifically approved by the MACOM. Normal selective thinning not to exceed 70 square feet basal area is acceptable.

*g.* Explosively configured agent munitions may be stored in the same structure as class 6. 1 munitions of the same fill.




SYMBOL 1. WEAR FULL PROTECTIVE CLOTHING

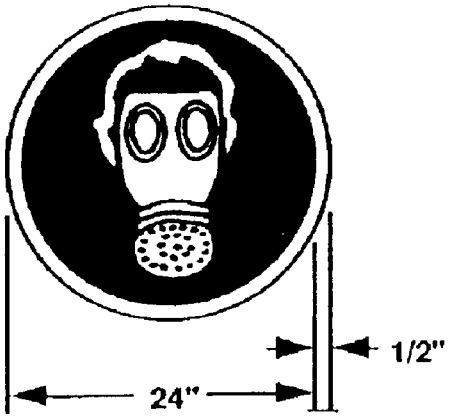
BACKGROUND IS BLUE
FIGURE AND RIM ARE :

RED FOR SET 1 PROTECTIVE CLOTHING
24" NSN-7690-01-081-9586
12" NSN-7690-01-081-9585

YELLOW FOR SET 2 PROTECTIVE CLOTHING
24" NSN-7690-01-081-9587
12" NSN-7690-01-082-0281

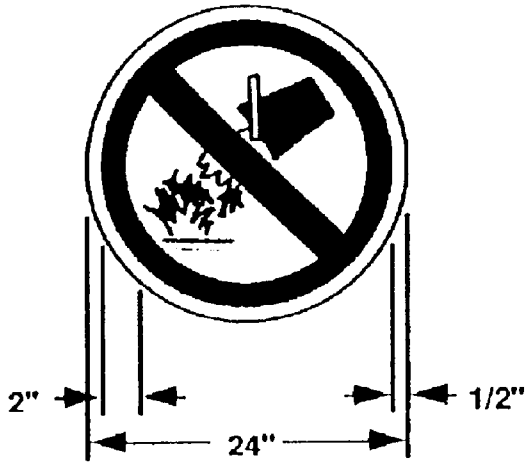
WHITE FOR SET 3 PROTECTIVE CLOTHING
24" NSN-7690-01-083-6272
12" NSN-7690-01-081-9588

COLORS PER FED. STD. 595A OR GSA CATALOG:
RED #11105
BLUE #15102
YELLOW #13538
WHITE #17875
BLACK #17038




SYMBOL 2. WEAR BREATHING APPARATUS

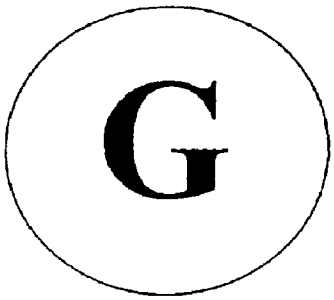
BACKGROUND IS BLUE
FIGURE AND RIM ARE WHITE
24" NSN-7690-01-081-9589
12" NSN-7690-01-082-6710



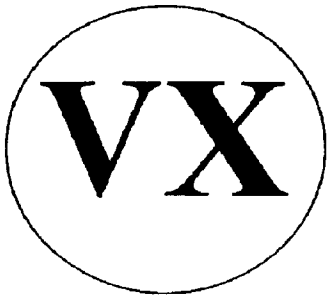

SYMBOL 3. APPLY NO WATER

BACKGROUND IS WHITE, CIRCLE AND DIAGONAL ARE RED, FIGURES ARE BLACK
24" NSN-7690-01-082-2254
12" NSN-7690-01-082-0292

**Figure 9–1. Chemical hazard symbols**

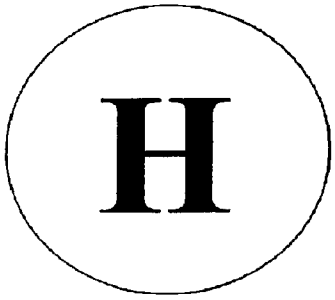



1. G-Type Nerve Agents
24" NSN-7690-01-082-5418
12" NSN-7690-01-081-7481

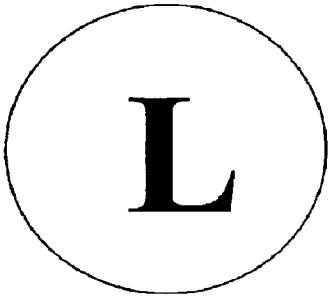



2. VX Nerve Agent
24" NSN-7690-01-081-7483
12" NSN-7690-01-081-7482


3. Incapacitating Agent BZ
24" NSN-7690-01-082-6712
12" NSN-7690-01-082-6711




4. H-Type Mustard Agents
24" NSN-7690-01-082-6713
12" NSN-7690-01-083-1663




5. Lewisite
24" NSN-7690-01-082-6715
12" NSN-7690-01-082-6714

**Figure 9–2. Supplemental chemical hazard symbols**

### 9–3. Storage drawings

Storage of chemical agents or munitions will be according to approved standard drawings. Storage drawings and changes thereto will be reviewed and approved by the MACOM.

### 9–4. Material handling equipment

Only electrically operated material handling equipment (MHE), or clean burning diesel, as specified below, may be used within enclosed areas containing chemical agents or munitions. Requests for authorizations to use other than electrically operated MHE will specifically address the effects of exhaust gases on protective clothing, charcoal canisters and filter elements, and agent monitoring equipment. Gasoline-, diesel-, propane-, or liquefied petroleum gas (LPG)-fueled MHE will not be used in earth covered or Richmond-type magazines because of the hazard of carbon monoxide. Exceptions are specifically approved "clean burning" diesel-fueled forklifts that meet the criteria contained in MIL SPEC 52932.

*a.* Material that is located in the hazardous location, as determined by the National Electric Code (NEC), must be handled by equipment rated by the NEC for use in those areas.

*b.* Concentration of combustion products and noise emitted by the MHE must be monitored by the using installation or activity to assure compliance with standards of the Occupational Safety and Health Administration (OSHA) and The Surgeon General (TSG).

## Chapter 10
## Shipping

### 10–1. Shipping requirements

*a.* This chapter contains the requirements essential for proper handling and transportation of agent-filled munitions and containers. In addition to the shipping requirements outlined herein, the provisions set forth in AR 50–6, AR 190–59, the regulations in Title 49 of the Code of Federal Regulations dealing with the Department of Transportation and TM 38–250/AFI 24–204 must be observed.

*b.* Chemical agents munitions and containers are classified by DOT as explosive 1.1 or 1.2, or poison 6.1. In addition to identifying the proper shipping name, hazard class/storage compatibility group, UN serial number, packaging group, and EX-number; the following rules apply:

(1) Projectiles, shells, bombs, mines, and so forth, containing poison materials but not equipped or packaged with ignition elements, bursting charges, detonating fuzes, or explosive components must be labeled with the applicable poison label and marked nonexplosive (section 101, part 172, title 49, Code of Federal Regulations (49 CFR 172.101)).

(2) Projectiles, shells, bombs, mines, and grenades containing poison materials and equipped with ignition elements, bursting charges, detonating fuzes, or explosive components must be labeled with the applicable poison label and the applicable explosive label (49 CFR 172.101).

### 10–2. Requirement for escort

All shipments of mustards, Lewisite, GB, or VX will be escorted in accordance with AR 50–6 and AR 740–32.

### 10–3. Transportation

*a. Routing.* Routing of shipments will be determined by the controlling transportation movement activity in conjunction with the Army movement monitor. Shipping routes should be selected to avoid congested areas and peak traffic periods to the maximum extent practicable and to ensure maximum availability of emergency equipment.

*b. Monitoring for leakage enroute.* The items will be monitored for leakage prior to and immediately upon completion of shipment. The SOP and the hazard analysis will outline the procedures to be followed and the equipment to be used.

*c. Rail and water shipments.* Refer to AR 50–6.

*d. Air shipments.* Shipment of mustard, Lewisite, G agents, or VX by military aircraft will be in accordance with TM 38–250.

### 10–4. Other regulations

In addition to the shipping requirements outlined and referenced above, DA policy is to comply with applicable State or local regulations governing such transportation, provided this compliance does not prevent the Army from accomplishing its mission. Public Laws 91–121, as amended by PL 91–441 (50 USC 1511–1518), specifies requirements for the transportation of lethal chemical agents, except for research quantities or emergency disposal situations.

## 10–5. Shipment of RDTE quantities of chemical agents

*a.* Ship chemical agents and RDTE solutions in accordance with DOT requirements for hazardous materials, title 49, Code of Federal Regulations (49 CFR). For RDTE solutions, consideration must be given to the chemical agents and the solvent present when determining the proper shipping name.

*b.* The following description provides information on the packaging that is mandatory for all chemical agent (to include RDTE) shipments:

(1) Each agent will be containerized in a flame-sealed glass ampoule. Maximum quantity per ampoule is 40 ml.

(2) One ampoule will be placed in each mailing tube with absorbent to fill voids and to absorb any spill.

(3) Each mailing tube is overpacked in a metal or fiberboard can with a slip-fit top that will be taped in place. All voids within the can are filled with vermiculite. The quantity of mailing tubes per can depends on the size of the ampoule.

(4) The metal or fiberboard can is placed in a laboratory sample container (LSC). The number of cans per LSC is dependent on the length of the LSC. Vermiculite (NSN 5640–01–324–2664) is used to fill all voids between the cans.

(5) The laboratory sample container is a performance-oriented packaging (POP) developed in accordance with 49 CFR for these shipments. It consists of a steel cylinder constructed in the following fashion: on one end the flat bottom is welded; on the other a flange is welded. O-rings are placed in the two grooves in the flange; the inner o-ring is teflon, and the outer o-ring is butyl rubber. Six bolts secure the domed lid to the cylinder. Each bolt is tightened to a specified torque.

(6) Each LSC is overpacked in a wooden box.

*c.* Bubbler samples will be transported in accordance with 49 CFR. See paragraph *b* above for a description of packaging that will be used. Further requirements for shipment are as follows:

(1) Characteristics of the collection media in the bubbler (for example, flammability) as well as the toxicity of the chemical agents will be used to determine proper shipping requirements.

(2) Bubbler openings will be sealed with parafilm tape.

(3) Bubblers must be kept cold during shipment, as required by paragraph 3–1*d*.

## 10–6. Shipment of environmental samples

Environmental samples may consist of soils and other solids, water, sludge, and vegetation. Prior to packaging, samples will be screened using either airborne (ensure concentrations are below the AEL), or soil extraction methods (ensure agent concentrations are below detectable levels). Packaging is as follows:

*a.* Solids, water, and sludge are usually packed in glass jars with a screw top. The top of each jar is sealed with parafilm.

*b.* Vegetation samples may be contained in securely sealed plastic bags.

*c.* Such samples are packed in coolers with cold packs. The coolers are overpacked in wooden boxes to provide a stronger packaging.

## 10–7. On-post transportation

*a.* All on-post movements will have an approved SOP and a supporting hazard analysis (see chapter 6).

*b.* The hazard analysis should include but not be limited to—

(1) Personnel protection.

(2) MHE.

(3) Procedures used in removal from storage.

(4) Item containment.

(5) Loading and unloading of the transportation vehicle.

(6) Suitability of the transportation vehicle (for example, truckbed, open truckbed, or closed van).

(7) Transportation route to include distances involved, population exposure, surface types, and traffic to be encountered.

(8) Monitoring requirements.

(9) Emergency response procedures.

*c.* Materials contaminated with chemical agents may be transported from one location to another. The material shall be encapsulated within an agent tight barrier. The following must be placed in compatibly lined drums or provided with other suitably tested containment before being transported—

(1) Items potentially contaminated with liquid toxic chemical agent.

(2) Items failing a XXX determination.

(3) Items suspected of offering hazards of percutaneous exposure to a chemical agent.

## Chapter 11
## Separation Distance Criteria

### 11–1. Overview

*a.* The risk to personnel at any point in the path of a chemical agent cloud released from munitions, containers, or processing facilities as a result of an accident or leakage is a function of the inherent toxicity of the agent. The mean concentration is influenced by the general climatic conditions, particular temperature gradient near the ground, and the topographical features.

(1) Persistent agent concentrations are even more affected by natural conditions because, in view of the time factor involved, much wider variations are likely to occur and alter diffusion and cloud travel characteristics. Evaporation from the source is an additional factor that varies considerably with temperature, wind speed, and the vapor pressure of the agent.

(2) The accidental functioning of the burster charge in a chemical munitions resulting in maximum aerosolization of the agent filler will require prompt action to identify the path and downwind concentration of the agent cloud.

*b.* In consideration of the variables involved, operational facilities, activities, and storage sites must be selected to provide the maximum separation distance to nonrelated personnel located on the installation as well as to the general public.

### 11–2. Public access exclusion distance

The public access exclusion distance (PAED) is defined as the greater of the inhabited building distance (based on the fragment hazard distance or the net explosive weight (NEW) of the munitions) or the 1-percent lethality distance defined below. For siting purposes, the PAED is analogous to IHBD for explosives, and personnel not directly associated with chemical operations are not to be allowed within the PAED. Personnel who have a means of evacuation, a briefing on evacuation procedures, and access to a warning system (automated, radios, or manual) that would enable them to escape prior to agent exposure may be allowed within the PAED in lieu of absolute exclusion. Details of the evacuation procedures will be included in the site plan and safety submission.

### 11–3. Maximum credible event

*a.* In accordance with standards established by DOD and AR 385–61, the potential for an accident or incident must be carefully analyzed to determine the MCE that could occur and cause agent release.

*b.* For chemical munitions that have explosive components assembled in them, the MCE will be based on functioning of the most disruptive component that would produce maximum release of agent. The MCE must be realistic with a reasonable probability of occurrence. The propagation characteristics of the munitions and damage to adjacent munitions sufficient to cause leakage of the agent filler must also be considered.

*c.* For chemical munitions without explosive components, spillage or leakage of the agent fill usually determines the MCE. Other factors affecting the MCE are rate of release, puddle size, time of decontamination, type of surface, and the agent's characteristics.

### 11–4. 1-percent lethality distance

The 1-percent lethality distance is calculated from a given MCE and meteorological conditions (temperature, wind speed, and so forth) and is established as the distance at which the dosage from an MCE or actual agent release would be 150 mg-min/$m^3$ for H and HD agents, 75 mg-min/$m^3$ for HT agent, 150 mg-min/$m^3$ for Lewisite, 10 mg-min/$m^3$ for GB agent, 4.3 mg-min/$m^3$ for VX vapor, and 0.1 mg for inhalation/deposition of liquid VX. The meteorological conditions used will be the existing conditions in the event of an actual agent release or the realistic, worst-case conditions used will be the existing conditions for siting purposes. Meteorological information must be obtained from an accurate source, with the methodology presented in DDESB Technical Paper No. 10. The AMC handbook for chemical hazard prediction and the several available computer programs consistent with DDESB Technical Paper No. 10 should be used to facilitate calculations. Use of the computer program D2PC will satisfy DDESB Technical Paper No. 10. Any downwind hazard prediction models other than D2PC require HQDA approval. Requests for approval to use modifications to the D2PC or other models will be sent to Director, U.S. Army Nuclear and Chemical Agency, ATTN: ATNA-CM, 7150 Heller Loop, Suite 101, Springfield, VA 22150–3198, for technical review. Submissions will include the rationale and benefits of using the proposed model. Requests will contain a copy of the documentation to include source codes, verification and validation test results, and any other test data, to include field trials. The U.S. Army Nuclear and Chemical Agency will conduct necessary technical reviews and forward justification and recommendation to HQDA (DACS-SF), WASHINGTON DC 20310–0200 for approval.

### 11–5. Inhabited building distance

Inhabited building distance for chemical munitions containing both explosive components and agent filler will be as shown in applicable tables of DA Pam 385–64, based on the hazard class involved. Most chemical munitions are

(12)1.2 hazard class. This distance category is applicable to separation of nonrelated operations, conventional ammunition storage, and installation boundaries from chemical operations.

### 11–6. Intraline distance

Intraline distance for chemical munitions containing both explosive components and agent filler will be as shown in tables of DA Pam 385–64 based on the hazard class of the munitions involved. This distance category is applicable to separation of related operations, facilities, and support facilities within operating areas such as maintenance buildings, change-houses, lunchrooms, field offices, laboratories, laundries, and storage magazines. The intraline distance will be a minimum of 100 feet from potential source of agent release to the other facilities, whether or not explosive components are involved.

### 11–7. Magazine distance

Magazine distance for chemical munitions containing both explosive components and agent filler will be as shown in tables of DA Pam 385–64 based on the hazard class of the munitions involved. For storage of dissimilar class 6.1 agents (without explosives) the magazine distance is 50 feet.

### 11–8. Public traffic route distance

For chemical hazard distance computation purposes, all State and multilane interstate highways and major passenger railroad lines will be considered as public traffic route areas and the greater of public traffic route DA Pam 385–64or 1-percent lethality distance will apply. With respect to the application of 1-percent lethality distance, other roads and railroads will be evaluated on a case-by-case basis, with consideration given to the traffic density for peak periods.

### 11–9. Evacuation/protective distance

In the event of an actual agent release that threatens unprotected personnel, every effort must be made, in proper coordination with civil authorities, to evacuate or take other appropriate protective action for everyone determined to be within the anticipated no significant effects level arcs. Distances to those arcs (no effects distances) are determined for the no significant effects dosage of 2.0 mg-min/$m^3$ for mustard and Lewisite, 0.5 mg-min/$m^3$ for GB, 0.4 mg-min/$m^3$ for VX vapor, and 0.011 mg-min/$m^3$ for VX inhalation-deposition. The no significant effects dosage is that dose at which the general population (to include more susceptible sub populations) would not experience any significant effects.

### 11–10. Quantity distance criteria specific to chemical munitions

The following criteria are applicable to toxic chemical munitions:

*a.* PAED will be applied from toxic chemical facilities, storage, and operations to nonrelated facilities and their related support facilities.

*b.* As a minimum, the inhabited building distance will be applied from conventional munitions storage, operations, and facilities to toxic chemical facilities and their related support facilities.

*c.* Combined chemical and explosive change-houses will be partitioned and will be separated by the appropriate 1-percent lethality distance or inhabited building distance from each area served.

*d.* Facilities for housing security personnel who are required by their mission to have a quick reaction capability in the immediate vicinity of a potential accident/incident site will be sited not less than barricaded intraline distance based on the amount of explosives stored in nearby magazines. If sited inside a 60 degree angle from the unbarricaded door end of an igloo, unbarricaded intraline distance will be used. In any case, the distance will not be less than 150 feet.

*e.* Conventional ammunition storage magazines and toxic chemical storage magazines are required to be separated by magazine distance.

*f.* Drinking water or other suitable replenishment liquid may be located 100 feet upwind per paragraph 7–3*d*. Eating, drinking, chewing, and smoking areas must be located at unbarricaded intraline distance.

*g.* For siting of toxic chemical facilities that present different hazards, PAED will be applied. Where similar hazards are presented, unbarricaded intraline distance is appropriate. Barricaded intraline distance is not appropriate when personnel are exposed.

*h.* For siting chemical facilities and operations, the PAED calculated in accordance with paragraph 11–4 will not extend beyond the boundaries of government-controlled land. Operational and meteorological restrictions need to be applied to keep hazard distances on post.

## Chapter 12
## Toxic Chemical Agent Training

### 12–1. Training overview

*a.* The provisions of this chapter are applicable only to—

(1) Military training operations involving toxic chemical G-agents and VX at the Chemical Defense Training Facility (CDTF) at the U.S. Army Chemical School, Fort Leonard Wood, MO.

(2) Operations directly associated with, and in support of military toxic chemical agent training at the CDTF.

(3) Operation of the CDTF.

*b.* Where conflicts exist between the requirements of this chapter and other parts of this pamphlet, the requirements of this chapter have precedence during training/support operations.

*c.* The requirements contained in this chapter do not apply to any other DA facilities, installations, activities, or depots containing toxic chemical agents.

### 12–2. Airborne exposure limits

*a.* Personnel working or training without respiratory protection in areas where chemical agent may be present, will not be exposed to concentrations exceeding the criteria specified below (AR 385–61, table 2–3). When known or suspected and/or foreseeable agent concentrations exceed these values, appropriate protective clothing will be worn as specified in paragraphs 12–4 or 4–2 and 8–6.

(1) GB: 0.0001 $mg/m^3$ averaged over any 8-hour workshift (8-hour time-weighted average (TWA)).

(2) VX: 0.00001 $mg/m^3$ averaged over any 8-hour workshift (8-hour TWA).

(3) Personnel without respiratory protection will not be allowed access to areas where exposure to agent vapor may exceed 0.2 $mg/m^3$ (GB), or 0.02 $mg/m^3$ (VX), for any period. If these levels are exceeded, a NIOSH/MSHA-approved, full-facepiece, positive-pressure demand, supplied-air respiratory protection must be worn. (For emergency escape, a full-facepiece, chemical-canister, air-purifying protective mask (M9-, M17-, or M40-series) is acceptable.)

*b.* Unrelated personnel will not be exposed to concentrations of chemical agents GB or VX greater than 0.000003 $mg/m^3$ averaged over 72 hours (AR 385–61, table 2–4). Where a deliberate release of chemical agent into training operation areas is an operational requirement, means, methods and procedures (including use of engineering controls) will be implemented to ensure unrelated personnel are protected within the above limits.

*c.* In no case will the concentration of chemical agent at the point of deliberate release from engineering controls (for example, effluent/emission from exhaust ventilation agent filtration systems of a hazardous waste incinerator) exceed the source emission limit of 0.0003 $mg/m^3$ for GB and VX, averaged over any 1-hour period (1-hour TWA).

*d.* No individual will be intentionally exposed to direct skin or eye contact with any amount of solid or liquid chemical agent, or with contaminated material or equipment that has not been certified to the 3X level of decontamination.

### 12–3. Toxic chemical agent monitoring during training exercises and operations

*a. Overview.* For enclosed chemical agent training areas, first entry monitoring may be performed in MOPP4 (modified), as specified in paragraph 12–4*a*, provided—

(1) Dispensed agent has been neutralized, and training aids have been decontaminated.

(2) There have been no agents released in the training area since the last training exercise cleanup.

(3) The exhaust ventilation systems have remained in continuous operation.

*b. Chemical agent monitoring.* The requirements contained in paragraphs 3–3 and 3–4 will be implemented.

(1) During indoor chemical agent operations, continuous monitoring with low-level, real-time monitors (MINICAMS, ACAMS) will be conducted. Monitoring is also required at adjacent nonagent (cold) areas (as identified in para 3–5*a*).

(2) Periodic monitoring with a low-level, real-time monitor (MINICAMS, ACAMS or DAAMS) will be accomplished for all exhaust air filtration systems in agent operating areas and exhaust stacks for chemical agent waste incinerators.

(3) Contaminated equipment and clothing containers will be monitored with a low-level, real-time monitor (MINICAMS, ACAMS or DAAMS). The equipment/clothing will be certified as decontaminated to 3X level of decontamination before removal from the agent operational ("hot") areas (including "hot" decontamination operations laundry area).

(4) Workers in areas with continuous agent monitoring, in accordance with paragraphs 3–5*a* and 12–3*b*(1), may perform assigned duties in level-F protective clothing. A protective mask will be readily available to each worker. In those instances where operations cannot be monitored as outlined in the preceding paragraphs, workers will be dressed in the level of protective clothing and equipment appropriate to the operation in progress. MOPP 4, however, is the minimum level of protection authorized.

(5) Even though continuous agent monitoring shows an area to be free of agent, each worker must be trained to be observant and alert for the symptoms and effects of agent exposure in themselves and others. Suspect conditions or symptoms will be immediately reported to supervisory personnel.

*c. Enclosed areas.* Monitoring is not required prior to entering enclosed agent training areas and operating areas that have been used for agent training or operations if the last monitoring of the area indicated a 3X condition and there has been no agent-filled items brought into, or agent released in, the enclosed area after achieving 3X.

## 12–4. Personal protective clothing and equipment

*a. Overview.* For agent training and support operations, the following levels of protection are defined to supplement those at paragraph 4–1. Increased levels of protection may be used to support specialized training or high-risk operations, as determined by the Chief, CDTF:

(1) *Modified MOPP 4.*

*(a)* Battle dress overgarment (chemical protective).

*(b)* Coveralls or fatigues (optional during warm weather).

*(c)* Butyl apron (M2), extending below top of overboots.

*(d)* Overboots (boot, TAP, safety toe, M2A1, is optimal).

*(e)* Chemical protective glove set.

*(f)* Undershirt.

*(g)* Drawers.

*(h)* Socks.

*(i)* Combat boots or other foot gear designated as part of the duty uniform for training.

*(j)* Mask, worn: M9-, M17-, or M40-series.

*(k)* Hood, TAP M3– (M9–Mask), M6A2– (M17–mask), or M3A1– (M40–series mask).

(2) *Chemical protective overgarment—combat uniform.*

*(a)* Battle dress overgarment (U.S. Army)/MARK III (U.S. Navy)/blucher (German military/MARK IV (British military).

*(b)* Coveralls or fatigues—optional during warm weather).

*(c)* Overboots.

*(d)* Chemical protective glove set.

*(e)* Undershirt.

*(f)* Drawers.

*(e)* Socks.

*(f)* Combat boots or other foot gear designated as part of duty uniform for training.

*(g)* Mask, worn: M9-, M17-, M40-, MCU–2P, M42-, M43-, M24-, M25-series, M65 (German), S10 (British) with hood, as specified for use with masks designated above.

(3) *Refer to chapter 4 for other levels of protective clothing.*

*b.* Impregnated undershirt, drawers, socks, gloves, or chemical protective linen ensemble may be worn as optional, additional items with level A (for example, where their use is essential for realism in training).

*c.* The TAPES may be substituted for level A protection, as defined above, for use in environments that have been approved by TSG.

*d.* In laboratories, a lab coat may be substituted for coveralls, fatigues, or equivalent government issued clothing. The mask may be readily available at the worksite instead of being carried on the person in the slung position. Gloves will be worn when specified in this chapter, or by the requirements of chapter 8.

*e.* Commercially available emergency escape devices may be used under certain conditions for the protection of transient personnel. These devices must have a self-contained air service (5 to 15 minute duration) and a hood and neck seal system that provides positive pressure clean air to the entire hood. They must be NIOSH approved as an escape device. These devices may be used for installation visitors who cannot be properly fitted with a regular protective mask.

*f.* Upon approval by TSG, new respirators may be substituted, as appropriate.

*g.* The level of protection required will be determined for each operation and must be specified in the SOP. Conditions under which the various levels of protection are required are described below (also see para 4–2):

(1) *Level A.* Use level A (para 4–1*c*) in the following circumstances:

*(a)* Personnel who respond to known liquid agent spills, except as noted in this paragraph and paragraph 12–10.

*(b)* CDTF personnel who perform maintenance/cleanup operations in training bay sumps.

*(c)* Technical escort unit/EOD student wear, as required for training realism.

(2) *Level B.* Use of level B (para 4–1*c*(3)) is not applicable to agent training operations/scenarios unless specified as part of the training requirements.

*(a)* Level B will be worn when contact with suspect agent-contaminated items is required, when performing operations that may result in release of agent vapors within the work area (for example, change-out of air filters, operations in the "hot" laundry), and where there is no anticipated contact with liquid agent.

*(b)* Personnel who perform first entry monitoring may wear level B.

*(c)* Personnel performing maintenance within the toxic, or agent operational ("hot") training areas will wear level B (except as noted in (1)*(b)* and (3)*(b)*.

*Note.* Alternate foot wear as specified in paragraph 12–4*a*(2) in combination with overboots (boot covers) as specified in paragraph 12–4*a*(1)*(d)* and 12–4*a*(2)*(c)* may be used as approved by Commander, CDTF on a case-by-case basis.

(3) *Modified MOPP 4.* This level of protection will be worn as determined on a case-by-case basis and approved in the training facility/operation safety submission—

*(a)* By personnel (agent handlers or pourers) designated to contaminate training aids with chemical agents, GB, and VX, within the CDTF.

*(b)* By personnel designated to perform CDTF training bay decontamination/cleanup. Modified MOPP 4 will not be worn for cleanup/maintenance work in training bay sumps. Level A will be worn by personnel working in sumps.

*(c)* In place of level A (for example, M3 TAP suit), for spills of liquid agent, as determined on a case-by-case basis, and when directed by the CAICO, or officer in charge of the CDTF.

*(d)* By medical personnel stationed at CDTF.

*Note.* Authorization for use during agent contamination of training aids (agent pouring) will be made on a case-by-case basis for facility operations as specified in the approved final safety submission and as authorized by the officer in charge of the CDTF. This level of protective clothing is considered to provide protection from agent intermediate between level A and level B (as defined in chap 4).

(4) *Chemical protective overgarment—combat uniform.* This level of protection will be worn as determined on a case-by-case basis and approved in the training facility/operation safety submission:

*(a)* Worn by students and instructors during agent training operations.

*(b)* May be worn by personnel within the toxic or "hot" (agent contamination potentially present) area of laundry, in place of level B.

*(c)* Worn by support personnel in the CDTF protective clothing change-out area.

*(d)* Technical escort/EOD students may wear level A.

*(e)* This level of protective clothing provides agent protection at least as effective as level B but less than modified MOPP 4.

*(f)* Chemical agent vapor concentration must remain below IDLH and/or 0.003 $mg/m^3$ for mustard and Lewisite levels as described in paragraph 12–2 and paragraph 2–6.

(5) *Level E.* Level E will be worn by personnel in the "cold" (for example, decontaminated item) laundry, and by laboratory personnel. "Cold" laundry personnel will wear level E during washing of decontaminated (3X level) items of personal protective clothing and equipment. Paragraphs 8–5, 8–6, and 12–8 of this pamphlet contain requirements for laboratory personnel.

(6) *Level F.* Level F will be worn by visitors who may enter clean areas. These include nonagent operational areas of the training buildings and those areas immediately adjacent to agent operating areas that are continuously monitored in accordance with paragraph 3–5. Visitors not entering the laboratory as part of their tour are not required to carry protective masks as part of level F.

(7) *Nonstandard gloves.* Nonstandard gloves may be used in place of standard TAP gloves for agent activities requiring special handling consideration, such as laboratory operations where good hand dexterity is essential for glovebox operations, subject to the requirements of paragraph 4–2*i*.

*h. Care of protective clothing.* Clothing must be in a serviceable condition and properly fit the wearer. Unserviceable clothing will not be issued or used.

(1) All TAP clothing used in agent operations must be sent to the laundry for inspection and testing quarterly. The M3 coveralls, M3/M4, gloveset gloves, and M2A1 boots will be leak tested prior to issue and use—

*(a)* When newly removed from stock.

*(b)* After each laundering.

*(c)* When they have not been tested within the previous 3–month period.

*(d)* Whenever there is evidence of deterioration or damage that might cause leakage.

(2) The M3 coveralls, gloveset, glove box gloves, and M2A boots will be leak tested using either the Q79A1 or the procedures in TM 10–8415–210–13&P. Because of adhesive left on TAP clothing, tape should not be used for sealing cuffs or marking suits (except as in para 4–2*a*). Masks, coveralls, hoods, aprons, and so forth, may be marked by affixing flexible plastic tags or similar devices to the item or by stenciling in ink in accordance with TM 10–277 and TM 10–8415–210–13&P. Each wearer is to assure serviceability of their PCE by visual inspection before and after use.

(3) Unserviceable TAP items (for example, M2A1 boots) and chemical protective overgarments (MOPP/Mark III) being used for nonagent operations will be clearly, conspicuously, and permanently marked as unserviceable for chemical agent use. They will be treated as 3X decontaminated items, in accordance with chapter 5, unless they are known to have never been exposed to chemical agent contamination.

*i. Laundering of protective clothing.* Requirements for decontamination and laundering of protective clothing will be as follows:

(1) TAP clothing, worn in known or suspected chemical agent vapor contaminated areas, will be decontaminated in accordance with approved SOPs.

*(a)* Clothing will be placed in a container or bag sealed to prevent escape of chemical agent vapors.

*(b)* After at least 4 hours at a location providing a minimum ambient temperature of 70 degrees F or 21 degrees C, the atmosphere inside the container will be tested for chemical agent contamination. Testing should be done using a low level detector to verify that chemical agent vapor concentrations do not exceed the concentrations specified in AR 385–61, table 2–3 (AEL–TWA levels).

*(c)* The CDTF chemical agent monitoring facility has the option of testing protective clothing in accordance with TMs and FMs. Testing must be done before the clothing is removed from the container and sent to the laundry facility.

*(d)* If chemical agent concentrations above the permissible limits are detected, the clothing will be further decontaminated, in accordance with approved SOPs, and retested.

(2) Protective clothing worn in simulated chemical agent training or simulated chemical agent operations, that has not been subjected to liquid or vapor toxic chemical agent contamination, will be flushed with water, air dried, and recertified prior to reuse. Protective clothing that has been worn shall be laundered once every 3 months, as a minimum, as outlined in the SOP, except that water temperature may be reduced to 140 degrees F or 60 degrees C.

(3) Chemical protective overgarments will be containerized/bagged and monitored the same as TAP clothing. These overgarments will not be removed from the container or bag, but will be considered as 3X decontaminated, upon meeting the agent vapor concentration test requirements above and destroyed by incineration in accordance with chapter 5. If controlled agent emission incineration facilities are available, the overgarments may be destroyed without testing; however, the items must be verified decontaminated to the 3X level if removal from engineering controls (agent vapor containment) is required.

(4) Decontamination, autoclaving and reissue of BDOs for toxic training is authorized within the limits of approval granted to the CDTF by TRADOC and TSG.

(5) Protective clothing subject to liquid chemical agent contamination will be decontaminated and tested as described above, and disposed of in accordance with chapter 5. If controlled agent emission incineration facilities are available, the clothing may be destroyed without testing; however, the items must be verified as decontaminated to the 3X level if removal from engineering controls (agent vapor containment) is required.

(6) Whenever the degree of contamination is questionable, the clothing will be treated as if it were subjected to major liquid chemical agent contamination.

(7) Butyl rubber protective clothing contaminated with petroleum base products, including solvents or lubricants, will be disposed of in accordance with chapter 5.

(8) Overgarments identified for simulated chemical agent training will not be used for toxic agent training. This clothing will be marked in accordance with guidance in paragraph 12–4*h*(3) or otherwise maintained under positive control to ensure they are not used in a toxic chemical agent environment.

(9) Protective clothing, which has been decontaminated as specified above, and which will be reused, will be laundered and tested for serviceability, as noted in paragraphs 4–3*f*, 12–4*h* and 12–4*i*, as applicable.

*Note.* For additional decontamination of protective clothing that tests "positive" on initial container sampling, a 10 percent solution of HTH or sodium carbonate should be used. If contamination with GB is known, a 10 percent solution of sodium carbonate or sodium hydroxide is acceptable. For known contamination with VX only, a 10 percent solution of HTH or STB slurry should be used.

*j. Temperature consideration.* To prevent heat exhaustion and fatigue while wearing the M3 TAP suit or chemical agent protective overgarment (battle dress overgarment/MOPP or MARK III overgarment), maximum wearing time should be established by the local medical authority. Factors such as relative humidity, use of evaporative cooling suits, and activity levels should be taken into consideration. Additional guidance for preventing heat injuries is provided in TB Med 507, and FM 21–10, FM 21–11, and FM 3–4. As a general guide, see table 12–1.

*k. Respiratory protection program.* In activities where respiratory protection is required, a program for selection, use, inspection, testing, and maintenance that complies with DA Pam 40–8 and TB Med 502 will be established. The program will include the following essential elements:

(1) *Selection.* The device that will give the best protection and that can be worn with the greatest degree of comfort under conditions of employment will be selected using the standards below—

*(a)* Air-supplied respiratory protection is required in oxygen deficient atmospheres (less than 19. 5 percent oxygen) with auxiliary self-contained air supplied to an air storage receiver with alarm.

*(b)* Canister or filter-element type air purifying masks can be used where oxygen deficiency is not a factor and chemical agent concentrations do not exceed IDLH and/or 0.003 $mg/m^3$ for mustard and Lewisite levels. This category of protection includes the M9-, M17-, and M40-series masks and other protective masks, as specified in paragraph 4–1.

*(c)* All M17-series masks must be equipped with M13A2 filter elements having green filter element sleeves NSN 4240–00–165–5026. M13 and M13A1 filter elements with black or gold filter element sleeves will not be utilized for protection against agents GB and VX.

*(d)* Canister or filter-elements for all masks approved for use, must be approved for their intended use and meet serviceability requirements of applicable TMs and SBs.

(2) *Wearer instructions.* The wearer will be properly fitted and trained in the use and care of the device, and the means by which it gives protection.

*(a)* The wearer will be clean shaven, to the extent that there is no possible interference by any facial hair growth (including beard and sideburns) with the sealing surfaces of the protective mask.

*(b)* Personnel with beards will be denied access to agent training and operations. Anyone who needs to grow a beard to effect a cure, as determined by his attending physician or dermatologist, will be excused from agent training or operations until such time as the beard is no longer required. This restriction does not apply to visitor personnel provided with a self-contained emergency escape device.

*(c)* Female soldiers will remove all hairpins, combs, hair knots, buns, or braids that interfere with the facepiece seal.

*(d)* For the wearing of optical inserts, glasses, and contact lenses see paragraph 4–4*b*.

(3) *Storage.* Protective masks will be stored so they are not exposed to sunlight, heat, extreme cold, moisture, and so forth that might cause deterioration.

*(a)* Protective masks should be stored in the carriers provided and should be hung by the shoulder strap or D-ring on the carrier or stored in separate bins. Masks not in their carrier may be stored in separate bins.

*(b)* M40-series masks will have faceforms inserted into the facepiece when in storage for longer than 30 days.

(4) See appendix B and C for protective mask fit requirements and exemptions.

## 12–5. Decontamination

*a. Decontamination agents.* Standard decontaminating agents that are acceptable for decontaminating equipment or spills include, but are not limited to (see para 5–1*f*)—

(1) DS2 for GB and VX. Because DS2 has damaging effects on butyl rubber, frequent inspection of protective garments must be made to ensure protective equipment will provide adequate protection. Suspect or damaged clothing will be disposed of in accordance with chapter 4 and paragraph 12–4*h*. Never mix DS2 with pure STB or HTH.

(2) STB slurry or HTH solution for agent VX.

(3) 10 percent sodium hydroxide or sodium carbonate solution for agent GB.

(4) Commercial liquid bleach (nominal 5 percent solution of sodium hypochlorite).

*b. Decontamination equipment (see para 5–1g).*

(1) Equipment provided for decontamination during training exercises should be precharged prior to the start of the exercise.

(2) Training facility staff personnel will verify the serviceability of decontaminating equipment.

(3) Decontamination equipment will be positioned in locations that allow ready access to decontamination and emergency response personnel.

## 12–6. Safety criteria for training facilities

*a. SOPs.*

(1) SOPs and changes to SOPs will be prepared, reviewed, validated, and approved in advance of operations, and they will include sufficient detail to outline necessary safety and operational requirements.

*(a)* SOPs and changes to SOPs will be coordinated with the local installation safety manager.

*(b)* Copies of the applicable SOP will be posted at the worksite for personnel information, guidance, and compliance. self- and buddy-aid procedures must be included.

*(c)* Where reliable communication between instructors or cadre and operations control is in effect, SOPs need not be posted within agent training or operational areas (for example, CDTF toxic agent training bays).

(2) Personnel limits will be established to allow supervisory and transient personnel (that is, safety, security, surety) to evaluate the operation.

*b. Floor drains.* For buildings and laboratories utilizing chemical agents, and wherever personnel emergency showers are located, floor drains or other collection means should be utilized. All drains that could possibly receive agent or agent contaminated effluent should be connected to a sump or collection tank. Final neutralization of chemical agent will take place in this sump or tank.

*c. Criteria for containment of agent training operations.*

(1) All facilities in which GB or VX is used for training and/or for operations to support chemical agent training, will be designed to prevent agent release exceeding the limits specified in AR 385–61, table 2–3 and paragraph 12–2.

(2) Agent emissions will be controlled by the use of one or more of the following engineering measures:

*(a)* Negative pressure, controlled pressure, controlled air flow, walled or multiple-walled containment structures, filtered enclosures, and/or filtered exhaust ventilation systems.

*(b)* Examples are laboratory hoods, gloveboxes and vapor containment rooms or buildings. An exception to this requirement is allowed where periodic monitoring, including air monitoring, verifies that adequate agent containment is maintained.

## 12–7. Emergency response equipment

*a.* The following emergency response equipment will be immediately available at any site or facility where training operations involving nerve-agent items are conducted.

(1) A Government vehicle that can be used as an patient transport vehicle.

(2) A communication system with which to summon aid.

(3) Suitable decontaminating materials.

(4) A supply of clean water for decontaminating purposes.

(5) Equipment and supplies with which to render first aid.

(6) Three MARK 1 nerve-agent antidote kits (NAAK) per person. MARK 1 kits for visitors will be contained in chemical agent casualty kits located in toxic agent training building. (The MARK 1 NAAK must not be stored in the proximity of solvents, even when sealed in polyethylene bags, because some solvent vapors can cause the auto-injector to malfunction. The auto-injectors must be protected from freezing because the injector will not function properly while frozen.)

(7) Suitable, operable chemical agent detection equipment, appropriate for the type of agent (GB and VX) present.

*b.* The following additional emergency equipment, as a minimum, will be available for emergency use by trained personnel (quantities will be sufficient for the operation being performed as determined by the supporting MEDDAC).

(1) Atropine.

(2) 2-PAM chloride.

(3) Commercial liquid bleach (nominal 5 percent solution of sodium hypochlorite).

(4) Clean water for flushing eyes and skin.

## 12–8. Laboratory safety

*a. Agent containment.* Containment of chemical agent liquid and vapors is required at all times within a laboratory. Within the CDTF, transferring chemical agent from the laboratory hood, by the pass-through chute, into the service gallery, and subsequently to the training bays, is not considered to be removal from agent containment engineering controls. When chemical agent must be removed from the containment provided by engineering controls, the following restrictions apply:

(1) For quantities of 1 milliliter (ml) or less of chemical agent, one of the following is required:

*(a)* A double containment system.

*(b)* A single containment system with a protective mask worn.

(2) For quantities in excess of 1 ml of chemical agent, a double containment system is required.

*b. Monitors.* MINICAMS, ACAMS, and DAAMS sample analyses may be conducted outside the ventilation hood.

*c. Agent monitoring.*

(1) A detection capability for GB/VX with a sensitivity equal to or better than the M8 alarm must be maintained within the laboratory or readily available outside.

(2) During the first 5 days of new chemical agent operations, MINICAMS, ACAMS, or bubbler (AEL—TWA level) monitoring will be conducted to verify the adequacy of engineering controls. Remonitoring will be conducted for one operating day quarterly, following any significant changes in the operation, or following any damage or repairs to the ventilation system.

*d. First entry.* Monitoring will be conducted in accordance with this chapter and chapters 3, 4, and 5 respectively. Unmasked personnel will not reenter until airborne chemical agent vapor contamination is verified to be below the AEL—TWA specified in AR 385–61, table 2–3. If continuous chemical agent monitoring by MINICAMS or ACAMS to AEL—TWA levels is not in effect, the following conditions require first entry monitoring:

(1) Chemical agent spill outside of agent containment (engineering) controls.

(2) Major chemical agent spill within laboratory ventilation hood (20 ml or more).

(3) Ventilation failure of laboratory ventilation hood, with uncontained chemical agent present within hood.

(4) Ventilation failure of a laboratory ventilation hood, containing any amount of chemical agent, lasting longer than 24 hours.

*e. Protective clothing and equipment (see para 8-5 and 8-6).* Personal protective clothing, such as butyl gloves, aprons, and TAP or MOPP4 clothing necessary to protect personnel during chemical agent operations and for use in case of an emergency, will be kept readily available.

*f. Labeling containers (see para 8-8i).* Those inner containers too small for complete labeling must have the name or code name of the agent clearly marked, and they may refer to additional required information by a locally determined system.

## 12–9. Storage requirements

*a.* Installations and activities using GB and VX agents for training, or in operations to support training, will implement the following storage procedures.

(1) Agent-filled containers will be stored only in specifically designated locations.

(2) Storage locations will have floors and floor surfacing that can be decontaminated.

(3) Bulk agent may be transferred to smaller containers, and stored in these containers. The quantity of agent will not exceed 1 liter per container.

(4) Agent containers will be stored in a single containment system within a laboratory hood or in a double containment system.

*b.* Leaking containers will be handled only by authorized personnel who have been instructed and are qualified in the appropriate procedures to be used.

*c.* Chemical hazard symbols/markers will be used to identify areas designated for the storage of nerve agents.

### 12–10. Firefighting requirements

*a.* Firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and rescue operations in buildings or areas containing agents GB or VX. Respiratory protection is required. Positive-pressure, full-facepiece, NIOSH/MSHA-approved SCBA will be worn where there is a danger of oxygen deficiency, when a potential for agent release exists, or when directed by the fire chief or CAICO.

*b.* In cases where firefighters are responding to a CAI for rescue or reconnaissance rather than firefighting, they will wear appropriate levels of protective clothing as described in paragraph 4–2*a* (level A), or as specified by the CAICO.

(1) Firefighters will be warned of the combustible characteristics of butyl rubber protective clothing.

(2) For accident incident situations, the CAICO may determine the proper level of protection required for initial entry (reconnaissance) teams and may modify existing levels of protective clothing to meet emergency requirements.

## Appendix A
## References

### Section I
### Required Publications

**AR 11–34**
The Army Respiratory Protection Program (Cited in para 4–6)

**AR 40–5**
Preventive Medicine (Cited in para 7–4)

**AR 50–6**
Nuclear and Chemical Weapons and Material, Chemical Surety (Cited in paras 1–1*a*, 1–1*e*, 5–2*h*, 10–1*a*, 10–2, and 10–3*c*)

**AR 75–15**
Responsibilities and Procedures for Explosives Ordnance Disposal (Cited in para 5–2*b*)

**AR 385–10**
The Army Safety Program (Cited in paras 1–4*b*, 1–4*c*, and 7–7*d*)

**AR 385–16**
System Safety Engineering and Management (Cited in para 6–5)

**AR 385–61**
The Army Technical Agents Safety Program (Cited in paras 1–1*a*, 1–1*c*, 1–4*c*, 1–7*a*, 2–6*a*, 2–6*b*, 3–5*a*, 3–9*a*(1)*(a)*, 3–9*a*(1)*(b)*, 4–1*a*, 4–2*c*, 4–6, 5–2*f*, 6–2, 6–3*c*, 6–5*c*, 6–7*a*(2),6–8*b*, 6–8*d*(1)*(b)*, 6–11*a*, 7–3*d*, 8–1*a*, 8–3*c*(5), 9–1*b*(3), 11–3, 12–2*a*, 12–2*b*, 12–4*i*(1)*(b)*, 12–6*c*(1), 12–8*d*, B-2*m*, F-2*c*, and F-3)

**AR 385–64**
U.S. Army Explosives Safety Program (Cited in paras 1–4*c*, 5–2*b*(5), 6–8*a*, 6–8*d*(1)*(d)*, 6–11*a*, 8–8*e*, and 9–2*e*(6))

**AR 420–90**
Fire and Emergency Services (Cited in paras 6–5*n* and E–4*b*)

**AR 700–68**
Storage and Handling of Compressed Gases and Gas Liquids in Cylinders (Cited in para 8–7*g*)

**AR 740–1**
Storage and Supply Activity Operations (Cited in para 1–4*d*)

**AR 740–32**
Responsibilities for Technical Escort of Dangerous Materials (Cited in para 10–2)

**DA Pam 40–8**
Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD and VX (Cited in paras 1–1*c*, 3–7*a*, 4–2*h*(1), 4–2*h*(2), 4–4*e*(3), and 7–4)

**DA Pam 40–173**
Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT (Cited in paras 1–1*d*, 3–7*a*, 4–2*h*(1), 4–4*b*(3), 7–4, and 12–4*k*)

**DA Pam 385–64**
Ammunition and Explosives Safety Standards (Cited in paras 6–5*n*, 11–5, 11–6, and 11–7.)

**FM 3–4**
NBC Protection (Cited in paras 12–4*j* and D–4*c*)

**FM 3–5**
NBC Decontamination (Cited in para 5–1*f*(2)*(b)*)

**FM 3–9**
Potential Military Chemical/Biological Agents and Compounds (Cited in para 2–3)

**MIL STD 105E**
Sampling Procedures and Tables for Inspection by Attributes (Cited in para 5–1*f*(2)*(c)*)

**SB 742–1**
Inspection of Supplies and Equipment: Ammunition Surveillance Procedures (Cited in paras 1–4*d*, 3–6*b*(1), 6–7*b*, 6–8*a*, and 9–1*b*(2))

**TB Med 502**
Occupational and Environmental Health Respiratory Program (Cited in paras 4–6 and 12–4*k*)

**TB Med 507**
Occupational and Environmental Health: Prevention, Treatment, and Control of Heat Injury (Cited in para 12–4*j*)

**TB Med 577**
Occupational and Environmental Health: Sanitary Control and Surveillance of Field Water Supplies (Cited in paras 5–2*e*(1) and 8–2*a*)

**TM 3–4240–279–10**
Operator's Manual for Mask, Chemical-Biological: Field M17, M17A1, M17A2 (Cited in para 4–6*e*)

**TM 3–4240–346–10**
Chemical Biological Masks: Field M40AI; Combat Vehicle M42A2d, M40 (Cited in para 4–6*e*)

**TM 38–250**
Preparing Hazardous Materials for Military Air Shipments (Cited in paras 10–1*a*, 10–3*d*)

**29 CFR 1910**
Occupational Safety and Health Standards (Cited in paras 3–7*c*, 6–3*a*, 8–1*a*, and 8–10*a* and *b*) www.osh.gov

## Section II
## Related Publications

**AR 55–228**
Transportation by Water of Explosives and Hazardous Cargo

**DA Pam 50–6**
Chemical Accident or Incident Response and Assistance (CAIRA)

**FM 3–21**
Chemical Accident Contamination Control

**FM 8–285**
Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries

**FM 9–20**
Technical Escort Operations

**FM 21–10**
Field Hygiene and Sanitation

**FM 21–11**
First Aid for Soldiers

**TM 3–250**
Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals

**TM 3–4230–209–10**
Decontaminating Apparatus: Power Driven, Skid Mounted, Multipurpose Nonintegral 500 Gallon, M12A1

**TM 3–4240–279–20&P**
Unit Maintenance Manual for Mask, Chemical-Biological; Field ABC-M17, -M17A1, -M17A2

**TM 3–6665–254–12**
Operator's and Organizational Maintenance Manual: Detector Kit, Chemical Agent, ABC-M18A2

**TM 3–6665–307–10**
Operator's Manual for Chemical Agent Detector Kit, M256 and M256A1

**TM 3–6665–311–10**
Operator's Manual for Paper, Chemical Agent Detector: M9

**TM 3–6665–312–12&P**
Operator's and Organizational Maintenance Manual for the M8A1 Automatic Chemical Agent Alarm

**TM 10–8415–210–13&P**
Operator's, Unit, and Direct Support Maintenance Manual Including Repair Parts and Special Tools List for the Toxicological Agent Protective (TAP) Ensemble

**40 CFR 260–265, 270**
Regulations for the Management of Hazardous Waste

**49 CFR 171–177**
Hazardous Materials Regulations

**49 CFR 178**
Shipping Container Specifications (Department of Transportation, Washington, DC)

### Section III
### Prescribed Forms
This section contains no entries.

### Section IV
### Referenced Forms

**DD Form 2271**
Decontamination Tag

## Appendix B
## Qualitative Protective Mask Fit Testing

### B–1. Isoamyl acetate test
*a. Overview.*
(1) The test depends on the odor of isoamyl acetate (so-called banana oil because of its odor).

*Note.* Amyl acetate and N-amyl acetate are also acceptable.

(2) The test consists of two parts, odor sensitivity check and mask fit check.
(3) Select a location for testing that is free of sources of ignition because isoamyl acetate is flammable. The flash point is 77 degrees F, and the lower explosive limit in air is 1 percent. The safe limit in air is 0.25 percent.
(4) Test chamber should be in a well ventilated room separate from where the facepiece selection and sensitivity check are performed in order to avoid olfactory fatigue.
(5) Chamber consists of a plastic enclosure about 24 inches in diameter that covers the head and upper body of the test subject. A clear 55–gallon drum liner suspended upside down on a suitable frame is adequate.

*b. Equipment and supplies.*

(1) 55-gallon drum liner and suitable frame.

(2) Supply of 4–inch by 5–inch pieces of absorbent paper.

(3) Small bottle (2 to 4 ounces) of isoamyl acetate, eyedroppers calibrated in milliliters, and a supply of cotton-tipped swabs.

(4) Four 1 liter glass jars with metal lids (for example, Mason or Ball jars).

(5) A stock solution of 1 ml of isoamyl acetate in 800 ml of odor-free water in a 1 liter container (from (4) above). Fresh solutions will be made up weekly.

(6) Two 1 liter containers (from (4) above), each containing 500 ml of odor-free water. These will be the blank solutions in the sensitivity test.

(7) A sensitivity solution of 0.5 ml of stock solution in 500 ml of odor-free water in a 1 liter container (from (4) above). Fresh solutions will be made daily.

(8) Preparation or expiration date should be marked on the containers of the stock and sensitivity solutions.

*c. Odor sensitivity test.*

(1) In a room separate from the test chamber set up the two containers of blank solutions and the container of the sensitivity solution in random order.

(2) Instruct the test subject to identify the container of the sensitivity solution (isoamyl acetate solution) by opening lids and inhaling.

(3) If subject is unable to distinguish between the odor of the liquid in containers, olfactory impairment is assumed and paragraph B–2 applies.

(4) Don and adjust protective mask prior to entering the test chamber room.

*d. Fit check.*

(1) Hang absorbent paper, which has been folded in half and wetted with 0.5 ml of isoamyl acetate, on the hook in the top of the chamber (examiner may accomplish prior to subject being tested).

(2) Wait 2 minutes before allowing the test subject to enter the chamber. This allows the isoamyl acetate concentration to reach the required level of 150 ppm (nominal).

(3) Instruct the test subject to enter the test chamber and perform each exercise listed below for 30 seconds:

*(a)* Normal breathing.

*(b)* Deep breathing. Be certain breaths are deep and regular.

*(c)* Turn head from side to side. Be certain movement is complete, with one turn every second. Avoid bumping of the respirator on the shoulders.

*(d)* Nod head up and down. Be certain motions are complete and made about every second. Avoid bumping of the respirator on the chest.

*(e)* Talking. Read a paragraph that incorporates the full range of speech sounds such as the so-called rainbow passage used by speech therapists. Be certain the paragraph is read aloud and slowly.

*(f)* Normal breathing.

(4) Mask fit is deemed adequate if the isoamyl acetate (banana oil) odor is not detected at any time during the fit test.

*Note.* After fit check is deemed adequate, remove the mask without loosening the head straps. If the head straps are loosened when doffing the mask, repeat the fit check. Do not loosen any of the straps on the M9 or M17 mask. If the mask is a M40, do not loosen the top two head straps.

(5) Terminate the test if the isoamyl acetate odor is detected at any point during the test. Detection of the banana oil odor of the isoamyl acetate by the subject indicates that the mask does not fit or is defective.

(6) Remove the wetted paper after the subject leaves the test chamber and deposit in a closed container.

(7) If test is not passed satisfactorily, either because of improper mask size or mask is found to be defective, instruct test subject to obtain a new mask and repeat the entire fit test sequence.

(8) If mask is found to be defective, a new mask will be issued and the defective mask identified and turned in as unserviceable.

### B–2. Irritant fume protocol

*a.* When an individual's olfactory senses are impaired, it will be necessary to test the mask for fit and leakage with irritant smoke.

*b.* The test subject will be allowed to smell a weak concentration of the irritant smoke to familiarize him or her with the characteristic odor.

*c.* The test subject will properly don the mask and wear it for at least 10 minutes before starting the fit test.

*d.* The test conductor will review this protocol with the test subject before testing.

*e.* The test subject will perform the conventional positive pressure and negative pressure fit checks. Failure of either check will be cause to select an alternate mask.

*f.* Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to deliver 200 ml per minute.

*g.* Advise the test subject that the smoke can be irritating to the eyes and that his or hers eyes must be closed while the test is performed.

*h.* The test conductor will direct the stream of irritant smoke from the tube towards the faceseal area of the test subject. Testing will begin at least 12 inches from the facepiece and gradually move to within 1 inch, moving around the whole perimeter of the mask.

*i.* The following exercises will be performed while the mask seal is being challenged by the smoke. Each will be performed for 1 minute.

(1) Normal breathing.

(2) Deep breathing. Be certain breaths are deep and regular.

(3) Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the mask on the shoulders. Have the test subject inhale when his or her head is at either side.

(4) Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the mask on the chest. Have the test subject inhale when the head is in the fully up position.

(5) Talking. Talking slowly and distinctly, count backwards from 100.

(6) Normal breathing.

*j.* If the irritant smoke produces an involuntary reaction (cough) by the test subject, the test conductor will stop the test. In this case the tested mask is rejected and another mask will be selected.

*k.* Each test subject passing the smoke test without evidence of a response will be given a sensitivity check of the smoke from the same test tube to determine whether the test subject reacts to the smoke. Failure to evoke a response will void the fit test.

*l.* Steps in *e*, *h*, and *i*, above, will be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the irritant smoke.

*m.* Masks successfully tested by the protocol may be used in contaminated atmospheres (see table 2–1, AR 385–61).

*n.* If the mask is doffed after the smoke test and prior to use, DO NOT loosen the head straps. If the head straps are loosened, retest the mask on the subject. Do not loosen any of the straps on the M9 or M17 mask. If the mask is a M40, do not loosen the top two head straps.

## Appendix C
## Mask Wearing Procedure and Protective Mask Leak Testing

### C–1. Donning the M9 and M17 protective mask

The mask is donned using the following procedures:

*a.* Stop breathing. Do not take a deep breath.

*b.* With left hand, pull open the carrier flap, and with the right hand reach into the carrier, grasp the front portion of the facepiece in the area of the voicemitter-outlet valve assembly, and withdraw the mask from the carrier.

*c.* Grasp the left side of the facepiece with the left hand and the right side of the facepiece with the right hand. Slip the thumbs under the head harness straps. Separate the hands to open the facepiece.

*d.* Seat the chin in the chin pocket and slip the head harness straps over the head to pull the mask up onto the face (do not slip the head harness straps over the head and then pull the mask down over the face).

*e.* Make sure that the head harness straps lie flat against the head.

*f.* Place the palm of one hand over the openings in the bottom of the outlet valve cover. Expel the air that has been held in the lungs, forcing exhaled air to escape around the facepiece, therefore, clearing the mask of contaminated air.

*g.* Press the palms of the hands over the canister inlet (M9,) or the inlet valve caps (M17). Inhale lightly and hold breath for approximately 10 seconds to determine whether an airtight seal of the mask against the face has been obtained as indicated by collapse of the facepiece.

*h.* Resume normal breathing.

*i.* Fasten neck strap (M9 mask only).

### C–2. Donning the M40 protective mask

The mask is donned using the following procedures:

*a.* Stop breathing and close eyes.

*b.* Open carrier with left hand and hold open while grasping facepiece with the right hand. Remove mask from carrier.

*c.* Put the chin in chin pocket and press facepiece snugly against the face.

*d.* With palm of hand, cover inlet port of the canister(s) and breathe in. Facepiece should collapse against the face and remain so while holding breath. If it does, facepiece is airtight.

*e.* Cover openings at bottom of outlet valve with palm of one hand and squeeze the outlet valve cover. Breathe out hard so that air escapes around edges of facepiece.

*f.* Grasp the top tab and pull head harness over the head. Be sure the ears are between the temple straps and check straps. While holding facepiece to face with one hand, maintain seal. Using other hand, tighten check straps one at a time. Be sure headpad is centered at the high point of rear of the head.

*g.* Make sure that the head harness straps lie flat against the head.

*h.* Clear the facepiece again (step d) and recheck facepiece for leaks (step e).

*i.* Resume breathing.

### C–3. Doffing the protective mask

*a.* Remove the protective mask only in an area known to be free of agent contamination, including personal contamination.

*b.* Unfasten neck strap (M9 mask only).

*c.* Pull up from the chin and remove over the head.

*d.* Record use-time or take other locally determined actions to comply with paragraph 4–4c.

### C–4. Irritant chamber

*a.* For student groups training at the CDTF, mask testing for fit and leakage in an irritant chamber may be conducted provided the following procedures are used. (M40 mask wearers must have previously been fit tested using the M41 PMFVS).

(1) Use a chamber that can be ventilated after each test.

(2) Personnel will don the protective mask prior to entering the chamber. The protective mask hood, if attached, will be in a rolled-up position. (When students, instructors, or others are in level A, the protective mask hood need not be in a rolled-up position. Verification of mask facepiece to face seal, however, must be done with the hood rolled-up, prior to personnel entry into toxic agent chamber.)

(3) At least two instructors will accompany all personnel entering the irritant chamber.

(4) The primary instructor will open and exhaust a commercially available smoke tube containing stannic chloride.

(5) Instruct personnel to breath deeply and move their head in all directions.

(6) Instructors will be alert for any signs of irritation from the personnel.

*b.* The assistant instructor will lead anyone experiencing irritation from the chamber.

## Appendix D
## Hot-Line Operations

### D–1. Hot line operations

Hot line operations will be established following a chemical accident or incident as required by the installation or activity CAIRA Plan. The purpose is to provide a systematic means to decontaminate potentially contaminated personnel and equipment leaving a CAI site. (Additional information outlined in FM 3–21 may be used as a guide to hot-line operational procedures.) The CAICO has the authority to deviate from the requirement in this appendix. Deviations will be based on the operational hazards.

### D–2. Site selection

The site for hot-line operations should be preselected where possible for storage and operations. The site selected should—

*a.* Be upwind of the accident site.

*b.* Be as close to the accident site as feasible.

(1) Initially, the site should not be closer than the fragmentation distance of the munitions involved (normally 1200 feet).

(2) After explosive ordnance reconnaissance and/or the CAI site has been evaluated free of any explosive hazard, the hot line may be moved closer, as long as the site provided the area between the initial site and the proposed new site has not been contaminated. The minimum distance will be 50 meters from the incident site.

*c.* Provide for an area for parking vehicles and large equipment, to include turnaround space without having to back up or advance toward CAI site.

*d.* Have an area for decontamination of vehicles and large equipment.

## D–3. Description

The hot-line operations area will consist as a minimum of—

*a. Hot line.* The downwind end of hot-line operations.

*b. Contamination reduction area (CRA).* The CRA area between the hot line and the contamination control line that is used for the decontamination of personnel and equipment. The CRA should have—

(1) An equipment drop for radios, detection equipment, tools, and weapons.

(2) A decontamination station for equipment.

(3) Step-in decontamination pans leading to the personnel decontamination stations.

(4) Personnel decontamination station (PDS).

(5) A monitoring station for personnel and equipment.

(6) An area for decontaminating, monitoring, and handling medical casualties.

*c. Contamination control line (CCL).* A line separating the contamination reduction Area from the clean area. It will be established immediately upwind from the CRA.

(1) Only those personnel and equipment that have been through the decontamination process and found free of contamination will cross the CCL.

(2) The CCL should be a minimum of 50 meters upwind from the hot line.

(3) If at anytime the clean area upwind of the CCL becomes contaminated, the CCL will be reestablished in a clean area.

*d. Clean area.* Upwind of the contamination control line will be the clean area. All weather facilities for bathing and redressing will be provided for individuals who have processed across the CCL. These facilities may be fixed, semifixed, semi- mobile, mobile, or a combination. Care is to be exercised in use of outside showering facilities during adverse weather conditions to prevent hypothermia. The CAI control officer will consult the medical officer regarding the use of outdoor showers during adverse weather. The installation medical officer and safety officer will be consulted regarding health hazards associated with antifreezing substances used in outdoor showering facilities.

## D–4. Establishment of hot-line operations

*a.* Initially and immediately, a minimum of two persons in proper toxic agent protective clothing will report to a site upwind of the CAI to establish the hot line. These individuals should be prepared to perform emergency decontamination procedures and monitoring of personnel and equipment prior to establishment of the PDS. Emergency decontamination should be restricted to agent exposures and medical casualties requiring expeditious transport to the MTF and to themselves, if required. (See *d*, below.)

*b.* The approach to the proposed hot line will generally be from an upwind direction. Approximately 1 mile from the incident/accident site, protective clothing will be donned. While moving toward the hot line, periodic agent sampling will be done to reassess the level of protective clothing. Monitoring will be done with fast-responding devices (for example, M8 detector units, blue band tubes).

*c.* At the appropriate distance from the CAI site (para D–2*b*), monitor the proposed CCL. If the test is negative, advance toward the CAI site 50 meters and perform two more tests 50 meters apart on an axis that is perpendicular to the route of advance. If these two tests are negative, move to the center of the three test sites and perform vapor tests (fig D–1). If all tests are negative and there is no visual evidence of agent, the team can unmask in accordance with FM 3–4.

*d.* If any of the tests are positive, the team will decontaminate themselves as well as possible and move back to the area just short of the last negative test site. There, the team will await the arrival of personal decontamination equipment and process through it.

*e.* A determination of wind speed and direction will be made at least every 30 minutes. If smoke grenades are used, caution should be taken to ensure that smoke does not engulf personnel, limiting vision and/or causing exposure to smoke. Keep a minimum of 50 meters upwind from personnel.

## D–5. Command and control

There should be one individual exercising control of all personnel and equipment at the CCL. All emergency crews dispatched to the CCL are to report to and be dispatched to the CAI site by the CCL controller.

*a.* Communications are to be established with the chemical accident/incident site and the emergency operations center.

(1) Emergency teams on separate independent two-way radio networks are to keep the CCL controller apprised of the current situation in their areas of responsibility.

(2) The CCL controller is to continually advise the CAI control officer of actions taken and status of those actions.

*b.* Strict control must be maintained on the casualties through the hot line.

*c.* Supervisors and the CCL controller must be aware of the current physiological condition of the emergency response personnel and any heat imposed limitations.

### D–6. Agent contamination control

One of the primary goals of CAIRA is to contain agent contamination and, if it cannot be contained immediately, to restrict the contamination to the CAI site and prevent the spread of agent to other areas. Every effort is to be taken to prevent the contamination of the environment and ground water systems through liquid runoff during recovery operations.

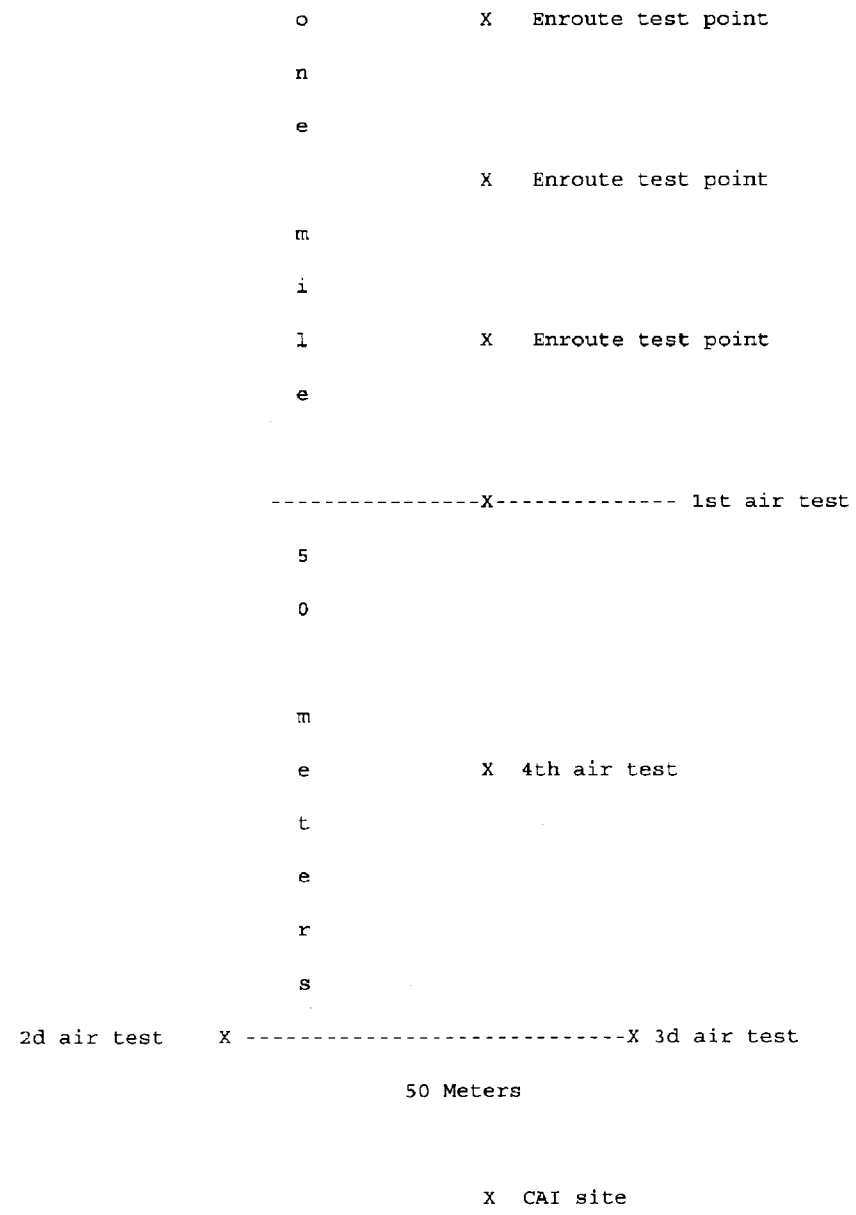



**Figure D–1. Hot-line setup with negative results**

## Appendix E
## Engineering Design Guidance for Facilities

### E–1. Minimum engineering

Minimum engineering design guidance is set fourth herein for facilities that are used for handling, storage, maintenance, surveillance, transportation, training, testing, research, disposal, and demilitarization of chemical agents or ammunition. This design guidance is intended for new construction or major renovation projects. Support areas for these operations and for operations personnel are included. Other design features that afford the same degree of safety can be used.

### E–2. Air ventilation systems

Air-handling systems will be designed to ensure that control of agent-contaminated exhaust will not exceed source emission limits. In operations requiring air ventilation systems, the following techniques may be used:

*a.* Filters or scrubbers for exhausted air will be designed and approved for the MCE of the operations involved. Additionally, exhausted air from a facility that is potentially contaminated with agent vapor can be thermally treated. Adequate treatment of the air is based on high temperature and sufficient residence time. This process is used at the demilitarization sites to treat contaminated air from the furnace rooms prior to passing through the pollution abatement systems. Changes in the agent operations within a facility require that the design of the existing filter be evaluated for adequacy in terms of the new MCE. When a single filter or scrubber is employed, a gas life indicator or other suitable method to predict filter life will be used to allow filter change-out before source emission limits are exceeded.

(1) When high concentrations of agent are involved and breakthrough of agent can be expected, preprocessing through a series of scrubbers or use of redundant filters will be employed. High efficiency particulate air filters also will be used in the air ventilation systems. Each filter bank will be provided with a means to measure differential pressures across each bank of filters.

(2) In larger facilities, ducting and manually operated dampers will be provided for backup exhaust ventilation capability. Filter disposal will be accomplished by placing the used filter in an agent-tight package, transporting the package to an approved incinerator. The incinerator will be designed so that source emission limits during and after destruction are not exceeded and the whole package is incinerated. A bag-in, bag-out type filter system should be considered for new facilities.

*b.* The air-handling system, that is, ductwork and blower housing, will be sealed to preclude leakage or entrapment of agents exceeding the AEL.

*c.* All exhaust equipment will have backup blowers that engage automatically if the main blower fails. The backup blowers will ensure that a negative pressure is maintained at all times in any facility area where there is a potential for chemical agent to be released. If backup blowers are not utilized then adequate positive safe shutdown devices should be employed. Due to the design, a given system may be shutdown safely based on the induced draft (ID) fan wind down times and air flow bypasses to other operating systems. Where a backup blower is not utilized, a supporting risk analysis should be performed to support this design decision.

*d.* The airflow for laboratory exhaust hoods and glove boxes will be designed to contain agents below AEL for unprotected workers. The design parameters will consider equipment and process layout as well as makeup airflow and operational positions with regard to maintaining flow balance and cross currents. The system will maintain negative pressure in operating areas in relation to hallways, offices, and other nonagent areas. Glove boxes will be used when the hazard analysis indicates that the toxicity, dusting, or dispersion of material caused by airflow and type of operation require such protection.

*e.* Performance of the chemical hood is affected by airflow within the facility as well as hood geometry, design, and operating parameters. The adequacy of the hood performance must be based upon test data ensuring that source emission limits for the materials used have not been exceeded. The adequacy of hood performance can be determined periodically using ventilation measurements, smoke testing, and monitoring of worker exposure to ensure proper functioning of the hoods.

*f.* Catch basins and traps of suitable size will be provided within hoods and glove boxes.

*g.* Special design features will be incorporated for situations that involve explosives fines (dust, particles) that may become airborne to segregate these materials from the air stream to minimize or preclude contamination of the air-handling system.

## E–3. Mechanical and utilities design for facilities

A concept of agent contamination avoidance and control will be incorporated and included with the facility layout and design.

*a.* Working surfaces, such as walls, floors, and ceilings within a facility likely to be agent-contaminated during regular or accidental situations will be constructed of materials that are resistant to agent retention. The surface treatment will have properties incorporated to accelerate agent degradation; or the surface can at least be decontaminated to the AEL for unprotected workers. Flooring shall be coved 6 inches onto all wall surfaces unless other means (for example, steam/decon systems) are shown to thoroughly decontaminate residue agent in cracks and corners. Floor surfaces shall be treated, silled, or sloped and seams sealed to contain and control agent contamination and ease agent clean up.

*b.* Utilities, mechanical rooms, and other nonagent areas will be located so that air flows toward agent operating areas. Access to these nonagent areas will be accomplished without entry into agent areas.

*c.* The electrical system will be equipped with a backup power source designed to start automatically and supply enough power to support critical functions in the event of power outage. Wiring, controls, lighting protection, and other electrical devices will meet the requirements of the national electrical code for the applicable hazardous operational facility.

*d.* All water outlets in the agent operational facility, to include agent operating hoods or gloveboxes will be fitted with vacuum breakers to prevent backflow of water into the service lines.

*e.* Dedicated liquid waste systems will be designed to collect and maintain the effluent produced by the activity until processed and certified to meet the source emission limit required for release. The system will be equipped with a means to sample and test the agent content of the effluent, to add required agent decontaminant, and to release the waste when authorized. Vents or other openings in the waste system will be fitted with approved agent filters. A containment dike designed to hold the total content of the waste system plus 10 percent of the volume will be placed around above ground liquid waste systems. For multiple tank waste containment systems, the containment dike will hold 110 percent of the largest tank.

*f.* Decontamination facilities of sufficient capacity to catch and contain the effluent will be provided for agents involved. Ammunition, drained of agent and chemically decontaminated, will be processed through approved agent-destruction incinerators before release.

*g.* When operations require work assignments to be conducted at exposure levels above or potentially above the AEL, decontamination change facilities with showers will be provided.

## E–4. General design considerations

*a. Facility alarms and monitors for engineering systems.* Each chemical facility will have a master alarm and control panel that will permit functional verification of the exhaust blowers, backup blowers, air-conditioning units, fire control systems, waste treatment, agent and chemical storage areas, critical monitors (for example, agent and nonagent) and exhaust filters. Keyed to this master alarm panel will be visual and audible alert alarms to indicate instantly the failure of exhaust blowers, agent breakthrough of primary filter, backup blowers, fire alarm (infrared, ultra-violet, ionization, or particulate activated sensors) field waste pump failure and temperature increases in low temperature storage areas. Alarms will be incorporated for use in the work areas when injury or accidents occur in the facility. Except for static storage operations, all facility alarm systems for dynamic operations will be monitored, consistent with operational requirements. In the absence of real-time monitors, first entry monitoring procedures are required after loss of engineering controls that may have caused contamination in excess of the AEL.

*b. Fire detection and protection.* Fire detection and protection systems for production and maintenance facilities will comply with the requirements and guidelines published in AR 420–90, Fire Protection.

*c. Bulk storage tanks.* Impermeable dikes that have enough capacity to hold at least 110 percent of the tank capacity and the required volume of decontaminant solution will be placed around all bulk agent tanks, reactors, and mixers.

*d. Isolation of facility functions.* The agent facilities will be designed to isolate one activity from another activity in an independent and completely autonomous manner. Special design criteria will segregate explosives from drain lines and sumps to prevent deposition of explosives materials in these process units.

*e. Monitoring.* Stations will be established around chemical operational areas and facilities to monitor the air and liquid waste effluents to determine if source emission limit or thresholds are exceeded.

*f. Agent operational areas.* The chemical handling and maintenance areas associated with industrial operations will be isolated from the main facility by protective walls and doors and will be operated at a negative pressure with respect to the main facility area. All hazardous materials will be handled in these rooms unless a glove box is required. The handling rooms will be equipped with local exhaust ventilation and approved work surfaces that inhibit agent penetration and retention, and other means to minimize the spread of contamination. All air leaving the facility will be filtered or decontaminated before release to the atmosphere. Air flow in facility cascade ventilation systems will be from the areas of least contamination (hazard) to areas of increasing contamination (i. e. , clean to dirty),whereby the flow is controlled by differential in negative pressure. Appropriate containment facilities will be used as necessary during ammunition maintenance procedures.

*g. Utility area.* Electrical control panels, hot water heaters, and vacuum pumps will be located in a utility area. Compressed air, argon, and nitrogen will be supplied to the facility from gas bottle manifolds. Facilities that utilize large quantities of compressed air (for example, breathing air, instrument air, and plant air that require different levels of quality) require different types of air compressor systems. For these facilities, manifolded systems are too small and are very labor intensive for the amount of compressed air utilized. When air-supplied protective clothing and equipment are used, breathing-quality air will be provided with suitable connections throughout the facility. The waste liquid treatment area and the emergency auxiliary power will be located in the facility complex. Appropriate access to all plumbing, electrical conduits and relays, refrigeration equipment, and air-handling equipment will be incorporated.

*h. Viewing of operations.* A valuable asset in the industrial facility design is to provide for visual observation of virtually all workspaces by a viewing hall. A clear view of the laboratory exhaust hood, workrooms, main laboratory rooms, storage areas, and safety shower area is possible by selection of the appropriate design.

## Appendix F
## Risk Management Program

### F–1. Risk management

The intent of risk management is to optimize safety within the framework of mission accomplishment and is not to put safety "first" or ensure "zero defects. " System safety is applied with the overall goal of improving operational effectiveness by conserving valuable resources and reducing inherent risk.

### F–2. Risk assessment

*a.* Risk assessment, as a part of risk management, provides a useful tool for estimating the effectiveness of existing and proposed safeguards against chemical agent mishaps. The potential for and consequences of mishaps must be carefully analyzed. The risk assessment must consider not only the traditional MCEs and resulting consequences, but also the probabilities and consequences of any realistic accident scenario that could present a risk to worker, the environment or the public. The risk assessment assumptions should be verified for accuracy to the maximum extent possible.

*b.* A risk assessment procedure based upon both hazard probability and hazard severity will be used to establish priorities for corrective action and resolution of identified hazards.

*c.* Decisions regarding the acceptability of chemical agent facilities, equipment and proposed operations will be based on an assessment of the risk involved and will be in accordance with the written system safety engineering and management program and AR 385–61.

### F–3. Risk management requirements and associated documentation

Decisions to accept risks of hazards will be made at a management level commensurate with the risk. Risk assessment criteria contained in AR 385–61 will be used to assess risks in Army systems and facilities. Figure F–1 provides the Department of the Army model for risk acceptance authority. The risk acceptance hierarchy will be published in the written system safety engineering and management plan.

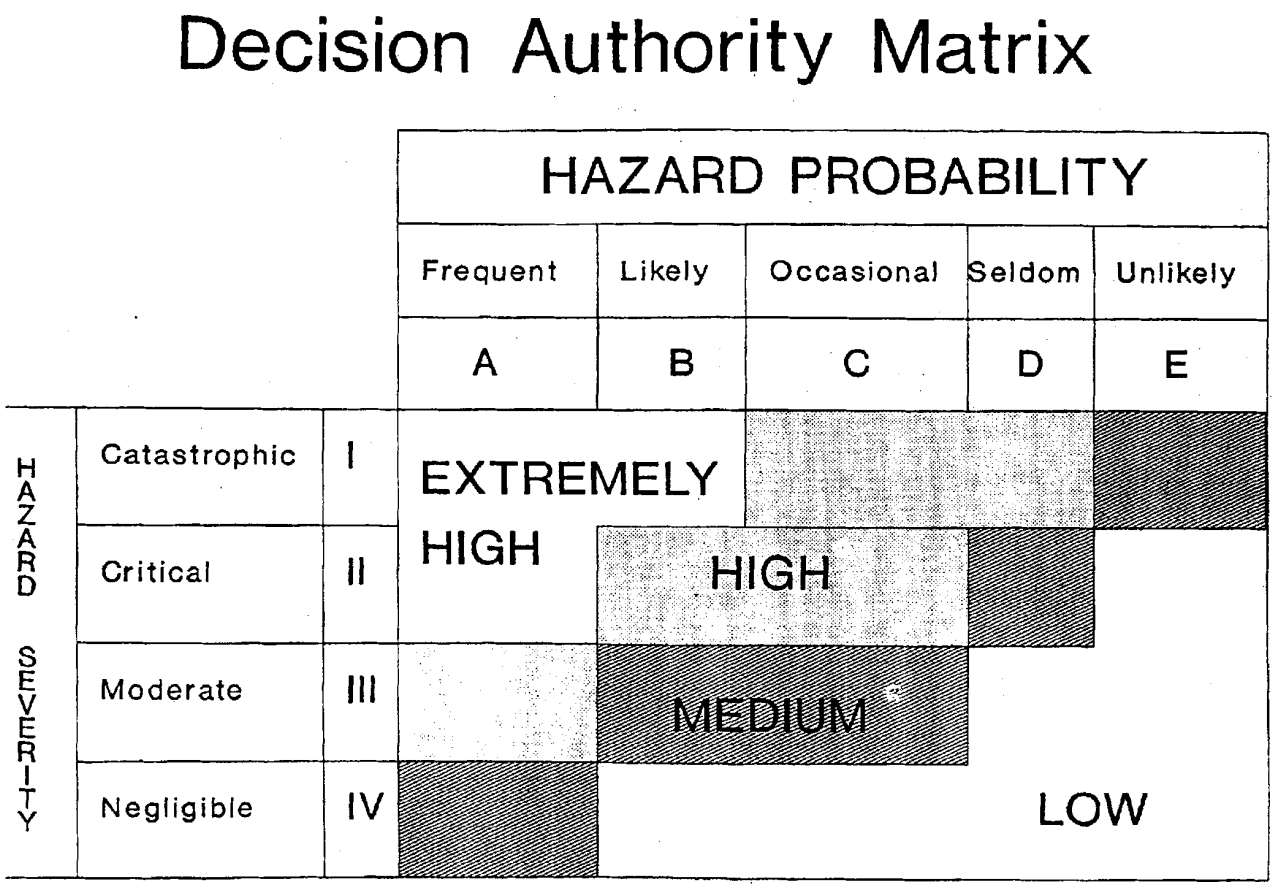



**Figure F–1. Decision authority matrix**

## Appendix G
## System Safety Engineering and Management Plan

### G–1. General program requirements

*a.* Purpose.
*b.* References.
*c.* Scope.
*d.* Objectives.

### G–2. Organization

*a.* Participating organizations.
*b.* Integration of associated disciplines.

### G–3. Risk Management

Procedures for hazard identification, categorization, tracking, and elimination should be discussed. The decision authority for action or inaction on a hazard and for acceptance of residual risk should be defined for this program. The decision authority matrix should be incorporated.

### G–4. Administration

Details not covered in other sections of the plan such as procedures for obtaining risk acceptance and recordkeeping of the risk assessment. Appropriate signature should be obtained. The appropriate MSC safety office signature block will be included unless the MSC grants approval to waive the requirement.

*SYSTEM SAFETY ENGINEERING & MANAGEMENT PLAN FOR (INSTALLATION/ACTIVITY NAME)*

***1. General program requirements.***

***a. Purpose.*** This plan established management policies, objectives, and responsibilities for execution of a risk management program at (installation/activity name).

***b. References.***

(1) DA Pam 385-61

(2) MIL-STD-882

(3) AR 385-61

***c. Scope.*** This plan establishes the ground rules and methodology by which risk assessments will be developed, the decision authority and the overall management for the (installation/activity name) risk management program.

***d. Objectives.*** Objectives are as follows:

(1) To use risk assessment as a tool for accepting risk when a requirement in AR 385-61 or DA Pam 385-61 cannot be met.

(2) To ensure that no hazard is accepted without formal documentation of associated risks.

(3) Risk acceptance decisions are documented.

***2. Organization.*** (List organizations involved in formulating risk assessments and their relationship for example, operator, industrial hygiene, safety) The safety representative will be the risk assessment team leader.

***3. Risk Management.***

***a. Risk assessment.*** The risk associated with a hazard is a function of its probability and severity. Therefore, all hazards will be evaluated to determine or verify probability and severity. Probability will be categorized as frequent, probable, occasional, remote, and improbable. The categories for severity will be catastrophic, critical, marginal, and negligible.

***b. Risk resolution.***

(1) When a requirement mandated by AR 385-61 cannot be met a risk assessment team composed of (list appropriate organizations) will be formed. The risk assessment team will identify the requirement, why it cannot be met, what measures will be taken to reduce the hazard, and will assign a RAC. The risk assessment team will completely identify the potential methods of controlling or eliminating a hazard and the expected effectiveness of each option. The report will be submitted immediately when a Category IA, IB, IC, ID, IIA, IIB, IIC or IIIA hazard is identified.The Chief, Safety Office will complete and sign Part II of the System Safety Risk Assessment (SSRA).

(2) The consequences of risk acceptance of the proposed configuration and alternative actions will be expressed using projected costs, if available, due to deaths, injuries, and equipment damage. The risk assessment team (or safety personnel)will calculate personnel death and injury costs using AR 385-40, table 2-1. The decision to accept the risk will also consider other factors such as impact on schedule and operational effectiveness.

(3) A written system safety risk assessment(SSRA) (part I) will be signed and submitted by the risk assessment team to the Chief, Safety Office stating risk assessment results and hazard control recommendations.

(4) Part III of the SSRA will be signed by the supervisor responsible for the operation.

(5) Part IV of the SSRA will signed by the decision authority level representative determined by the decision authority matrix (enclose copy of matrix).

***4. Administration.*** The approved system safety risk assessment will be kept on file in the(installation/activity) safety office. Risk assessments performed in support of operations will be filed with the applicable hazard analysis. Risk assessments with RACs of extremely high will be provided to the Director, USATCES.

***Installation/Activity safety office Command safety office above installation/activity (if required by that level)***

**Figure G–1. Sample format for a system safety engineering and management plan**

## Appendix H
## System Safety Risk Assessment Preparation Guidance

### H–1. Part I

*a.* Item-system identification.
*b.* Hazard topic.
*c.* Hazard description and consequences of risk acceptance of the proposed configuration.
*d.* Hazard classification (severity and probability according to MIL-STD–882).
*e.* Source document or reference.
*f.* Alternative actions that could reduce hazard level.

### H–2. Part II

Safety manager (Chief, Safety Office) recommendation regarding risk acceptance.

### H–3. Part III

Recommendation by operator(s) supervisor (operator recommendation should be included if not a member of the risk assessment team)

### H–4. Part IV

Approval by the appropriate decision authority.

## Glossary

### Section I
### Abbreviations

**AMC**
U.S. Army Materiel Command

**APE**
ammunition peculiar equipment

**AQL**
acceptable quality level

**CAI**
chemical accident incident

**CAICO**
chemical accident incident control officer

**CAIRA**
chemical accident and incident response and assistance

**CDTF**
chemical decontamination training facility

**DA**
Department of the Army

**DODESB**
Department of Defense Explosives Safety Board

**EOD**
explosive ordnance disposal

**HQDA**
Headquarters, Department of the Army

**MACOM**
major Army command

**MCA**
military construction, Army

**MEDCEN**
medical center

**MEDDAC**
medical department activity

**MSA**
mine safety appliance

**TB**
technical bulletin

**TM**
technical manual

**TSG**
The Surgeon General

**USATCES**
U.S. Army Technical Center for Explosive Safety

## Section II
## Terms

**Advisory provisions**
Those provisions in which the term *should* is used and from which deviation may be made with written authorization from the local commander.

**Aerosol**
A liquid or solid, composed of finely divided particles, suspended in a gaseous medium. Examples of common aerosols are mist, fog, and smoke.

**Agent activity/operation**
Any operation that involves chemical agents, including storage, shipping, handling, manufacturing, maintenance, test chamber activities, laboratory activities, surveillance, demilitarization, decontamination, disposal, and training.

**Agent area**
A physical location where entry and exit are restricted and controlled; and where chemical agents are manufactured, processed, packaged, demilitarized, released, handled, stored, used, and/or disposed.

**Agent facility**
Any location at which chemical agent operations are carried out, including storage facilities; renovation, maintenance, and demilitarization facilities; manufacturing plants; disposal sites; and laboratories. Depending on the activity, the facility may be a building, enclosure, or, possibly, an open area.

**Agent operating area**
That portion of an agent area where workers are actively conducting chemical agent operations.

**Agent BZ**
The chemical 3–quinuclidinyl ester, chemical abstracts service registry No. 6581–06–2. BZ is a code designation for a potent physchoactive compound that has a pharmacological action similar to that of other anticholinergic drugs (atropine, scopolamine, for example) except that the effects are more severe and longer lasting. It is an incapacitating agent classified as a class B poison for transportation purpose. It is an odorless, white, crystalline solid that in granular form may be compounded with a fuel-oxidizer mix for thermal dissemination.

**Agent GA**
The chemical dimethylphosphoramidocyanidate, chemical abstracts service registry No. 77–81–6, in pure form and in the various impure forms that may be found in storage as well as industrial, depot, or laboratory operations.

**Agent GB**
The chemical isopropyl methylphosphonofluoridate, chemical abstracts service registry No. 107–44–8, in pure form and in the various impure forms that may be found in storage as well as in industrial, depot, or laboratory operations.

**Agent GD**
The chemical phosphonofluoridic acid, methyl–1,2,2–trimethy-propyl ester, chemical abstracts service registry No. 96–64–0, in pure form and in the various impure forms that may be found in storage as well as in industrial, depot, or laboratory operations.

**Agent H**
Levinstein mustard of bis(2–chloroethyl) sulfide. Mustard produced by Levinstein process contains about 30 percent sulfur impurities.

**Agent HD**
Distilled mustard or bis(2–chloroethyl) sulfide, chemical abstracts service registry No. 505–60–2. HD is H that has been purified by washing and vacuum distillation to reduce sulfur impurities.

**Agent HT**
A mixture of 60 percent HD and 40 percent T. T is bis(2–chloroethylthioethyl) ether, chemical abstracts service registry No. 63918–89–8.

**Agent L**
The chemical dichloro (2–chlorovinyl) arsine, chemical abstracts service registry No. 541–25–3, in pure form and in the various impure forms that may be found is storage as well as in industrial, depot, or laboratory operations.

**Agent VX**
The chemical phosphonothioic acid, methyl-,S-(2–(bis(1–methyl-ethyl)amino)ethyl) 0–ethyl ester, chemical abstracts service registry number 50782–69–9, in pure form and in the various impure forms that may be found in storage as well as in industrial, depot, or laboratory operations.

**Airborne exposure limits**
Allowable concentrations in the air for occupational and general population exposures.

**Annual basis or annually**
Annual basis or annually should be from the month of the current year to the same month of the following year. However, the time period will not exceed 13 months. This does not apply to items covered under the Army Maintenance Management System.

**Atropine**
An alkaloid obtained from the plant Atropa belladonna. It is used as an antidote for nerve-agent poisoning. It inhibits the actions of acetylcholine at the nerve/muscle junction.

**Blast**
The brief and rapid movement of air vapor away from a center of outward pressure, as in an explosion. This term is commonly used to mean explosion, but the two terms should be distinguished.

**Blister agent**
A chemical agent that injures the eyes and lungs and burns or blisters the skin.

**Carcinogenicity**
The potential for development of cancer in a living individual. A cancer is a malignant tumor resulting from a change in the normal growth and development of cells. Cancerous tumors have the tendency to invade surrounding tissue and to spread to other sites in the body.

**Ceiling value**
Normally refers to the maximum exposures concentration of chemical agent at any time, for any duration. Practically, it may be an average value over the minimum time required to detect the specified concentration.

**Chemical agent**
A chemical compound intended for use (to include experimental compounds) in military operations to kill, seriously injure, or incapacitate persons through its physiological effects. Excluded are RDTE solutions, riot control agents, chemical defoliants and herbicides, smoke, flame and incendiaries, and industrial chemicals.

**Chemical casualty**
A person who has been affected sufficiently by a chemical agent to make him incapable of performing his duties or continuing his mission.

**Chemical contamination**
The presence of a chemical agent on a person, object, or area. Contamination density of a chemical agent is usually expressed either in milligrams or grams per square meter ($mg/m^2$, $g/m^2$) or in pounds per hectare (lb/ha). Hectare is 10, 000 square meters.

**Chemical warfare**
All aspects of military operations involving the use of lethal munitions/agents and the warning and protective measures associated with such offensive operations.

**Chemical weapons system**
An integrated relationship of chemical agents, munitions or spraying devices and their mode of delivery to the target.

**Clean areas**
Those areas whose environments are free of liquid agent contamination and that have been monitored to verify that air concentrations are below the AEL.

**Collective protective**
A shelter, with filtered air, that provides a contamination–free working environment for selected personnel and allows relief from continuous wear of protective gear.

**Concentration**
The amount of a chemical agent present in a unit volume of air. Usually expressed in milligrams per cubic meter ($mg/m^3$).

**Controlled release**
A release of chemical agent that may not be intended but is anticipated. It is followed by immediate action that will suppress the vapor or liquid release by approved decontamination procedures and/or use of other suppression techniques that have also been approved beforehand.

**Decontamination**
The process of decreasing the amount of chemical agent on any person, object, or area by absorbing, neutralizing, destroying, ventilating, diluting, or removing chemical agents.

**Decontamination (levels)**
*a.* 1X (X)—An agent symbol with a single X indicates the item has been partially decontaminated of the indicated agent. Further decontamination processes are required before the item is moved or any maintenance or repair is performed without the use of chemical protective clothing and equipment. This degree generally shall be applied to the item as it stands in place after being used and subjected only to routine cleaning after use

*b.* 3X (XXX)—An agent symbol with three Xs ("XXX") indicates that the item has been surface decontaminated by locally approved procedures, bagged or contained in an agent-tight barrier, of sufficient volume to permit sample air to be withdrawn without being diluted with incoming air, and/or appropriate tests/ monitoring have verified that concentrations above 0.0001 $mg/m^3$for agent GB, 0.00001 $mg/m^3$for agent VX, 0.003 $mg/m^3$ for H or L, or 0.00003 $mg/m^3$ for agent GD (unmasked worker AEL values for other covered chemicals do not exist). Monitoring is not required for completely decontaminated and disassembled parts that are shaped simply (no crevices, threads, or the like) and are made of essentially impervious materials (such as simple lab glassware and steel gears).

*c.* 5X (XXXXX)—An agent symbol with five Xs ("XXXXX") indicates an item has been decontaminated completely of the indicated agent and may be released for general use or sold to the general public. An item is decontaminated completely when the item has been subjected to procedures that are known to completely degrade the agent molecule, or when analyses, submitted through MACOM and DA channels for approval by the DODESB, have shown that the total quantity of agent is less than the minimal health effects dosage as determined by The Surgeon General. 5X condition must be certified by the commander or designated representative.

*d.* 0—A "0" (zero) indicates that an item, though located in an area with liquid agent and/or agent vapor, has not been contaminated (that is, it does not present an agent contact or vapor hazard).

*e.* Clean conditional—When situations such as metallurgical investigations require testing at locations outside the installation, the item will be disassembled and exposed to moderately high temperatures long enough to decompose agent to compounds of lesser toxicity. A temperature of 177 degrees C (350 degrees F) for 4 hours is considered sufficient to decompose agent. Samples will be taken to assure vapor concentrations do not exceed 0.0001 $mg/m^3$ for agent GB, 0.00001 $mg/m^3$ for agent VX, and 0.003 $mg/m^3$ for H or L.

**Decontaminating material**
Any substance used to chemically destroy, physically remove, seal, or otherwise make harmless a chemical agent.

**Detection**
The determination of the presence of a chemical agent.

**Emergency disposal**
Immediate transportation and disposal of chemical agents/munitions when the senior EOD person determines the health or safety of any person is clearly endangered.

**Enclosed area**
Any operating building, shed, magazine, railroad car, truck, or trailer that sufficiently restricts natural ventilation to allow possible accumulation of agent vapors.

**EOD**
The detection, identification, field evaluations, rendering safe, recovery, and final disposal of unexploded explosive ordnance or munitions chemical agents.

**EOD procedures**
Those particular courses or modes of action for access to, recovery, render safe, and final disposal of explosive ordnance or any hazardous material associated with an EOD incident.

**Exemption**
A permanent written exception approved by HQDA. An exception is based on a determination that conformance to the established standard is impossible, highly impracticable, unnecessary, or not in the best interest of the U.S. Government.

**Exclusion area**
The area immediately surrounding one or more receptacles in which chemical agents are contained. In the absence of positive preventive measures, access into area constitutes access to the chemical agent.

**Experimental chemical agent**
Chemical substances being tested, developed, or altered for chemical defense purposes that:
*a.* Will be used solely by the military.
*b.* Will be contained in items configured as a weapon.
*c.* Have toxicities equal to or greater than current nerve or mustard agents.

**Exposure/exposed worker**
*a.* An exposed worker is an individual who—
(1) Exhibits clinical signs or symptoms of nerve-agent intoxication.
(2) Has cholinesterase depression, consistent with nerve-agent effect.
(3) Exhibits clinical signs or symptoms of mustard or Lewisite effect.
*b.* A potentially exposed worker is an individual who works in an agent operating area where levels of nerve agent, Lewisite or mustard—
(1) Exceed the protective capability of the PPE.
(2) Are detectable and there is a breech in PPE or engineering controls.

**Field operations**
Operations conducted outdoors or outside of man-made enclosures or structures that contain built-in alarms or engineered chemical agent controls. Short-term operations in storage structures are also considered field operations.

**Immediately dangerous to life or health**
An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere regardless of PPE use. For planning purposes, the respirator wearer shall be unaffected by the environment for up to 30 minutes without any respirator being worn. IDLH also includes atmospheres where oxygen content by volume is less that 19. 5 percent.

**Impervious**
Providing protection by precluding penetration of nerve agents and mustard (as demonstrated by methods prescribed in MIL-STD 282) for the useful life of the item concerned.

**Incapacitating agents**
Agents that produce physiological or mental effects, or both, that may persist for hours or days after exposure, rendering individuals incapable of concerted effort in the performance of their assigned duties. Complete recovery of incapacitating agent casualties is expected without medical treatment.

**Industrial chemical**
Chemicals developed or manufactured for use in industrial operations or research, by industry, Government, or academia. These chemicals are not primarily manufactured for the specific purpose of producing human casualties or rendering equipment, facilities, or areas dangerous for use by man.

**Laboratory**
A location or facility where engineering controls include a glovebox or laboratory-type ventilation hood, and the quantities of chemical agents in use at one time are small, normally not exceeding 1 liter. Laboratory operations may include research and development, production/acceptance testing, sample analysis and evaluation, limited detoxification, animal testing, or other small-scale agent operations.

**Laboratory-type hood**
An enclosed ventilation device that does not require the insertion of any portion of an individual's body other than the hands and arms, and that is designed, constructed, and maintained as described in appropriate portions of this pamphlet.

**Limited area**
A designated area immediately surrounding one or more exclusion areas. Normally, the area between the boundaries of the exclusion areas and the inner fence.

**Mandatory requirements**
Those requirements in which the terms *will*, *shall*, and *must* are used. Deviations from those requirements must be expeditiously corrected, and the waivers procedure in AR 385–61, chapter 3 must be followed.

**Miosis**
The excessive contraction of the pupils of the eyes caused by exposure to minute quantities of nerve agents. The pupil is unable to dilate and remains contracted. Thus, performance of tasks, navigating on foot, identifying or engaging targets, or driving vehicles is practically impossible. Miosis also is often accompanied by pain, headache, and pinpointing of the pupils.

**Monitoring**
The continued or periodic act of seeking to determine whether a chemical agent is present.

**MOPP**
A flexible system that provides maximum nuclear, biological, and chemical protection for the individual with the lowest risk possible and still maintains for mission accomplishment.

**Mustard**
The chemical bis(2–chloroethyl)sulfide, chemical abstracts service registry No. 505–60–2, in pure form and in the various impure forms that may be found in munitions as well as field, industrial, or laboratory operations. These include Levinstein mustard (H), distilled mustard (HD), and closely related preparations. This standard is not meant to be applied to nitrogen mustards.

**Mutagenicity**
The cause of changes in cellular genetic material that may be passed on to subsequent generations of cells. When these changes occur in germ cells (for example, sperm or ova), the mutations may be passed on to subsequent generations' offspring.

**Nerve agent**
A lethal agent that causes casualties by interfering with the ability of muscles to relax after stimulation by associated nerves.

**Neutralent**
Those materials remaining from the chemical neutralization of agents.

**Neutralization**
The act of altering the chemical, physical, and toxicological properties to render the chemical agent ineffective for use as intended.

**Nonrelated personnel**
All personnel who are not specifically involved with chemical agent operations, medically monitored, trained (first aid, use of detectors, and so forth) or fitted with a protective mask.

**Nonstandard glove**
Any other glove not covered by a military specification. These gloves must be tested in accordance with an acceptable quality level (AQL) plan and be approved by the MACOM.

**On-scene coordinator**
A general officer who has operational control of emergency response forces and supervises all on-site operations at the scene of a chemical accident. Also referred to as Service Response Force commander.

**Oxygen deficient atmosphere/Oxygen deficiency**
An atmosphere containing less than 19. 5 percent oxygen by volume at sea level.

**Periodic surveillance**
Annual and other cyclic-type inspections conducted by quality assurance specialists (ammunition surveillance). This term may be used casually in a security context to mean a close watch or observation, either electronic, mechanical, human, or any combination of these that are sufficiently frequent and adequate to make known any attempt to gain access to or unauthorized possession or control of chemical agent materiel.

**Persistency**
An expression of the duration of effectiveness of a chemical agent. This is dependent on physical and chemical properties of the agent, weather, methods of dissemination, and conditions of the terrain. The terms *persistent* and *nonpersistent* should not be used to denote classes of chemical agents.

**RDTE solution**
Solutions of chemical agents in concentrations and quantities reduced by admixture (dilution) to levels that can be handled with the same precautions associated with hazardous industrial chemicals (acids, bases, or solvents). The following levels are considered RDTE solutions:

*a.* Concentrations of H, HD, or HT not greater than 10 mg/ml (chemical agent/solvent) and containing not greater than 100 mg of chemical agent.

*b.* Concentrations of GB not greater than 2 mg/ml (chemical agent/solvent) and containing a maximum quantity of 20 mg of chemical agent.

*c.* Concentrations of VX not greater than 1 mg/ml (chemical agent/solvent) and containing a maximum quantity of 10 mg of chemical agent.

*d.* Concentrations of L and HL not greater than 5 mg/ml (chemical agent/solvent) and containing a maximum quantity of 50 mg of chemical agent.

**Real time**
Is defined for this pamphlet as a period of less then 15 minutes.

**Riot control agent**
A substance that produces temporary irritating or disabling physical effects that disappear within minutes of removal from exposure. There is no significant risk of permanent injury, and medical treatment is rarely required.

**Screening and signaling smokes**
Compounds that produce an obscuring smoke when burned, hydrolyzed, or atomized; they are used to limit observation and to reduce the effectiveness of aimed fire. Signaling smokes are similar to screening smokes, except that signaling smokes generally are colored and are used for visual communication. The standard colors are green, red, violet, and yellow.

**Self/buddy aid**
Administration of a chemical agent antidote to one's self or to a co-worker upon experiencing early symptoms of chemical agent poisoning.

**Source emissions**
All intentional, uncontrolled releases of agents GA, GB, GD, and VX, to include stack emissions.

**Standard glove**
All gloves covered by a military specification (for example, TAP and gloveset glove).

**Technical escort**
Individuals technically qualified and properly equipped to accompany designated materiel requiring a high degree of safety and security during shipment.

**Toxicity**
The property possessed by a material that enables it to injure the physiological mechanism of an organism by chemical means, with the maximum effect being incapacitation or death.

**Training agent and compounds**
An agent authorized for use in training to enhance proficiency for operating in a chemical environment.

**Vesicant agent**
Agent that acts on the eyes and lungs and blisters the skin.

**Waiver**
A temporary (1 year or less) written relief from a requirement, granted according to this regulation for operational and/or compelling reasons, pending accomplishment of actions or programs that will result in conformance to the required standards. Waivers will not be extended beyond 5 years.

## Section III
## Special Abbreviations and Terms

**ACAMS**
Automatic Continuous Air Monitoring System

**ACGIH**
American Conference of Governmental Industrial Hygienists

**AEL**
airborne exposure limits

**CAM**
chemical agent monitor

**CAS**
chemical abstracts service

**CASARM**
chemical agent standard analytical reference material

**CCL**
contamination control line

**CFR**
Code of Federal Regulations

**CPR**
cardiopulmonary resuscitation

**CPU**
chemical protective undergarment

**CRA**
contamination reduction area

**DAAMS**
Depot Area Air Monitoring System

**DCAC**
demilitarization chemical agent concentrator

**DOT**
Department of Transportation

**DPE**
demilitarization protective ensemble

**EPA**
Environmental Protection Agency

**FM**
field manual

**fpm**
feet per minute

**HTH**
high test hypochlorite

**HYFED**
hydrogen flame photometric emission detector

**ID**
induced draft

**IDLH**
immediately dangerous to life or health

**lfpm**
linear feet per minute

**LPG**
liquefied petroleum gas

**LSC**
laboratory sample container

**MCE**
maximum credible event

**mg**
milligram

**MHE**
material handling equipment

**MINICAMS**
miniature chemical agent monitor

**ml**
milliliter

**MOPP**
mission-oriented protective posture

**MSHA**
Mine Safety and Health Agency

**MSC**
major subordinate command

**MSDS**
material safety data sheet

**MTF**
medical treatment facility

**NAAK**
nerve-agent antidote kit

**NEC**
national electric code

**NEW**
net explosive weight

**NFPA**
National Fire Protection Association

**NIOSH**
National Institute for Occupational Safety and Health

**NSN**
national stock number

**OSHA**
Occupational Safety and Health Administration

**PAED**
public access exclusion distance

**PDS**
personnel decontamination station

**PCE**
protective clothing and equipment

**PPE**
personal protective equipment

**ppm**
parts per million

**QC**
quality control

**RCRA**
Resource Conservation Recovery Act

**RDTE**
research, development, test, and evaluation

**RTAP**
real-time analytical platform

**RTM**
real-time monitor

**SB**
supply bulletin

**SCBA**
self-contained breathing apparatus

**SOP**
standing operating procedure

**STB**
super tropical bleach

**STEPO-I**
self-contained toxicological environmental protective outfit—I

**TAP**
toxicological agents protective

**TAPES**
toxicological agent protective ensemble, self-contained

**TWA**
time-weighted average

**UBID**
unbarricaded intraline distance

**USAMRICD**
U.S. Army Medical Research Institute of Chemical Defense

## Index

This index is organized alphabetically by topic and subtopic within a topic. Topics and subtopics are identified by paragraph number.

# USAPA

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