

Department of the Army  
Pamphlet 385-61

Safety

# Toxic Chemical Agent Safety Standards

Headquarters  
Department of the Army  
Washington, DC  
17 December 2008

**UNCLASSIFIED**

# ***SUMMARY of CHANGE***

DA PAM 385-61

Toxic Chemical Agent Safety Standards

This major revision, dated 17 December 2008--

- o Establishes procedures as it relates to Chemical Agent Identification Sets (para 1-1).
- o Defines personal protective clothing and equipment approval through the Office of the Director of Army Safety and its usage (paras 1-7 and 8-6).
- o Establishes guidelines for the refrigeration storage of research, development, test, and evaluation (para 8-2).
- o Defines ventilation exhaust system guidelines (para 8-3).
- o Updates the chemical hygiene plan (para 8-10).
- o Defines storage requirements for chemical agents (para 9-4).
- o Provides guidance on the usage of chemical agent and ammunition hazard symbols (para 9-5).
- o Establishes chemical agent shipping and transportation requirements (paras 10-1 through 10-4).
- o Establishes guidelines for chemical separation distance criteria (para 11-1 through 11-7).
- o Provides overview for toxic chemical agent training (paras 12-1 and 12-3).
- o Establishes training chemical agent airborne exposure limits (para 12-2).
- o Introduces additional safety criteria for chemical facilities (para 12-6).

## Safety

# Toxic Chemical Agent Safety Standards

---

By Order of the Secretary of the Army:

GEORGE W. CASEY, JR.  
*General, United States Army*  
*Chief of Staff*

Official:

  
JOYCE E. MORROW  
*Administrative Assistant to the*  
*Secretary of the Army*

---

**History.** This publication is a major revision.

**Summary.** This pamphlet updates Army guidance and implementing procedures for conducting chemical agent safety program in accordance with AR 385–10.

**Applicability.** This pamphlet applies to the Active Army, the Army National Guard/Army National Guard of the United States, and the U.S. Army Reserve on or off a Department of Defense installation,

unless otherwise stated. It applies to Army civilian employees in a duty status, on or off a Department of Defense installation, and to Army contractors (unless otherwise specified within contract clauses) with a responsibility for toxic chemical agent operations or a toxic chemical agent mission. It also applies to other Department of Defense personnel and foreign military personnel working with and under Army operational control.

**Proponent and exception authority.** The proponent for this pamphlet is the Director of Army Safety (DASAF), under the Office, Chief of Staff, Army. The proponent has the authority to approve exceptions to this pamphlet that are consistent with controlling law and regulations. The proponent may delegate this approval authority, in writing, to a division chief within the proponent agency or its direct reporting unit or field operating agency, in the grade of colonel or the civilian equivalent. Activities may request a waiver to this pamphlet by providing justification that includes a full analysis of the expected benefits and must include formal review by the activity's senior legal officer. All waiver requests will be

endorsed by the commander or senior leader of the requesting activity and forwarded through their higher headquarters to the policy proponent. Refer to AR 25–30 for specific guidance.

**Suggested improvements.** Users of this pamphlet are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to the Army Safety Office (DACS–SF), Chief of Staff, 200 Army Pentagon, Washington, DC 20310–0200.

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

---

## Contents (Listed by paragraph and page number)

### Chapter 1

**Introduction,** *page 1*

Purpose • 1–1, *page 1*

References • 1–2, *page 1*

Explanation of abbreviations and terms • 1–3, *page 1*

Function • 1–4, *page 1*

Guidance • 1–5, *page 1*

Composite risk management • 1–6, *page 1*

Personal protective clothing and equipment • 1–7, *page 1*

Concept • 1–8, *page 2*

Provisions • 1–9, *page 2*

---

\*This pamphlet supersedes DA Pamphlet 385–61, 27 March 2002.

## **Contents—Continued**

### **Chapter 2**

#### **Agent Information, page 2**

Overview • 2-1, page 2

Types of hazards • 2-2, page 2

Mechanism of action and physiological effects • 2-3, page 3

Persistency • 2-4, page 4

Stability of chemical agents • 2-5, page 4

Weather and terrain • 2-6, page 5

Hydrolysis • 2-7, page 5

Rate of detoxification • 2-8, page 5

Rate of action • 2-9, page 5

Dosage • 2-10, page 6

Agent information • 2-11, page 6

Classification • 2-12, page 6

Airborne exposure limits • 2-13, page 6

### **Chapter 3**

#### **Agent Monitoring Requirements, page 7**

Purpose • 3-1, page 7

Detection methods and equipment • 3-2, page 8

Detection equipment capabilities • 3-3, page 10

Chemical agent monitoring requirements • 3-4, page 11

Excursion above the worker population limit • 3-5, page 12

Monitoring support requirements • 3-6, page 13

Monitoring requirements • 3-7, page 13

Monitoring plan • 3-8, page 13

Recordkeeping • 3-9, page 13

### **Chapter 4**

#### **Personnel Protective Clothing and Equipment, page 14**

Respiratory protection program • 4-1, page 14

Determination of protection required • 4-2, page 14

Protection levels for chemical agent workers • 4-3, page 16

Heat-stress plan • 4-4, page 16

Special requirements, M40 Series, chemical biological protective mask, application • 4-5, page 17

Taping of equipment pertaining to Army protective clothing ensembles • 4-6, page 17

Corrective glasses or goggles • 4-7, page 17

Nonstandard gloves • 4-8, page 18

Build up of static electricity • 4-9, page 18

Care of equipment and protective clothing • 4-10, page 18

Handling of personal protective clothing and equipment for laundering • 4-11, page 18

Monitoring of decontaminated clothing • 4-12, page 19

User Inspection • 4-13, page 19

Personal protective clothing and equipment inspection • 4-14, page 19

Personal protective clothing and equipment marking • 4-15, page 19

Butyl rubber flammability • 4-16, page 19

Demilitarization protective ensemble • 4-17, page 19

### **Chapter 5**

#### **Decontamination and Disposal, page 20**

Decontamination • 5-1, page 20

Decontamination and disposal of tools, supplies, equipment, and facilities • 5-2, page 20

Decontamination of tools, supplies, and equipment • 5-3, page 21

Facilities • 5-4, page 21

Chemical agent associated surplus material • 5-5, page 21

## **Contents—Continued**

Clean for release to the public • 5–6, *page 21*  
Equipment decontamination plan • 5–7, *page 21*  
Chemical agent associated waste • 5–8, *page 22*  
Testing of chlorine-based decontaminants • 5–9, *page 22*

### **Chapter 6**

#### **Safety Criteria for Agent Activities, *page 22***

Design change-house facilities/areas • 6–1, *page 22*  
Design of operational agent facilities • 6–2, *page 23*  
Criteria for containment of operations • 6–3, *page 25*  
Leaking munitions and containers • 6–4, *page 26*  
Special operational provisions for emergency preparedness • 6–5, *page 26*  
Mishap risk management • 6–6, *page 27*  
Standing operating procedures • 6–7, *page 27*  
Other administrative and work practice controls • 6–8, *page 28*  
Pre-operational safety survey • 6–9, *page 29*

### **Chapter 7**

#### **Personnel Protective Practices, *page 29***

Checking safety equipment • 7–1, *page 29*  
Training personnel • 7–2, *page 29*  
Safeguarding of personnel • 7–3, *page 30*  
Emergency response equipment • 7–4, *page 30*  
Self/buddy-aid procedures • 7–5, *page 30*

### **Chapter 8**

#### **Laboratory Safety, *page 30***

Overview of common laboratory safety guidelines • 8–1, *page 30*  
Research, development, test, and evaluation solutions • 8–2, *page 31*  
Ventilation • 8–3, *page 31*  
Agent monitoring • 8–4, *page 32*  
Loss of engineering controls • 8–5, *page 33*  
Protective clothing and equipment • 8–6, *page 33*  
Facility requirements • 8–7, *page 33*  
Personnel practices • 8–8, *page 34*  
Decontamination • 8–9, *page 35*  
Chemical hygiene plan • 8–10, *page 35*

### **Chapter 9**

#### **Storage, *page 35***

Storage procedures • 9–1, *page 35*  
Explosively configured munitions • 9–2, *page 36*  
Storage drawings • 9–3, *page 36*  
Storage requirements • 9–4, *page 36*  
Chemical agent and ammunition hazard symbols • 9–5, *page 36*  
Material handling equipment • 9–6, *page 37*

### **Chapter 10**

#### **Shipping, *page 40***

Shipping requirements • 10–1, *page 40*  
Transportation • 10–2, *page 40*  
Shipment of environmental samples • 10–3, *page 40*  
Shipment of research, development, test, and evaluation quantities of chemical agents • 10–4, *page 40*

## Contents—Continued

### Chapter 11

#### Separation Distance Criteria, *page 41*

Overview • 11-1, *page 41*

Maximum credible event • 11-2, *page 41*

Public exclusion distance • 11-3, *page 41*

Inhabited building distance • 11-4, *page 42*

Intraline distance • 11-5, *page 42*

Magazine distance • 11-6, *page 42*

Public traffic route distance • 11-7, *page 42*

Site planning before and response to a chemical agent accident • 11-8, *page 42*

Quantity distance criteria specific to chemical munitions • 11-9, *page 43*

### Chapter 12

#### Toxic Chemical Agent Training, *page 43*

Training overview • 12-1, *page 43*

Airborne exposure limits • 12-2, *page 44*

Toxic chemical agent monitoring during training exercises and operations • 12-3, *page 44*

Personal protective clothing and equipment • 12-4, *page 45*

Decontamination • 12-5, *page 46*

Additional safety criteria for training facilities • 12-6, *page 47*

Emergency response equipment • 12-7, *page 47*

Laboratory safety • 12-8, *page 48*

Chemical agent storage requirements • 12-9, *page 48*

Firefighting requirements • 12-10, *page 48*

Emergency response for rescue purposes • 12-11, *page 49*

## Appendixes

A. References, *page 50*

B. Engineering Design Guidance for Facilities, *page 53*

C. Types of Health-Based Criteria for Determining Suitability for Public Release, *page 55*

## Table List

Table 2-1: Airborne exposure limits, *page 7*

Table 3-1: Detector sensitivity and response, *page 11*

Table 4-1: Respirator selection decision logic, *page 15*

Table 4-2: Daily maximum use limits for M40 in H, HD, and HT environment above the WPL, *page 17*

Table 4-3: Approved demilitarization protective ensemble use for elevated temperatures, *page 19*

Table 6-1: Source emission limits (SELs) (mg/m<sup>3</sup>) ~|1~, *page 24*

Table 12-1: Training airborne exposure limits, *page 44*

Table C-5: Types of Health-Based Criteria Types of health-based criteria that may be used in risk assessment to determine suitability of public (unrestricted) release of items/equipment/facilities exposed to chemical agent, *page 57*

## Figure List

Figure 9-1: Chemical Hazard Symbols, *page 38*

Figure 9-2: Supplemental chemical hazard symbol, *page 39*

## Glossary

## **Chapter 1 Introduction**

### **1-1. Purpose**

- a.* This mandatory pamphlet describes the minimum safety criteria, guidance, and procedures for use in processing, handling, storage, transportation, disposal, and decontamination of chemical agents.
- b.* This pamphlet does not apply to tactical military operations.
- c.* This pamphlet does not apply to research, development, test, and evaluation (RDTE) dilute solutions except where specifically addressed in this pamphlet. These provisions should be used in conjunction with hazard analyses/standing operating procedures (SOPs) and good laboratory practices to minimize the risks associated with these operations.
- d.* Specific requirements pertaining to chemical agent safety during the conduct of military tactical training are noted in chapter 12. Where conflicts exist between the requirements of chapter 12 and other parts of this pamphlet, the requirements of chapter 12 have precedence.
- e.* This pamphlet does not apply to Recovered Chemical Warfare Material (RCWM), except where required by DA Pam 385-72.
- f.* DA Pam 385-65 contains the requirements for developing and submitting chemical site plans.
- g.* This pamphlet does not apply to Chemical Agent Identification Sets (CAIS) that contain dilute chemical agents or industrial chemicals, which are managed as hazardous waste; the exception is CAIS components that contain dilute nerve agent.

### **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. Function**

Army Commands (ACOMs), Army Service Component Commands (ASCCs), Direct Reporting Units (DRUs), Army National Guard (ARNG), installations, garrisons, units, or activities with a chemical agent safety function will ensure that all applicable safety procedures and guidance outlined herein are implemented and enforced. To maintain an effective chemical agent safety function, it is important that commands take the same aggressive leadership in chemical agent safety that is taken in other command functions.

### **1-5. Guidance**

Chemical agent missions will be executed in a safe, efficient and effective manner that protects personnel involved in the agent operations, the public, and the environment.

### **1-6. Composite risk management**

- a.* The goal of composite risk management (CRM) is to enhance operational effectiveness through the conservation of our combat resources without degrading the Army's performance. The CRM process contributes to a high level of operational readiness and increased combat effectiveness, through the elimination of unnecessary hazards. The identification of hazards and the elimination of those that are unnecessary greatly contribute to our force protection and the Army's combat readiness and effectiveness.
- b.* The CRM for the chemical agent safety program will be executed in accordance with DA Pam 385-30 and chapter 6 of this pamphlet.

### **1-7. Personal protective clothing and equipment**

- a.* Personal protective clothing and equipment (PCE) must be approved by the Office of the Department of the Army Safety (ODASAF) unless type-classified (for example, assigned an NSN) with specific intent including non-battlefield use, North Atlantic Treaty Organization (NATO)-approved, or National Fire Protection Association NFPA/National Institute for Occupational Safety and Health (NIOSH) certified for Chemical, Biological, Radiological, Nuclear (CBRN).
- b.* Use of type-classified, NATO, or NFPA/NIOSH (CBRN) PCE in an operational (that is, industrial, training or homeland defense) setting must be approved by the ODASAF if the use exceeds the conditions of type-classification, NATO approval, or NFPA/NIOSH (CBRN) certification. For example, longer use duration, use with a chemical agent not previously tested, addition of components (for example, communication equipment attached to the mask), or use in different scenarios than intended by the certification.
- c.* Organizations requesting approval of PCE in accordance with paragraphs 1-7*a* and 1-7*b* above, should contact the ODASAF for submittal requirements. Requesting organizations will, at a minimum, copy-furnish their ACOM,

ASCC, or DRU when submitting requests to the ODASAF. The ODASAF tasks the Department of the Army Chemical Agent Safety Council (DACASC) to evaluate alternate PCE requests and provide a recommendation.

*d.* Army Commands, ASCCs, and DRUs will ensure that PCE is being used within the approved use scenarios.

### **1–8. Concept**

Where there is conflict, this pamphlet takes precedence over the guidance contained in previously issued policy letters, technical manuals (TMs), field manuals (FMs), supply bulletins (SBs), technical bulletins (TBs), other DA pamphlets, and ACOMs, ASCCs, and DRUs 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.

### **1–9. Provisions**

*a.* This pamphlet has mandatory procedures and guidance as well as preferred and acceptable methods of accomplishment.

*b.* The words “should,” “will,” and “must” are used to state mandatory requirements. Deviation from these provisions requires a Certificate of Risk Acceptance per provisions of AR 385–10 and DA Pam 385–30.

*c.* The word “should” indicates an optional or preferred method of accomplishment. Deviation from these provisions requires written authorization from the local commander/senior manager or designee.

*d.* 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 60 percent bis(2-chloroethyl) sulfide (HD) and 40 percent bis (2-chloroethylthio)diethyl ether (T).

(*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. The 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. 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.

### 2-3. 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 agents 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) The chemical 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) The chemical agent 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 frothy 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 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.

## 2-4. Persistence

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)).

## 2-5. 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 buildings), 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.

## 2-6. 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.

## 2-7. 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.

## 2-8. 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<sup>3</sup> 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.

## 2-9. 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.

## 2-10. Dosage

a. Vapor dosage is the concentration of a chemical agent in the atmosphere (C) multiplied by the time (t) that the concentration remains, expressed as mg-min/m<sup>3</sup>. 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<sup>3</sup> 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<sup>3</sup> 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.

## 2-11. Agent information

Material Safety Data Sheets (MSDS) for the agents listed in paragraph 1-1 of this pamphlet are available from the U.S. Army Edgewood Chemical Biological Center (ECBC) at Army Knowledge Online (AKO) (<https://www.us.army.mil>) or call (410) 436-4411 or 4414, Monday through Friday, 0800 to 1630 hours Eastern Standard Time.

## 2-12. Classification

Chemical agents are classified as class 6.1 poisons by the Department of Defense (DOD) and Department of Transportation (DOT) and belong to storage compatibility group K. When explosively configured see Joint Hazard Classification System (JHCS) for the appropriate classification.

## 2-13. Airborne exposure limits

- a. The airborne exposure limits (AELs) for chemical agent are listed in table 2-1.

**Table 2-1  
Airborne exposure limits**

Airborne exposure limits for unprotected worker and general population					
Agent	Notes	GPL [mg/m <sup>3</sup> ]	WPL [mg/m <sup>3</sup> ]	STEL [mg/m <sup>3</sup> ]	IDLH [mg/m <sup>3</sup> ]
GA, GB	1, 2, 3, 6, 7	0.000001 (1 x 10 <sup>-6</sup> )	0.00003 (3 x 10 <sup>-5</sup> )	0.0001 (1 x 10 <sup>-4</sup> )	0.1 (1 x 10 <sup>-1</sup> )
GD, GF	1, 2, 3, 6, 7	0.000001 (1 x 10 <sup>-6</sup> )	0.00003 (3 x 10 <sup>-5</sup> )	0.00005 (5 x 10 <sup>-5</sup> )	0.05 (5 x 10 <sup>-2</sup> )
VX	1, 2, 4, 6, 7	0.0000006 (6 x 10 <sup>-7</sup> )	0.000001 (1 x 10 <sup>-6</sup> )	0.00001 (1 x 10 <sup>-5</sup> )	0.003 (3 x 10 <sup>-3</sup> )
HD, H, HT	1, 2, 5, 6, 8, 10	0.00002 (2 x 10 <sup>-5</sup> )	0.0004 (4 x 10 <sup>-4</sup> )	0.003 (3 x 10 <sup>-3</sup> )	0.7 (7 x 10 <sup>-1</sup> )
L, HL	1, 2, 5, 6, 9, 11		0.003 (3 x 10 <sup>-3</sup> )	0.003 (3 x 10 <sup>-3</sup> )	0.003 (3 x 10 <sup>-3</sup> )

Notes:

<sup>1</sup> The worker population limit (WPL) is an 8-hour time-weighted average (TWA). Exposure below the WPL is safe and not expected to produce any adverse health effect. Acute or sub-chronic exposure above the WPL is also not expected to produce any adverse health effect since the WPL is a chronic exposure limit.

<sup>2</sup> The short-term exposure limit (STEL) is a 15-minute TWA.

<sup>3</sup> For G-series nerve agent, exposure at the STEL should not be longer than 15 minutes and should not occur more than 4 times per day, and at least 60 minutes should elapse between successive exposures in this range.

<sup>4</sup> For VX nerve agent, exposure at the STEL should not be longer than 15 minutes and should not occur more than once per day.

<sup>5</sup> For sulfur mustards and lewisite, exposure at the STEL should be as short as practical (but not longer than 15 minutes) and should not occur more than once per day.

<sup>6</sup> Immediately dangerous to life or health (IDLH) is a 30-minute TWA. The 30-minute period is not meant to imply that anyone should stay in the environment any longer than necessary; in fact, every effort should be made to exit immediately.

<sup>7</sup> For nerve agents, the general population limit (GPL) is a 24-hour TWA.

<sup>8</sup> For sulfur mustards, the GPL is a 12-hour TWA.

<sup>9</sup> Since IDLH values are used solely for the purpose of establishing the concentrations at which self-contained breathing apparatus (SCBA) or supplied-air respirators are required, it is not necessary to formally establish IDLH values for L because workers will already be required to wear this level of respirator protection at concentrations much lower than what is considered IDLH for L because of concerns over carcinogenicity.

<sup>10</sup> HT is measured as HD.

<sup>11</sup> All concentrations measured as Lewisite.

b. Table 2-1 has the following references:

(1) 68 FR 54460 (17 September 2003) (corrected in 68 FR 58348 (9 October 2003)), Final Recommendations for Protecting Human Health from Potential Adverse Effects of Exposure to Agents GA (Tabun), GB (Sarin), and VX.

(2) Memorandum, Office of the Surgeon General (DASG-PPM-NC), 29 June 2004, subject: Nerve Agent Percutaneous Exposure Criteria and Airborne Exposure Levels for GD/GF for Use in Interim Department of Army Guidance on Implementation of the New Airborne Exposure Limits.

(3) 69 FR 24164 (3 May 2004), Interim Recommendations for Airborne Exposure Limits for Chemical Warfare Agents H and HD (Sulfur Mustard).

(4) 53 FR 8504 (15 March 1988) (corrected in 53 FR 11002 (4 April 1988)), Final Recommendations for Protecting Human Health and Safety against Potential Adverse Effects of Long-term Exposure to Low Doses of Agents: GA, GB, VX, Mustard Agent (H, HD, T), and Lewisite (L).

## Chapter 3 Agent Monitoring Requirements

### 3-1. Purpose

Employers are required to limit employee workplace chemical exposures to non-hazardous levels and to protect the public around their workplaces. To meet this requirement, air monitoring is needed to determine the employee exposure level to individual hazardous chemicals. The factors in determining airborne chemical exposure are type of contact, duration of contact, and chemical concentration. The purpose of an air-monitoring program is to confirm whether specific hazardous chemicals are present and to determine if the concentration presents a hazard.

### 3-2. 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, 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 may be used to confirm positive M8 paper tests. (See para 3-2g, below.)

(2) M9 chemical agent detector paper (NSN 6665-01-0498-982) 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<sup>3</sup> and GB as low as 1.0 mg/m<sup>3</sup>. 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<sup>3</sup> for mustard, 14.0 mg/m<sup>3</sup> for Lewisite, 0.05 mg/m<sup>3</sup> for GB, and 0.1 mg/m<sup>3</sup> 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<sup>3</sup> for mustard, 14.0 mg/m<sup>3</sup> for Lewisite, 0.005 mg/m<sup>3</sup> for GB, and 0.02 mg/m<sup>3</sup> 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<sup>3</sup> for mustard and Lewisite, 0.0001 mg/m<sup>3</sup> for GA/GB, 0.0001 mg/m<sup>3</sup> for GD, and 0.00001 mg/m<sup>3</sup> 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 chapter 10 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 celsius (C) (70 degrees fahrenheit (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.* The Depot Area Air Monitoring System (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<sup>TM</sup>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 sample 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 worker population limit (WPL)/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 will 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.* The Automatic Continuous Air Monitoring System (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<sup>3</sup>, VX at 0.00001 mg/m<sup>3</sup>, and HD at 0.003 mg/m<sup>3</sup>) and gross levels (up to 100 mg/m<sup>3</sup> with the use of low-volume sampler). The ACAMS can detect an agent at concentrations as low as 0.00002 mg/m<sup>3</sup> for GB, 0.000002 mg/m<sup>3</sup> for VX, and 0.0006 mg/m<sup>3</sup> 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<sup>3</sup> (GB) and 0.4 mg/m<sup>3</sup> (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.* The real-time monitor (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<sup>3</sup> (GB) and 0.00001 mg/m<sup>3</sup> (VX) and will provide an alarm response in 8 to 12 minutes. The RTM can only be used to assess worker exposure at the short-term exposure limit (STEL) concentrations values for GB and VX and cannot be used to report WPL exposure concentrations.

*i. M8A1 Detection Alarm.* The M8A1 alarm is a portable/fixd alarm using the M43A1 detector units. It is capable of detecting nerve agent concentrations as low as 0.2 mg/m<sup>3</sup> (GB) and 0.4 mg/m<sup>3</sup> (VX) with an alarm response of 30 seconds. The M43A1 has a much faster response time at higher concentrations. The M8A1 detection alarm is used to supplement other real time chemical agent monitoring systems and provide rapid alarm response to high-level concentrations.

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

*k. Hydrogen flame photometric emission detector.* The hydrogen flame photometric emission detector (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<sup>3</sup>, and mustard agents at concentrations of 0.003 mg/m<sup>3</sup>, 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 agents monitor.* The chemical agents monitor (CAM) is a lightweight, handheld, 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<sup>3</sup> (GB), 0.1 mg/m<sup>3</sup> (VX), and 0.1 mg/m<sup>3</sup> (mustard).

*m. Improved chemical agent monitor.* The improved chemical agent monitor (ICAM) is a portable, hand-held, gross-level instrument designed to indicate the hazard from nerve or mustard agent vapor present in the air. The ICAM is used to monitor for and identify contaminated personnel and equipment, and monitor the effectiveness of decontamination (see table 3-1). The ICAM merges two improvements to the CAM. A new modular design reduces repair time, while an updated electronics board increases reliability and decreases start-up time. The ICAM contains a beta radiation source (10 millicuries of Nickel-63) and operates on one battery. Battery life varies with frequency of use and temperature. At 68 degrees F (20 degrees C), a fresh battery will last at least 12 hours. The ICAM is easy to operate; it has two controls. Relative vapor hazard level is indicated on a liquid crystal display (LCD). It has a real-time response capability of 10 seconds for the detection of the following concentrations: 0.03 mg/m<sup>3</sup> (Nerve G and V) and 0.1 mg/m<sup>3</sup> (Mustard HD).

*n. 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.

*o. 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.

*p. 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.

*q. 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 the level of decontamination. Chloroform is a suspected human carcinogen. Exposure will be minimized. Proper personal protective equipment will be used.

*r. Miniature continuous air monitor.* The miniature continuous air monitor (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 light-weight, portable, real time, low-level monitor with alarm capability, designed to respond to 0.0001 mg/m<sup>3</sup> for GB in less than 5 minutes, 0.00001 mg/m<sup>3</sup> for VX in less than 15 minutes, and 0.003 mg/m<sup>3</sup> for mustard and L in less than 5 minutes.

*s. Real-time analytical platform* The real-time analytical platform (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<sup>3</sup> for GB, 0.00003 mg/m<sup>3</sup> for GD, 0.00001 mg/m<sup>3</sup> for VX, and 0.003 mg/m<sup>3</sup> for mustard and L in less than 15 minutes with alarm capability. The RTAP is especially useful in onsite clearance of igloos and other potential agent contamination sites.

*t. M22 automatic chemical agent detection alarm.* The M22 automatic chemical agent detection alarm (ACADA) 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 multipurpose integrated chemical agent alarm system (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<sup>3</sup> (VX) with a response time of 90 seconds, 0.1 mg/m<sup>3</sup> (GA/GB/GD) with a response time of 30 seconds, and 2.0 mg/m<sup>3</sup> (HD/L) with a response time of 2 minutes.

*u. 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 (DACS-SF), Washington DC 22202 is required.

### 3-3. Detection equipment capabilities

*a.* Capabilities, sensitivities, and response times for detector equipment listed in paragraph 3-2 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 short-term exposure limit (STEL)/AEL concentrations). 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 STEL/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<sup>3</sup> for mustard, 0.0001 mg/m<sup>3</sup> for GA/GB, and 0.00001 mg/m<sup>3</sup> for VX. Examples include the bubbler, MINICAMS, 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 STEL/AEL concentration 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 STEL/AEL concentration is obtained. The ACAMS, MINICAMS, and RTAP are examples.

**Table 3–1  
Detector sensitivity and response**

Detector sensitivity and response/processing time sensitivity (mg/m <sup>3</sup> ) <sup>1,2</sup>					
Equipment	Lewisite	Mustard	GB	VX	Response time
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	0.4	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
	—	—	0.005	0.1	15 min
M256A1	14.0	3.0	—	—	13 min
	—	—	0.005	0.02	16 min
Bubbler	0.005	0.003	0.001	0.00001	2 to 4 hrs
	0.003	—	—	—	8 hrs
DAAMS	N/A	0.003	0.0001	0.00001	1 to 4 hrs
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
ICAM	N/A	0.1	0.03	0.03	10 sec
HYFED	N/A	0.003	0.001	0.001	1 to 2 min
ACADA	—	—	—	0.04	90 sec
	—	—	0.1	—	30 sec
	2.0	2.0	—	—	2 min
MINICAMS	0.003	0.003	0.0001	—	5 min
	—	—	—	0.00001	15 min

Notes:

<sup>1</sup> Response times may vary.

<sup>2</sup> Real-time analytical platform (RTAP) is a vehicle that transport detectors to scene. Sensitivity, specifically, and response time depends on instructions used in the RTAP. MINICAMS are typical.

### 3–4. Chemical agent monitoring requirements

*a.* A quality assurance plan for monitoring will be developed that is based on guidance established by the Research Development and Engineering Command (RDECOM) CASARM Quality Assurance Plan, the Chemical Materials Agency (CMA) Laboratory and Monitoring Quality Assurance Plan (LMQAP) or an agency approved site-specific quality assurance program. This plan will be reviewed annually.

*b. Worker population limit monitoring.*

(1) Monitoring will be performed for identified areas of the facility where workers may have an exposure potential to chemical warfare agent.

(2) The monitoring may be either historical and/or real or near real-time based on the WPL Section of the site Monitoring Plan, described below.

*c. Short-term exposure limit monitoring.*

(1) Areas involving operations where release of chemical agent into the operating environment at levels exceeding the STEL can reasonably be expected to occur will be monitored.

(2) The monitoring will be conducted using equipment capable of measuring the chemical agent level in real-time or near-real time ensuring the time-duration of 15 minutes associated with the STEL is not exceeded.

(3) The monitoring equipment must be set to an alarm or notification level to account for the accuracy and precision of the equipment being used, for example, MINICAMS for a 15-minute cycle, set at the STEL concentration for a method that measures +/-25 percent of the true concentration, 95 percent of the time.

(4) Records will be maintained of excursions above STEL. They will include as a minimum: concentration, agent type, location, time and date.

*d.* Immediately dangerous to life or health (IDLH) monitoring for purposes of decontamination and release of equipment. When chemical agent concentrations exceed the IDLH, the exceedance will be documented and will be preserved for historical purposes (for example, logbook). Documentation of IDLH exceedances can be valuable for determining whether certain types of equipment are clean or need decontamination (see para 5–2).

*e.* The WPL Monitoring Section of the site specific monitoring plan will address—

(1) Monitoring of areas where workers may be exposed to chemical agent at levels exceeding the WPL.

(2) Monitoring levels at specific locations will be based on potential time of exposure (stay time) and incorporate the maximum use concentration (MUC) and assigned protection factor (APF) for a given respirator. Under these conditions, different monitoring levels may be implemented, depending on the level of PCE used and implementation of administrative controls to reduce potential exposures. The frequency of monitoring will be based on Industrial Hygiene (IH) best practices considering factors such as:

(a) Historical baselines;

(b) Level of PCE used;

(c) Engineering and work practices;

(d) Containment controls;

(e) Potential agent;

(f) Work, task or operation being performed;

(g) Number of entries (in/out) performed per shift;

(h) Frequency of occupancy by personnel;

(i) Regulatory and/or permit requirements;

(j) Frequency of work leading to excursions;

(k) Type of monitors being used;

(l) Duration of possible exposures;

(m) Reliability of engineering and work practices; and

(n) Reliability of containment controls.

### **3–5. Excursion above the worker population limit**

When monitoring indicates excursions of chemical agent levels above the WPL in areas where excursions are not expected, the following actions will be completed:

*a.* The area will be restricted (that is, increase level of PCE, limit transients) until the cause is evaluated and corrected. When evaluated and/or corrected, the restrictions may be lifted.

*b.* Notice of the Excursion will be posted informing all employees of—

(1) Location of the excursion;

(2) Period of time during which excursion occurred;

(3) Name of chemical agent observed;

(4) WPL for chemical agent monitored in mg/m<sup>3</sup>;

(5) Amount of exceedance in mg/m<sup>3</sup>;

(6) Statement of proposed action to limit future excursions;

(7) Safety POC with phone number;

(8) Medical POC with phone number; and

(9) Statement concerning the health significance of the excursion, with concurrence of the competent medical authority.

*c.* *Location and duration of posting.* The Notice of Excursion will be provided employees as soon as possible after the determination of the excursion in a manner that informs all possibly effected employees of the excursion. The notice may be delivered electronically, posted on a bulletin board near the location of the excursion, or other method that ensures effected employees are notified of the required information. If posted, the posting will remain for 3 days or, if the condition leading to the excursion is identified, until that condition is abated, whichever is later.

*d.* *Medical authority.* Competent medical authority will be notified of the excursion and provided the following:

(1) Location of the excursion;

(2) Period of time during which excursion occurred;

(3) Name of chemical agent observed;

- (4) WPL for chemical agent monitored in mg/m<sup>3</sup>;
- (5) Amount of exceedance in mg/m<sup>3</sup>;
- (6) Statement of proposed action to limit future excursions; and
- (7) Safety POC with phone number.

e. WPL Excursion Response Plan. A locally developed plan will be developed and executed to investigate, identify and control identified excursions. This plan may be incorporated with other facility documents such as contingency plan.

### **3-6. Monitoring support requirements**

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

b. *Calibration.* Air monitoring equipment must be calibrated and calibration methods must be approved before use. Calibration requirements are found in the quality assurance plan (see para 3-4a).

### **3-7. Monitoring requirements**

a. Monitoring equipment and results will be used to determine the level of PCE.

b. First entry monitoring is required when—

- (1) Unknown environment; or
- (2) Potential agent sources are present.

c. Monitoring during operations is as follows:

(1) Monitoring with continuous, near real-time devices with alarm capabilities will be conducted according to an approved monitoring plan (see para 3-8).

(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 or Site Specific Air Monitoring Plan.

### **3-8. Monitoring plan**

a. A monitoring plan will be written and implemented for all chemical agent facilities/operations and approved by the installation, garrison or activity commander or program manager. Safety managers will review and concur on all monitoring plans.

b. Development of the plan should be a coordinated effort involving, as a minimum, representatives from the safety office, and where available and applicable chemical agent laboratory, IH office, and environmental office.

c. The monitoring plan should contain the following elements:

- (1) Diagram of the operational site (OS) or storage facility (SF).
- (2) Agent and munitions involved.
- (3) Agent monitors to be used.
- (4) Placement of sample points based on characteristics of agent and munitions, airflow patterns, and monitoring equipment being used.
- (5) Type of sampling lines used, to include: length, material made from and whether sampling lines are heat traced. Tygon and rubber tubing will not be used.
- (6) Provisions for workplace monitoring during operations must be included.
- (7) Identification of monitoring work stations where agent leakage is considered possible.

d. 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.

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

### **3-9. Recordkeeping**

a. 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—

b. The date, sample number, duration, location, and results of each sample taken.

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

d. Type of PCE used.

e. A roster of personnel entering the building/area. The roster will have unique identifying information for individuals entering agent areas.

f. The installation, garrison, or activity commander must designate the official responsible for maintaining the monitoring records, 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 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)).

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

## **Chapter 4 Personnel Protective Clothing and Equipment**

### **4-1. Respiratory protection program**

In operations where respiratory protection is required, there will be a program for the selection, use, inspection, training, fit testing, and maintenance that complies with 29 CFR 1910.134, Respiratory Protection, AR 11-34, and TB MED 502. In addition, a MUC will be determined for each combination of chemical agent and respirator type for the WPL and STEL levels for the chemical of concern. This will be documented in the written respiratory protection program.

### **4-2. Determination of protection required**

Protective clothing and equipment is classified according to four levels A to D, where Level A provides the greatest level of protection. Its selection 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 PCE to work requirements and task-specific conditions, task duration, and heat stress. These factors will be considered in the hazard analysis for every agent operation.

a. *Level A.* Level A protection is selected when the greatest level of skin, respiratory, and eye protection is required. Level A protection will 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; or

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

b. *Level B.* Level B protection will be used when—

(1) The type and atmospheric concentrations of substances have been identified and require a high level of respiratory protection, but less skin protection.

(2) The atmosphere contains less than 19.5 percent oxygen; or

(3) The presence of incompletely identified vapors or gases is indicated by a direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the skin.

c. *Level C.* Level C protection 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 table 4-1). Level C protection will 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 (as set forth in table 4-1).

d. *Level D.* Level D protection will be used for chemical agent workers 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. *Local policy.* Local policy will determine required PCE for personnel who are not chemical agent workers.

f. Respiratory selection decision logic. Table 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 IH personnel can assist in selection of suitable respirators.

**Table 4–1**  
**Respirator selection decision logic<sup>1, 2, 3</sup>**

Step	Criterion	Respirators
1	Is the respirator to be used only for emergency escape purposes? If no, then proceed to Step 2.	If yes, then select: Respirator for the atmosphere in which it will be used.
2	Is any of the following true? The atmosphere is relatively unknown or poorly known. There is reasonable potential for oxygen content less than 19.5 percent (by volume). There is reasonable potential to be exposed above the immediately dangerous to life or health (IDLH) level. There is reasonable potential to be exposed above 10,000 times the worker population limit (WPL) and/or short-term exposure limit (STEL). If no, then proceed to Step 3.	If yes, then select: Tight-fitting full-facepiece self-contained breathing apparatus (SCBA) operated in pressure-demand mode with a minimum service life of 30 minutes; or Combination tight-fitting full-facepiece supplied-air respirator (SAR) operated in pressure-demand mode with an auxiliary self-contained air supply.
3	Is there reasonable potential to be exposed above 1000 times (but not above 10,000 times) the WPL and/or STEL? If no, then proceed to Step 4.	If yes, then select: Tight-fitting full-facepiece SCBA operated in pressure-demand or other positive-pressure mode; or Helmet or hood SCBA operated in pressure-demand or other positive-pressure mode; or Any respirator listed in Step 2.
4	Is there reasonable potential to be exposed above 50 times (but not above 1000 times) the WPL and/or STEL? If no, then proceed to Step 5.	If yes, then select: Tight-fitting full-facepiece SAR or airline respirator operated in pressure-demand or other positive-pressure mode; or Tight-fitting full-facepiece SAR or airline respirator operated in continuous-flow mode; or Tight-fitting full-facepiece power air-purifying respirator (PAPR); or Any respirator listed in Step 2 or 3.
5	Is there reasonable potential to be exposed above 25 times (but not above 50 times) the WPL and/or STEL? If no, then proceed to Step 6.	If yes, then select: Tight-fitting full-facepiece SCBA, SAR, or airline respirator operated in demand mode; or Helmet or hood SCBA operated in demand mode; or Tight-fitting full-facepiece air-purifying respirator (APR); or Any respirator listed in Steps 2–4.
6	Is there reasonable potential to be exposed above (but not above 25 times) the WPL and/or STEL? If no, then proceed to Step 7.	If yes, then select: Loose-fitting full-facepiece SAR or airline respirator operated in continuous-flow mode; or Helmet or hood SAR or airline respirator operated in continuous-flow mode; or Loose-fitting full-facepiece PAPR; or Helmet or hood PAPR; or Any respirator listed in Steps 2–5.
7	There is no reasonable potential to be exposed above the WPL and/or STEL.	None required.

Notes:

<sup>1</sup> The IDLH, WPL, and STEL are concentration-time values, not concentration-only values. The exposure potential depends on the specific use scenario, including both the airborne concentration and the task duration.

<sup>2</sup> Any respirator selected must comply with paragraph 1–7 of this pamphlet.

<sup>3</sup> References: 71 FR 50122 (24 Aug 06), Assigned Protection Factors (codified in 29 CFR 1910.134 as of 1 July 2007).

### 4-3. Protection levels for chemical agent workers

The following describes the protective equipment associated with each level of protection. Based on a local hazard analysis combinations of PCE may be used to provide flexibility in selecting more appropriate protection.

*a. Level A.* Level A protective equipment consists of a positive-pressure, full face-piece, self-contained breathing apparatus (SCBA), or positive-pressure supplied-air respirator with escape SCBA, approved by the NIOSH; totally encapsulating (vapor-tight) chemical protective suit; coveralls (optional); gloves, outer, chemical resistant; gloves, inner; boots, chemical resistant, steel toe, and shank.

*b. Level B.* Level B protective equipment consists of—

(1) A NIOSH-certified, 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

(2) A positive-pressure, supplied-air respirator with escape SCBA (NIOSH-certified); hooded, chemical-resistant clothing (coveralls 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).

*c. Level C.* Level C protective equipment consists of a full-face, air-purifying respirator (NIOSH-certified or DA-approved); hooded chemical-resistant clothing (coveralls; 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).

*d. Level D.* Level D protective equipment consists of a NIOSH-certified CBRN respirator or DA-approved 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).

### 4-4. Heat-stress plan

A heat-stress plan for chemical PCE will be developed for all chemical agent installations, garrisons, or activities. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) guide and NIOSH criteria for Occupational Exposure to Hot Environments will be used as guidance in developing the heat stress plan.

*a.* A heat-stress plan for chemical PCE will be developed for all toxic chemical agent installation/activities and will be reviewed annually. The following requirements for heat-stress plans will be met:

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

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

(3) Development of the plan will be a coordinated effort involving, at a minimum, representatives from the safety office, IH 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 usages of chemical PCE (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.

#### 4-5. Special requirements, M40 Series, chemical biological protective mask, application

a. For chemical agent environments in industrial operations and applications, the M40 mask conforms to the Occupational Safety Health Administrations (OSHA) criteria for designating all full-face, air-purifying negative-pressure respirators with an APF of 50. Therefore, the M40 mask may be used for respiratory protection in chemical agent environments up to a maximum of 50 times the WPL for GB, GA, GD, and VX. For H, HD, and HT, the M40 mask is authorized for use in either stable and characterized or monitored workplaces above the WPL per table 4-2. The decision to use the M40 mask in a chemical agent (mustard) environment must be supported by a risk assessment that supports the respirator decision logic. When using the M40 mask in mustard environments, leaders must ensure that controls are in place to prevent worker exposure above table 4-2's established limits.

**Table 4-2**  
**Daily maximum use limits for M40 in H, HD, and HT environment above the WPL**

Concentration <sup>1</sup> mg/m <sup>3</sup>	Duration per workday (hours)
0.006	2
0.003	4
0.0015	8
0.001	12

Notes:

<sup>1</sup> Concentration expressed as a Time Weighted Average.

b. The M40 mask will provide employee respiratory protection for up to a maximum of 50 times the STEL concentration for periods not to exceed 15 minutes, for escape purposes only.

c. Canisters for M40 masks will not be used for more than six continuous hours in a confirmed agent environment (that is, at or above the STEL concentration). Canisters must be replaced no later than six hours after the initial agent exposure, with no reuse.

d. The M40 mask will not be used for respiratory protection in IDLH environments.

e. Maintenance and care of military respirators.

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

(2) *Canisters and filters*. Canisters and filters will be replaced per the requirements of the latest TMs and SBs.

(3) *Storage*. Military protective masks will be stored in the carriers provided and will be hung by the shoulder strap or D-ring on the carrier. M40 masks attached to butyl hoods may be stored outside of the carrier between shifts by hanging the mask or hood by the hood armpit strap. 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.

(4) *Individual care*. Personnel issued a mask are responsible for maintaining it, including monthly detailed visual inspection. Any defects found will be reported to the supervisor.

(5) *Fit testing*. Quantitative fit testing will be conducted at least annually.

(a) For military applications, test procedures can be found in the latest revision of the operators manual for the M41 Protective Assessment Test System.

(b) For all other applications fit testing will comply with OSHA requirements.

(6) Mask wearing procedures and leak testing. Donning and doffing procedures for the M40-series protective masks can be found in TM 3-4240-346-10.

#### 4-6. Taping of equipment pertaining to Army protective clothing ensembles

a. Duct tape or a tape used with reusable suits should be evaluated to make sure the adhesive does not degrade the suit performance.

b. Duct tape does not provide a barrier against chemical agent, but rather joins or overlaps two barrier materials together.

#### 4-7. Corrective glasses or goggles

a. *Corrective glasses or goggles*. Corrective glasses or goggles that interfere with the sealing edge of a respirators facepiece are prohibited.

b. *Optical inserts*. Optical inserts (including mounts) have been developed for use inside a respirators facepiece and are required in accordance with DA Pam 40-8 and DA Pam 40-173.

*c. Visiting personnel.* Visiting personnel whose stays 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.* This pamphlet does not prohibit the use of contact lenses with respiratory protection. See U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Fact Sheet 63006-1206 (Chemicals, Contact Lenses, and Respirators) for information regarding the unique environment the respirator presents to the eye and the potential for irritation or injury, see [http://usachppm.apgea.army.mil/Documents/FACT/630061206\\_Chemicals\\_ContactLenses\\_Respirators.pdf](http://usachppm.apgea.army.mil/Documents/FACT/630061206_Chemicals_ContactLenses_Respirators.pdf).

#### **4-8. Nonstandard gloves**

Use of nonstandard type gloves may be used in place of standard toxicological agent protective (TAP) gloves for agent activities requiring special handling consideration. For example, laboratory operations where good hand dexterity is essential or glovebox operations subject to the following requirements:

*a.* The nonstandard glove selected is limited to use in operations where standard gloves cannot be used because of safety or operational considerations. An example is the use of lightweight, tight fitting, neoprene gloves in laboratory operations involving solvents incompatible with butyl rubber.

*b.* The nonstandard glove selected will have its agent penetration resistance ascertained by testing each purchased lot under an acceptable quality level (AQL) plan. The plan will, as a minimum, provide for testing in accordance with MILSTD 282 for the time period exceeding intended use with sufficient sampling to statistically demonstrate 95-percent reliability (no detectable penetration) at a 95-percent confidence level. Sampling to a 4-percent AQL at general level inspection 2 in accordance with MILSTD-105E or ANSI/ASQ Z1.42003 is acceptable.

*c.* Nonstandard gloves, which are approved for use as a result of AQL testing, will have their approved wear time clearly marked on each glove cuff and will be decontaminated and disposed of once approved wear time is reached or at the end of the operation.

*d.* Nonstandard gloves will be used only in a manner which prohibits intentional contact and has low potential for unintentional contact with liquid agent. In the event of actual or potential liquid contamination, the gloves will be decontaminated and removed as soon as feasible. They will be disposed of in accordance with paragraph 5-2.

#### **4-9. Build up of static electricity**

The PCE can accumulate static electricity. When dealing with chemical munitions involving explosives, propellants or other energetics consideration will be given to static electricity discharge in accordance with DA Pam 385-64.

#### **4-10. Care of equipment and protective clothing**

*a.* Personal PCE, chemical agent monitoring, and detection equipment, and other equipment associated with chemical agent operations will be used, inspected, tested, maintained, repaired, and calibrated according to the appropriate TMs, FMs, and manufacturers instructions.

*b.* Users of this equipment will be instructed in the proper use, inspection, testing, maintenance, repair, and calibration requirements.

*c.* Each installation, garrison, or activity will establish a separate area where protective clothing will be laundered, inspected, tested, and issued.

#### **4-11. Handling of personal protective clothing and equipment for laundering**

*a.* Clean PCE does not have to be monitored, will be labeled, and marked cleared for laundry.

*b.* If the PCE contacted liquid or aerosol chemical agent it will not be reused and will be disposed of in accordance with existing laws and regulations unless reuse is approved by the ODASAF, based upon review of the decontamination plan and evaluation of supporting test data.

*c.* Protective clothing and equipment that has been exposed above the STEL concentration will be decontaminated and/or monitored and marked cleared for laundry. Two options are permissible for exposed PCE being sent to the laundry. The options are either:

(1) If decontaminating and monitoring to the STEL concentration is used for clearing PCE for the laundry, then the laundry work area must be continuously air-monitored real-time or near real-time for STEL and periodic monitoring for WPL in accordance with WPL Monitoring Section for the Laundry; or

(2) If decontaminating and monitoring to the WPL concentration is used for clearing PCE for the laundry, then no real-time or near real-time monitoring or WPL Monitoring Section is required for the laundry work area.

*d.* Reusable commercial protective clothing will be laundered and tested in accordance with manufacturer recommendations.

e. The laundry facility will thoroughly clean, inspect, and repair (if required) in accordance with applicable TMs and/or manufacturers instructions.

#### 4-12. Monitoring of decontaminated clothing

Monitoring of decontaminated clothing will be performed as follows:

a. The clothing will be placed in a container or room and held for at least 4 hours at a minimum temperature of 21 degrees C (70 degrees F).

b. The atmosphere inside the container or room will be monitored for contamination with a low-level detector to verify that agent concentrations are below the appropriate AELs before the clothing may be sent to the laundry facility. If agent concentrations are detected above the appropriate AELs, the clothing will be further decontaminated and monitored.

#### 4-13. User Inspection

Each user must visually inspect PCE for serviceability before use. Unserviceable PCE must be clearly marked to not be mistaken for serviceable items. Serviceable PCE is not to be worn as a general utility item. Unserviceable PCE may be used for training provided it is clearly marked "For training use only" and segregated from serviceable PCE.

#### 4-14. Personal protective clothing and equipment inspection

All used PCE must be laundered, inspected, and tested quarterly. If the issued or ready-for-issue PCE has not been used within the initial three month period it may be extended for an additional quarter (three months), by a certified PCE inspector. The extension can only be granted one time. All PCE in standby status must be inspected and tested prior to issue.

#### 4-15. Personal protective clothing and equipment marking

a. 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.

b. The marking should both identify the item and provide means to track the recertification test date in accordance with the applicable TM.

c. The marking method must be able to withstand decontamination and sanitizing procedures and must not damage the clothing.

#### 4-16. Butyl rubber flammability

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.

#### 4-17. Demilitarization protective ensemble

a. The demilitarization protective ensemble (DPE) is approved for use as follows:

(1) At temperatures at or below 90 degrees F (32 degrees C), the DPE constructed of 30 mil thick material is approved for use in agent environments not to exceed two hours.

(2) At temperatures at or below 90 degrees F (32 degrees C), the DPE constructed of 20 mil thick material is approved for use in nerve agent environments not to exceed two hours.

(3) At temperatures above 90 degrees F (32 degrees C) the DPE is approved for use as shown in table 4-3.

**Table 4-3**  
**Approved demilitarization protective ensemble use for elevated temperatures**

Agent	Thickness	Max. Temp.	Not to exceed
G-series	20 mil	100 degrees F (38 degrees C)	45 minutes
V-series	20 mil	120 degrees F (49 degrees C)	60 minutes
H-series	30 mil	120 degrees F (49 degrees C)	45 minutes

*b.* Only in unusual circumstances when no other suitable protective ensemble is available, the DPE constructed of 20 mil material may be used in mustard agent environments as follows:

(1) At temperatures at or below 80 degrees F (27 degrees C), the DPW constructed of 20 mil material may be used not to exceed one hour.

(2) At temperatures between 80 degrees F (27 degrees C) and 90 degrees F (32 degrees C), the DPE constructed of 20 mil material may be used not to exceed 45 minutes.

*c.* The quality assurance program associated with manufacture of the DPE must include testing for chemical agent penetration sufficient to assure that the above times are within the protective capability of the suit, in accordance with CAMDS Specification 4818G, DPE Suit (20 or 30 mil).

*d.* The DPE must be used in accordance with a heat stress plan.

## **Chapter 5 Decontamination and Disposal**

### **5-1. Decontamination**

*a.* 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.

*b.* 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.

*c.* Items or materials that are known, because of air monitoring, or reasonably believed to present a chemical agent contact or vapor hazard will be managed to ensure that it is handled by the appropriate category of personnel for the level of decontamination. An item or material having been in the presence of agent vapor does not automatically mean that the item or material has been contaminated with chemical agent.

### **5-2. Decontamination and disposal of tools, supplies, equipment, and facilities**

*a.* Adopting the revised exposure limits for chemical agents has resulted in an evaluation of the previous method of using 0, X, 3X (XXX), and 5X (XXXXX) decontamination terminology. To move the Army into conformance with existing laws and regulations, these Decontamination Levels criteria are no longer prescribed, except as noted below. This does not preclude use of the X criteria for local internal controls.

*b.* Any existing material which was characterized under the old system may continue to be characterized under the old criteria. Material that has been disposed under previous Army regulations is exempt from these new requirements.

*c.* Tools, supplies, equipment and facilities used in and around chemical agent operations and activities should not automatically be considered contaminated. Due to their intrinsic value, every effort will be made to reuse them by limiting chemical agent exposure or decontaminating through implementing accepted IH practices to clean the tools, supplies, equipment and facilities and return them to useable service in accordance with locally approved procedures.

*d.* Tools, supplies, equipment and facilities, except for used carbon filter material which will be handled as contaminated (including respirator filters or canisters if they were used in an environment above the STEL for the given chemical warfare agent), meeting the following conditions will be considered clean and available for unrestricted use if the item never contacted liquid agent or experienced a chemical agent aerosol environment and meets one of the following conditions:

(1) If in a continuously-controlled environment where the environment is documented to never have had exceeded the STEL concentration when the item was present;

(2) If in a continuously-controlled environment where the environment is documented to never have had exceeded the IDLH concentration when the item was present, the item may be considered clean based on a risk assessment addressing the following factors as a minimum:

(*a*) Temperature of environment (for example, condensation of vapors);

(*b*) Type of process, operation or task;

(*c*) Concentration of agent and duration of exposure;

(*d*) Material composition (for example, porosity, density, organic, inorganic, metallic, crystalline);

(*e*) Historical documentation for similar operations and items;

(*f*) Type of equipment (for example, wrench, rubber mat, process equipment, auxiliary equipment); and

(*g*) Location of object considering source of vapor and airflow direction.

*e.* Tools, supplies, equipment and facilities will require decontamination or disposal if any one of the following conditions is met:

(1) Contacted liquid chemical agent;

(2) In a chemical agent aerosol environment;

(3) In a continuously controlled environment and exposed above the IDLH concentration for any period of time;

(4) In an uncontrolled environment where monitoring has indicated the environment exceeded the STEL concentration; or

(5) In an uncontrolled environment involving the storage, use or presence of chemical agent and where physical factors (for example, discoloration, stains, and so forth) indicate possible exposure to chemical agent.

### **5-3. Decontamination of tools, supplies, and equipment**

When the value, utility or uniqueness of the tools, supplies or equipment warrants reuse, and reuse will occur outside of the contaminating operation or activity, the item will be decontaminated in accordance with locally-approved procedures and current accepted IH practices, or the item will be disposed of as waste, described below.

a. For release to chemical agent workers and use in the chemical agent facilities or operations, the item will be decontaminated and/or monitored to a vapor screening level equivalent to less than the STEL concentration.

b. For release to the general (non-agent) facility, garrison or installation employee for maintenance, the item will be decontaminated in accordance with locally-approved procedures and monitored with a vapor screening procedure equivalent to less than the WPL concentration. Tools and equipment will not leave government control. It is a preferred practice that tools and equipment will not be modified or disassembled. However, if maintenance or disassembly of such items is necessary, it will be accomplished by personnel knowledgeable in agent symptomatology and agent characteristics, and in facilities equipped with appropriate safeguards to control potential hazards.

c. For release to the general (non-agent) facility, garrison, or installation employee for unlimited use, the equipment will be decontaminated in accordance with an approved Equipment Decontamination Plan and certified by the mission commander to the selected health-based criteria (for example, GPL, or values from app C) for the reasonably anticipated use environment.

### **5-4. Facilities**

When the value or uniqueness of a facility warrants use for non-chemical-agent operations, and use is limited to general workers (for example, office space, storage facilities, and so forth), the facility will be decontaminated in accordance with locally approved procedures, accepted IH practices and meet the conditions below or otherwise restricted to similar chemical agent operations, activities and tasks. Chemical agent facilities converted to non-chemical agent use prior to implementation of this guidance are not subject to these requirements.

a. The facility will be decontaminated and/or monitored to a vapor screening procedure equivalent to less than the WPL - unventilated.

b. A WPL Monitoring Plan will be developed and implemented for the facility's future use. The WPL Monitoring Plan will describe how the facility will be monitored prior to release of the facility for general worker use. The WPL Monitoring Plan will describe the intended use of the building and monitoring strategy for release of the facility. This includes the criteria for cessation of monitoring. If the facility is being exchanged between different organizations, the WPL Monitoring Plan for the facility will be approved by the mission commander releasing the facility and the mission or garrison commander receiving the facility.

c. Historical records will be transferred to the Garrison commander for recordkeeping.

### **5-5. Chemical agent associated surplus material**

Surplus material associated with chemical agent facilities and operations that meet the definition of clean and when not prohibited by applicable federal, state, or local laws and regulations may be sent to Defense Reutilization Marketing Office (DRMO), a landfill, recycling or treatment facility for disposal.

### **5-6. Clean for release to the public**

Surplus tools, supplies, equipment and facilities may be released unconditionally to the public in accordance with all applicable federal, state, and local regulations if one of the following conditions is met:

a. The item is heated to an internal temperature of 538 degrees C (1,000 degrees F) for at least 15 minutes.

b. The item is decontaminated in accordance with an approved equipment decontamination plan and certified by the mission commander or designee to the selected health-based criteria (for example, GPL or values from app C) for the reasonably anticipated use environment of the public owner.

### **5-7. Equipment decontamination plan**

A plan will be developed and approved for releasing tools, supplies, equipment, and facilities to the public which will address as a minimum—

a. Description of the item to be released to include type of fabrication materials.

b. The decontaminating process to be used, to include decontaminating materials, duration of decontaminating process, and decontaminating environment;

c. Rationale for selecting the health-based criteria being used;

d. The analytical method that will be used to determine the item has been decontaminated to below the selective health based criteria;

- e. The quality control process that will be used in conjunction with the analytical method to assure decontamination; and
- f. A statement of the reasonably anticipated environment in which the public could be expected to use it, considering: temperature, modification, etc. and how the selective decontaminating process and monitoring meets those conditions.
- g. The plan will be approved by the responsible mission commander.

### **5-8. Chemical agent associated waste**

Waste associated with chemical agent facilities and operations that do not meet the definition of clean will be managed, stored, and shipped in accordance with applicable federal, state, or local laws and regulations.

### **5-9. Testing of chlorine-based decontaminants**

The chlorine-based decontaminants must be checked at least annually, in accordance with quality assurance procedures, to ensure deterioration has not occurred. The minimum acceptable chlorine content for super tropic bleach (STB) is 10 percent, 30 percent for high test hypochlorite (HTH), and 3 percent for sodium hypochlorite solution. 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.

## **Chapter 6 Safety Criteria for Agent Activities**

### **6-1. Design change-house facilities/areas**

Field and laboratory operations only have to comply with paragraph 6-1g, below.

- a. Facilities must be provided for showering and changing clothes. It may be a designated area or a change-house.
- b. The following criteria apply to the location, design, and operation of change-house facilities:
  - (1) 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 unbaricaded intraline distance based on the maximum quantity of explosives at any nearby location.
  - (2) 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 airflow will be from the 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 6-1c:
    - (1) The building design (for example, floor slope, drainage, airflow, 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 unbaricaded 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. Change-houses/areas should include adequate toilet and shower facilities for all personnel involved in chemical agent operations.
  - f. Utilization of chemical change-houses/areas will be controlled by locally approved regulations.
  - g. 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 6-1c(3), above. Agent-contaminated protective clothing will not normally be worn or transported to change-houses/areas.

## **6-2. Design of operational agent facilities**

*a.* The following safety features will be included in the design and construction of operating agent facilities and equipment:

(1) The exhaust ventilation system will be designed so that 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, to scrub with a neutralizing solution or other approved technology 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 ACGIH Industrial Ventilation Manual. Systems should be designed and installed so that exposure of ventilation equipment mechanics to chemical agents is minimized.

(2) 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 limits (SELs) are exceeded.

(3) 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 will be employed.

(4) Where ventilation is a sole or primary method of personnel protection, backup emergency power (automatic start generator) or other fail-safe systems will be installed to prevent a release of agent in the event of an unplanned power outage.

(5) 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. This requirement is not necessary when ventilation system performance is continuously measured.

(6) New construction will meet all applicable DOD and Army regulations (for example, Corps of Engineers and National Guard design specifications, and so forth) and appropriate national consensus standards (for example, the criteria of the ACGIH, the NFPA, and American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)). The USACHPPM, 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.

(7) Chemical agent air exhaust filters will be leak tested in accordance with the latest version of American Society of Mechanical Engineers (ASME) N511 (Standard for in Service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air Conditioning Systems).

*b.* 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 levels in this pamphlet 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 non-hazardous 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 laboratories and industrial operations, and in other places where agent emergency showers and eyewash fountains are located, floor drains if used will be installed in accordance with Federal, state and local regulations.

(1) 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.

(2) Vents from holding tanks and drain lines must be engineered to preclude agent leakage to the atmosphere.

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

*h.* The electrical system will comply with NFPA's National Electric Code (NEC).

*i.* 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.

(1) The auxiliary electrical power source or fail-safe system will be tested at least annually.

(2) The test will involve insuring that pressure differential gradients are maintained and can be developed locally.

*j.* Construction materials:

(1) Nonporous steel, glass-brick, and reinforced concrete are approved materials.

(2) Materials such as wood or other porous materials that absorb agent are difficult to decontaminate and should be minimized in the construction of buildings where agent is to be stored, handled, or processed.

(3) Stainless steel and enameled steel are good materials for doors, cabinets, and furniture in agent areas.

(4) Existing facilities constructed of porous materials should be sealed as appropriate to enhance decontamination.

k. An audible and visual warning system should be used to provide an immediate warning to all personnel near the operational facility and within the 1percent lethality distance based on the worst-case risk in the event of a known or potential agent release.

l. Ventilation.

(1) Local exhaust ventilation is the most effective and preferred method of controlling agent vapor;

(2) However, dilution ventilation may be required for specific conditions where local exhaust ventilation is not practical.

(3) In general, ventilation airflow should be from clean areas to areas of increasing potential or actual contamination.

(4) 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.

(5) Agent work areas will be provided with an appropriate ventilation system to—

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

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

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

(6) The SELs provided in table 6–1 are primarily an engineering guideline. These limits should be attainable by a well operated facility, give an early indication of upset conditions, and be accurately measurable in a timely manner.

m. 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 (1fpm) 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 8–3b 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.

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

o. 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.

**Table 6–1**  
**Source emission limits (SELs) (mg/m<sup>3</sup>)<sup>1</sup>**

Chemical symbol	GD	GA/GB	VX	H, HD, HT <sup>3</sup>	L <sup>4</sup>
Source emission limit <sup>2</sup>	.0001	.0003	.0003	.03	.03

Notes:

<sup>1</sup> No individual will be intentionally exposed to direct skin or eye contact with any amount of solid or liquid chemical agent, or to solid materials contaminated with agent.

<sup>2</sup> The SELs are primarily an engineering guideline. These limits should be attainable by a well-operated facility, give an early indication of upset condition, and accurately measurable in a timely manner.

<sup>3</sup> HT is measured as HD.

<sup>4</sup> All concentrations measured as Lewisite.

### 6-3. Criteria for containment of operations

a. Certain operations involving 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, ammunition, and 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 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 6-3c(1) 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 using 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 an approved 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 an approved 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, glove boxes, 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 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 component.

(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 6-3c(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.

#### **6-4. Leaking munitions and containers**

a. Before starting operations in areas where chemical agents are stored without continuous air monitoring, first entry monitoring will be performed to assure that agent leakage has not occurred. In the event a leaker or contaminated item is discovered during the first entry monitoring or in subsequent operations, the immediate area will be evacuated.

b. 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 will be monitored to assure completion of decontamination.

(2) The area will be monitored to be below the STEL or below the protective capabilities of the PCE specified in this pamphlet.

c. 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 PCE required. If no real-time low-level continuous monitoring with alarm capability is available, entry will be conducted in level A. Steps will be taken to reduce the levels of agent contamination until 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.

#### **6-5. Special operational provisions for emergency preparedness**

a. A central control point will be established for coordination of emergencies. This control point is not required to be the center for chemical accident incident (CAI) control; however, the center may be used when it is more advantageous to the installation or garrison.

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

c. Unnecessary work not related to the operation will not be performed in agent operation areas. Laboratories should have areas set aside for non-agent operations.

d. Adequate operable monitoring equipment and materials must be maintained at all active agent 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 reporting emergencies to the operational control point 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 operate this equipment at all times. Designated personnel will be trained to operate this equipment in the event of an emergency. A Government vehicle or ambulance 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 PCE, and check for its proper fit, maintain records of entry and exit time, monitor stay times, 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. 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.

j. Any agent exposure, potential 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 personnel who have been exposed or potentially exposed to nerve agent will have a cholinesterase level drawn that day prior to release from duty.

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

## **6-6. Mishap risk management**

a. The mishap risk management component of CRM will be integrated into all chemical operations. A written plan will be implemented to establish policies and procedures for the assessment of hazards and the management of mishap risk associated with toxic chemical agent activities.

b. The hazard analysis process includes the first two steps of the five-step risk management process as defined in DA Pam 385-30.

(1) The hazard analysis should be performed by a team with expertise in operations, safety, occupational health and IH.

(2) The team should include at least one employee who has experience and knowledge specific to the operation being evaluated.

(3) Hazard analysis for all chemical operations will consist of a systematic, step-by-step, documented review of the operation. Hazard analyses are performed to identify hazardous conditions for the purpose of elimination or control. The hazard analysis will be conducted on the total system to include facilities, utilities, work stations, equipment, tools, procedures, and their interface. The greatest potential for injury may be from sources other than chemicals or explosives, and these sources will be evaluated.

(4) Analysis must include a 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 having a likely potential for adverse consequences in the workplace. Consequences of failures of engineering and administrative controls must also be addressed.

(5) Hazards will be assessed in terms of exposure/risk. The hazard/exposure (risk) must be evaluated in terms of probability and likely severity and assigned a risk assessment code (RAC).

(6) Ground rules and methodology for performing local hazard analyses will be defined in a written plan. This plan may be included in a SOP, System Safety Management Plan (SSMP) or other approved mishap risk management program. Included in this plan will be the definition of RACs used in local analyses.

(7) A written plan outlining employee participation in the development and implementation of the hazard analysis is required. Employees and their representatives will have access to the information developed.

(8) Applicable portions of Section 119, Part 1910, Title 29, of the Code of Federal Regulations (29 CFR 1910.119) will be applied. A written record of the hazard analysis will be made and retained with the record copy of the SOP. The hazard analysis will be reviewed during the annual SOP review.

c. All hazard analyses will be reviewed and concurred with by the activity/installation safety manager, prior to starting-up or implementing changes to the affected operation.

d. Mishap risk management will be formally documented and executed in accordance with DA Pam 385-30. Documentation will include risk management worksheets DA Form 7566 (Composite Risk Management Worksheet), Certificates of Risk Acceptance (DA Form 7632) or other documentation of the control measures selected and acceptance of residual risk at the appropriate level, per DA Pam 385-30.

e. For acquisition programs, a SSMP, as defined by DA Pam 385-16, is required to be developed by Army Acquisitions Executives, PEOs, and PMs for the life cycle of a system. The Army's standard System Safety Risk decision matrix is established in AR 70-1. Risk acceptance hierarchy will be published and updated as required in the SSMP.

## **6-7. Standing operating procedures**

a. An SOP is required for all chemical agent operations. SOPs will be prepared in advance of operations. Chemical agent SOPs are not required to be in a specific format, but will, as a minimum

(1) Describe, in detail, all necessary operational and safety and health requirements including inspection of all facilities and equipment involved.

(2) These operating steps and/or procedures will consider hazards and control measures identified during the hazard analysis/risk management process. They will be detailed enough to ensure that the operation is conducted safely but will avoid unnecessary detail not required for safety and health purposes, which may be unnecessarily restrictive for personnel performing the operations and/or may increase the hazards involved.

(3) Describe actions to be taken during an event or emergency (for example, actions to evacuate the immediate area).

(4) Address the PCE required for safely performing the operation.

(5) Address monitoring procedures, methods, and equipment to be used during the operation.

(6) Address tools and equipment necessary for performing the operation.

- (7) Describe, in detail, the location of all required equipment.
- (8) Address decontaminants, decontamination equipment, and decontamination procedures to be used during the operation.
- (9) Address operational hazards expected to occur or which could be reasonably anticipated during the operation.
- (10) Address personnel required for safely performing the operation. Personnel limits will allow for necessary supervision and reinforcement of the requirements contained in the SOP.
  - b. 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 and/or agent munitions is prohibited.
  - c. Self- and buddy-aid procedures may be included or the location of those procedures referenced.
  - d. The SOPs will be available at the work site, for personnel information, guidance, and compliance.
  - e. Supervisors will be responsible for monitoring all the areas and enforcing requirements outlined in the SOP.
  - f. Supervisors will read and indicate they understand all the requirements of the SOP relative to the operation and that it can be executed in an efficient, effective, and safe manner.
  - g. All employees will read and indicate they understand all the requirements of the SOP relative to their job and can execute it in an efficient, effective and safe manner.
  - h. The SOP will be strictly followed. If a worker has a concern involving the SOP, or feels the SOP is in error, the worker will immediately bring the concern to the attention of management. Management will immediately address the issue.
  - i. The SOPs will be certified for their accuracy at least annually by their proponent.
  - j. The SOP must be reviewed by safety personnel at least annually. An SOP or a change to an SOP will not be implemented until it is concurred by the installation/activity safety manager.

#### **6–8. Other administrative and work practice controls**

- a. *Cardinal principle.* The cardinal principle for an operation involving chemical agents or munitions is to limit the potential exposure to a minimum number of personnel, for a minimum period of time, to a minimum amount of the chemical agent consistent with safe and efficient operations. This includes prohibiting concurrent, unrelated work, within the same work area.
- b. *Personal protective clothing and equipment.* Guidance for operations will emphasize, as a minimum, the proper use, maintenance, care, decontamination, testing, and disposition of PCE.
- c. *Training and information.* All personnel who work with or have an association with chemical agents and/or munitions, or have a potential for exposure (for example, maintenance workers, clerical, firefighters, security) will be trained as outlined in this regulation prior to being assigned to chemical areas. Refresher training is required at least annually. Hazardous waste operator (HAZWOPER) training is required in accordance with 29 CFR 1910.120 for remediation sites, treatment, storage, and disposal sites.
  - (1) The training will include signs and symptoms of agent exposure, information on sources of exposure, possible adverse health effects, and practices and controls used to limit exposures. Environmental and medical monitoring procedures and purposes, and worker responsibilities in health protection programs, including instruction in first aid, self aid, and buddy aid techniques will also be included in the training program. This training will provide employee awareness to help employees assess personal risks to safety and health.
  - (2) The training must enable workers to take appropriate actions in the event of a chemical agent mishap.
  - (3) All workers must demonstrate proficiency prior to performing hazardous operations.
  - (4) Worker attendance at initial and refresher training will be documented and kept on file for the duration of employment plus 3 years.
- d. *Medical surveillance.* Medical surveillance programs will be established according to the specific guidance contained in DA Pam 40–8, DA Pam 40–173 and/or the most current published guidance. All employees with the potential for exposure to chemical agent will be enrolled in the medical surveillance program. Recommended pre-placement, periodic, and termination medical surveillance results will be managed in accordance with DA Pam 40–173 and DA Pam 40–8.
- e. *Emergency preparedness.*
  - (1) In the event of an accidental release of agent that may result in personnel exposure, all nonessential and unprotected personnel will be immediately evacuated or utilize in-place sheltering. Emergency procedures will be implemented. The source of the release will be contained and affected areas monitored and decontaminated, as appropriate, to applicable AEL before normal operations are resumed.
  - (2) Medical evaluations for personnel who may have been exposed should follow the procedures outlined in DA Pam 40–8, DA Pam 40–173, and/or the most current published guidance.
  - (3) The installation must maintain current chemical accident or incident response and assistance (CAIRA) plans in accordance with AR 50–6 and DA Pam 50–6. These plans will include those actions necessary to save life, preserve health, safety and the environment, secure chemical agent materiel, protect property, and help maintain public

confidence in the ability of the Army to respond to a mishap. Installations will establish a central control point to coordinate all chemical agent emergency actions and conduct periodic exercises of CAIRA plans.

(4) Local emergency support agencies, such as police departments, fire departments, health departments, and local governments, will be informed of chemical agent activities being conducted within their jurisdictions. Local support agencies will be advised of equipment, personnel, and other forms of support that may be required in the event of an emergency involving a chemical agent.

*f. Labeling and posting of hazards.*

(1) When chemical agent contamination is verified, equipment, tools, or other items will be marked or tagged to indicate degree of contamination (see glossary). Inactive equipment and decontaminated facilities will be marked to indicate the level of decontamination. Records will be maintained for historical documentation.

(2) Items containing chemical agent will be marked or labeled according to local requirements.

*g. Maintenance controls.* A continuing program for equipment and facility maintenance will be implemented and documented for all chemical agent operations. If feasible, the chemical agent process/operation or a portion of the process/operation will be shut down, and equipment or facilities decontaminated, before maintenance, testing, or repair operations are conducted.

*h. Agent sampling.* Sampling (drill, sample, tap, and plug) of chemical agent munitions in storage facilities or other locations is prohibited without the approval of the Department of Army. Approval to conduct sampling operations must be obtained by submitting written justification to the Chief of Staff (DACS-SF), 200 Army Pentagon, Washington DC 20310-0200. Justification must include a site plan/safety submission, risk assessment, and identified control measures.

## **6-9. Pre-operational safety survey**

*a.* A preoperational safety survey will be conducted when chemical site plans (CSP) and chemical safety submissions (CSS) of new chemical agent operations are required. DA Pam 385-65 provides guidance on situations that require a CSS and/or CSP. The preoperational safety survey will be conducted by the ACOM, ASCC, or DRU with responsibility for the chemical agent mission (for example, U.S. Army Corps of Engineers (USACE) for Formally Used Defense Site (FUDS) remediation). The ACOM, ASCC, or DRU can delegate the conduct of survey.

*b.* The preoperational survey will—

(1) Assure, that at least 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; and

(4) Include evaluation of emergency procedures as necessary.

*c.* Supervisory personnel will certify that facilities, equipment, training, and procedures are in accordance with 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 chemical operation that has not been conducted in the last 90 days. Installation/activity safety personnel will evaluate the procedures to ensure the operation will be conducted in a safe manner. 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.

## **Chapter 7 Personnel Protective Practices**

### **7-1. Checking safety equipment**

*a.* The supervisor will be responsible for ensuring that safety equipment is checked and ready for use.

*b.* Users will inspect the equipment before each use in accordance with their training, SOPs, and appropriate regulations.

### **7-2. Training personnel**

*a.* Supervisors will ensure that the training outlined in this pamphlet is accomplished and utilized by their personnel.

*b.* Safety, IH, and medical personnel (if medical information/issues are involved) will provide technical assistance.

*c.* All personnel who work with or have some association with chemical agents and munitions or have a potential for exposure will receive training to enable them to work safely and to understand the significance of agent exposures. (This applies to maintenance workers, clerical workers, firefighters, security guards, 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).
- (8) Heat stress recognition and prevention.

*d.* An ongoing program of instruction in accordance with this pamphlet, DA Pam 40–8, and DA Pam 40–173 will be used to maintain proficiency in the above subjects and will be provided at least annually.

### **7–3. Safeguarding of personnel**

*a.* Personnel who work in contaminated or potentially contaminated areas, or where handling or contact with agent-filled items will— (For laboratories, see chap 8.)

- (1) Change all clothing, including shoes, at the beginning and end of the work shift.
  - (2) Have open sores or wounds evaluated by the medical personnel.
  - (3) Shower thoroughly (using plenty of soap) with special attention given to hair, face, neck, and hands before leaving at the end of the workday.
  - (4) Eat, drink, chew, smoke, or apply cosmetics in designated areas only.
- b.* Supplies for decontaminating personnel will be available when operations are in progress.

### **7–4. Emergency response equipment**

*a.* The following emergency response equipment and supplies will be readily available at any site or facility involving agent operations. Trained personnel will also be available to use this equipment.

- (1) An ambulance or government vehicle to serve as a patient transport vehicle.
  - (2) A communication system to summon aid.
  - (3) Three MARK I nerve-agent antidote kits per person for nerve-agent operations (may be carried by the individual).
- (a)* 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.
- (b)* The injectors must be protected from freezing because the injector may not function properly while frozen.
- b.* The SOPs or local procedures will list additional equipment required.

### **7–5. Self/buddy-aid procedures**

*a. Exposure to mustard.* 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.

*b. Exposure to GB.* Exposure to GB poses primarily an immediate vapor hazard and unprotected 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. Decontamination of personnel exposed to liquid mustard or nerve agents will be done as quickly as possible by following the procedures in SOPs, DA Pam 40–8, and DA Pam 40–173.

## **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. All 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 in accordance with DA Pam 385–30 is a valid method of eliminating/reducing the unique hazards associated with research and development laboratory operations.

*b.* Paragraph 7–3 does not apply to agent laboratories.

*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 1 ml or less of neat chemical agent, one of the following is required:
  - (a)* A double-containment system. 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.

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

(2) For quantities in excess of 1 ml of neat chemical agent, a double-containment system is required.

(3) Prior to removal from engineering controls, agent containers will be sampled for surface liquid contamination with M8 paper or air monitoring.

d. Unattended overnight storage of neat 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 hazard analysis.

e. Operations in RTAPs and fixed-site, real-time monitoring operations are exempt from the 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 per paragraph 1-1c.

f. Unrelated 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).

g. Good housekeeping will be maintained.

h. SOPs for hazardous operations will require a daily checklist to be used at the beginning of each days operation to assure presence of required equipment as stated in the SOP. The listed equipment must be specific as to type such as specifying the type of glove or eye protection required (for example, butyl gloves, nitrile gloves, and so forth.).

## **8-2. Research, development, test, and evaluation solutions**

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

a. The 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; field operations may check and log interior temperature of refrigerators and freezers instead of installing an alarm. Refrigerator or freezer used with flammable materials will meet appropriate electrical requirements for flammable materials.

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

## **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 airflow 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 6-2a and 6-5l apply to ventilation systems in laboratories.

(4) A scheduled preventive maintenance program will be established to provide continued assurance of adequate ventilation system 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 to cause turbulence at the laboratory hood face.

(6) Ventilation hoods or gloveboxes used for overnight storage of agent will 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 within the hood or glovebox. Charged agent generators may be stored overnight and used in the same hood if other agent present is stored in a vault or refrigerator within the hood or glovebox.

(7) Where ventilation is a sole or prime method of personnel protection, backup emergency power (automatic start generator) or other fail-safe systems will 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 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.

(2) Laboratory hoods in which agent operations are conducted will be challenged with test aerosols (visible smoke)

with the sash in the maximum open position. No visible smoke will escape from the hood while the sash is slowly closed to as much as the operational set up will allow and then slowly raised to the fully opened position.

- (3) Laboratory chemical hoods will be tested and verified
  - (a) When installed and at least annually (within a 12-month period) thereafter.
  - (b) When substantive changes have occurred to the hood or hood operating environment, such as
    1. When the ventilation system has undergone repairs or changes that may affect the airflow rate or patterns;
    2. When the hood operating environment (for example, supply air distribution patterns and volume, lab/furniture geometry) has changed such that it may decrease the performance of the hood;
    3. When there have been changes in hood setup (that could decrease hood performance), hood face velocity control type, set point, range, and response time; and
    4. When there have been changes in exhaust system static pressure, control range and response time.
- (4) Sash stops may be used to define the maximum sash position opening.
- (5) 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.
- (6) 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.
- (7) 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 supporting industrial hygienist for design guidelines.
- (8) When ventilation hood exhaust systems contain filters that have been used for agent operations, the ventilation system must maintain an inward airflow through the hood even when the working area of the hood no longer contains agent or agent-contaminated material. In this case, no minimum face velocities are required; however, inward flow will be verified by smoke tests or other visual means. If the filter system is isolated from the hood (for example, back-flow dampers, and blind hinges), this subparagraph does not apply, though visible indicators that show the positioning of dampers (open/closed/partly closed) should be provided at the work station.
- (9) The design exhaust volume of the hood should provide excess initial capacity.
- (10) 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 USACHPPM, Industrial Hygiene Program, APG, MD 21010-5403 is a good source of information for assistance in laboratory hood construction criteria, concept development, and design review services.
- (11) Effluent air from laboratory hood systems must not contain concentrations of agent in excess of the STEL concentration contained in this PAM. 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.
- (12) 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.
- (13) 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.
- (14) No agent or agent-contaminated equipment will be allowed within 20 centimeters (8 inches) 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 (8-in) 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 (8-in) zone should be designated by paint or tape.

c. *Glovebox*. Glovebox requirements for the laboratory will be consistent with those in paragraph 6-2m.

#### **8-4. Agent monitoring**

During the first 5 days of new agent operations, monitoring at the WPL (AEL for Lewisite) 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. An alternative is monitoring lab operations in near real-time at the STEL (AEL for Lewisite). The methods, techniques, and rationale for agent monitoring in labs will be documented in the local agent air monitoring plan.

## 8-5. Loss of engineering controls

Local policies will be developed to address conditions constituting loss of engineering controls, actions taken to evaluate the hazard, protect personnel, decontamination, and conditions for restored use of the area.

## 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 paragraph 4-8.

*d.* Surgical gloves may be used without testing only if the total quantity of agent accessible is less than 1 milliliter; a time limit of 5 minutes from the beginning of access to uncontained agent is established; an individual wearing approved gloves (non-surgical) 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 allows 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, and dispose of in accordance with local permits and procedures.

*(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 10-8415-210-13P.

(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 agent contamination occurs, decontaminate immediately and continue operation. Upon completion, decontaminate again, remove gloves, and dispose of in accordance with local permits and procedures.

*f.* All personnel handling agent containers will wear, as a minimum, level D PCE 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 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 non-porous surfaces or coatings that resist agent absorption, decontamination materials/solutions 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 non-work 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 in the filter use record.

*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. The provision of interior corridors, which is typical for protecting the means of egress from laboratory space to an exit providing egress to the outside, is in compliance with the intent of this text.

*g.* Compressed gas cylinders not necessary for current laboratory requirements will be stored safely in a 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 note taking, 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 PCE; 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 (DA Pam 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 6–5.

*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. Decontamination material.* 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. Personnel.* If a 0.5-percent bleach solution will be used for personal decontamination, sufficient quantities of the solution must be present to achieve the necessary immediate removal of the agent from the skin. Spray bottle quantities are not sufficient. At least one-gallon containers are required depending on the quantities of agent present.

*c. Equipment.*

(1) 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.

(2) 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.

(3) 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 (2), above.

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

(5) Monitoring is not required for completely decontaminated laboratory equipment that are shaped simply (no crevices or the like) and are made of essentially impervious materials (such as laboratory glassware.) However, a solvent wash is not considered complete decontamination.

(6) Contaminated laboratory equipment will remain within laboratory hoods or other protective container until it meets the definition of clean.

(7) Laboratory glassware will not be used to prepare or consume food or beverage.

*d. Animals.* Laboratory animals injected with or ingesting agent are not considered contaminated unless massive doses relative to the animals mass are given. Animals exposed by other routes of entry require decontamination and disposal in accordance with local permits.

*e. Agent detoxification.*

(1) 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.

(2) 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 these criteria may be considered decontaminated and need not be stored in an approved lab hood.

## **8–10. Chemical hygiene plan**

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

*b.* All laboratories will keep an inventory of hazardous chemicals and material safety data sheets (MSDS) on hazardous chemicals readily available to the workforce and emergency response personnel; the supervisor will ensure laboratory personnel are trained in accordance with Section 1450, Part 1910, Title 29, Code of Federal Regulations (29 CFR 1910.1450) (Occupational Exposure to Hazardous Chemicals in Laboratories). The standard requires that all storage containers within the laboratory be appropriately labeled as to content. 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 procedures**

Emphasis is to be given to the following storage philosophy:

*a.* Agent-filled munitions containing explosives will be in approved storage.

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

- c. Storage structures used for the storage of agent-filled items will have floors and floor surfacing that can be decontaminated.
- d. Ton containers of bulk agents will be stored in a horizontal position.
- e. Munitions or storage containers having different chemical agent fills must be stored separately from each other.

## **9-2. Explosively configured munitions**

Explosively configured agent munitions may be stored in the same structure as non-explosively configured munitions or containers of the same fill.

## **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 ACOM, ASCC, or DRU.

## **9-4. Storage requirements**

a. Standing operating procedures that implement the requirements of this chapter 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 approved storage structures. Agent-filled munitions that do not contain explosives will be stored in igloos or other approved storage structures specifically approved by the ACOM, ASCC, or DRU.

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

(3) Structures used for the storage of agent-filled items will have floors and floor surfacing that can be decontaminated.

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

(5) 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.

(6) 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 special 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 table 2-1.

## **9-5. Chemical agent and ammunition hazard symbols**

a. Locations where chemical agents and munitions are stored, handled, used, and processed require chemical hazard symbols. These symbols will 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 will 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 figs 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 (that cannot be removed) 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 departments, CAIRA teams, and so forth.

(6) In addition to the above, fire division symbols described in DA Pam 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 off-post 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 ACOM, ASCC, or DRU. Normal selective thinning not to exceed 70 square feet basal area is acceptable.

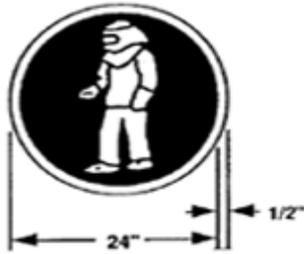
*g.* Explosively configured agent munitions may be stored in the same structure as class 6.1 munitions of the same fill.

#### **9-6. 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 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 OSHA and The Surgeon General (TSG).



**SYMBOL 1. WEAR FULL PROTECTIVE CLOTHING**

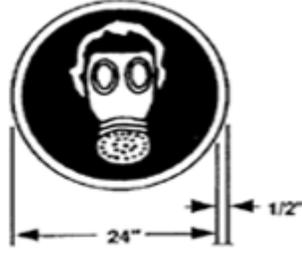
Background is BLUE,  
Figure and Rim are:

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 Federal Standard 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-Type Nerve Agents**  
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 symbol

## Chapter 10 Shipping

### 10-1. Shipping requirements

*a.* Movements involving chemical agents must comply with applicable Federal, State, and local laws, including 50 USC 1512a, 49 CFR, Parts 171-180, AR 200-1, DOD 4500.9-R, AR 50-6, TM 3-8250/AFMAN 24204 (I), and with the notification requirements of the Chemical Weapons Convention.

*b.* Chemical agent munitions and containers are classified by DOT as class 1.2 explosive or 6.1 poison. 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) Military munitions 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 non-explosive (Section 101, Part 172, Title 49, Code of Federal Regulations (49 CFR 172.101)).

(2) Military munitions 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. Transportation

The following are prohibited from transport in privately owned vehicles: neat chemical agents, chemical precursors, dilute chemical agents, chemical agent related environmental samples, and items and/or equipment that do not meet the definition of clean.

*a.* All on-post movements will have an approved SOP and a supporting hazard analysis (see chap 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 will 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 suspected of presenting hazards of inhalation or percutaneous exposure to a chemical agent.

### 10-3. Shipment of environmental samples

Environmental samples may consist of soils and other solids, liquids, sludge, and vegetation. The chemical agent hazard of potentially contaminated samples will be characterized using headspace monitoring, extraction methods, generator knowledge, or other appropriate method prior to shipment to a laboratory for analysis. Prior to shipment the sender will document the chemical agent hazard level and the laboratory chemical hygiene controls that adequately protect against that hazard. If unprotected exposure to the chemical agent hazard (that is, chemical hygiene controls fail) could be life-threatening, the sample should be sent to a surety laboratory or other laboratory accustomed to working with chemical agents. In all cases it is recommended that the sender notify the receiving laboratory that environmental samples are coming from a potential chemical agent site.

### 10-4. Shipment of research, development, test, and evaluation 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- or crimp-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 3-2*d*.

## **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 agent and its concentration. The mean concentration is influenced by the general climatic conditions, particular temperature gradient near the ground, and the topographical features.
- b. 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, 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.
- c. The accidental functioning of the burster charge in a chemical munition results in the greatest aerosolizing of the agent filler thereby requiring prompt action to identify the path and downwind concentration of the agent cloud.
- d. In consideration of the variables involved, operational facilities, activities, and storage sites must be selected to provide the maximum separation distance to unrelated personnel located on the installation or garrison as well as to the public.

#### **11-2. Maximum credible event**

- a. In accordance with standards established by DOD and DA Pam 385-65, the potential for an accident or incident must be carefully analyzed to determine the maximum credible event (MCE) that could occur and cause agent release.
- b. The MCE must be realistic with a reasonable probability of occurrence considering the explosion propagation, burning rate characteristics, and physical protection given to the items involved. For chemical munitions that are explosively configured, the MCE will be based on functioning of the most disruptive explosive component present that would produce the maximum release of chemical agent. The potential for functioning of the explosive component, the propagation characteristics of the munitions given packaging, and the potential for damage to adjacent munitions sufficient to cause a sympathetic detonation or release of the agent filler must be considered and should be addressed. The MCE evaluated on this basis may then be used as a basis for effects calculations and casualty predictions.
- c. For chemical munitions that are not explosively configured, the potential for spillage or leakage of the agent fill usually provides the basis for the MCE. Other factors affecting the MCE are rate of release, puddle size, time of decontamination, type of surface, and the agents characteristics.

#### **11-3. Public exclusion distance**

- a. The public exclusion distance (PED) is defined as the greater of the inhabited building distance (IBD) (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, personnel not directly associated with chemical operations are not to be allowed within the PED. 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 PED in lieu of absolute exclusion. Details of the evacuation procedures will be included in the site plan and safety submission.

*b.* 1 percent lethality distance.

(1) 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<sup>3</sup> for H and HD agents, 75 mg-min/m<sup>3</sup> for HT agent, 150 mg-min/m<sup>3</sup> for Lewisite, 10 mg-min/m<sup>3</sup> for GB agent, 4.3 mg-min/m<sup>3</sup> for VX vapor, and 0.1 mg for inhalation/deposition of liquid VX.

(2) 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.

(a) Meteorological information must be obtained from an accurate source, with the methodology presented in Department of Defense Explosives Safety Board (DDESB) Technical Paper No. 10.

(b) Use of a computer program or model (for example, D2PC, D2Puff) to predict downwind hazards must be consistent with DDESB Technical Paper No. 10.

(3) Any downwind hazard prediction model requires HQDA approval. Requests for approval to use a new model or to modify an approved model will be sent to Director, U.S. Army Nuclear and Combating WMD Agency (USANCA) (ATTN: MONA-CAB), 7150 Heller Loop, Suite 101, Springfield, VA 22150-3198, for technical review.

(a) Submissions will include the rationale and benefits of using the proposed model.

(b) 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.

(c) The USANCA will conduct necessary technical and operational review staffing and forward justification and recommendation to HQDA (DACs-SF), Washington DC 20310-0200 for approval.

#### **11-4. 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. This distance category is applicable to separation of nonrelated operations, conventional ammunition storage, and installation boundaries from chemical operations.

#### **11-5. 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.

#### **11-6. 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 poison agents (without explosives) the magazine distance is 50 feet.

#### **11-7. 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 distance per DA Pam 385-64 or 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.

#### **11-8. Site planning before and response to a chemical agent accident**

*a.* For site planning purposes a hazard zone (1 percent-lethality distance) will be calculated in accordance with DOD 6055.9-STD, chapter 11 (Toxic Chemical Munitions and Agents). Positive controls are required to exclude, evacuate, or otherwise protect personnel in that hazard zone in the event of a chemical agent accident. Site plans submitted for DDESB approval will describe these positive control measures.

*b.* In the event of an actual chemical 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 in accordance with the following (as applicable):

(1) Army-Federal Emergency Management Agency (FEMA) Chemical Stockpile Emergency Preparedness Program (CSEPP) Policy Statement #20 (Revised): Adoption of Acute Exposure Guideline Levels (AEGs), Chemical Stockpile Emergency Preparedness Program, FEMA and Department of the Army, February 2003. Protective actions should be

directed toward preventing or reducing exposures above the AEGL2. A protective action recommendation should be provided stating that no action is required to protect the public from AEGL1 exposure, but the projected AEGL1 plume should be provided to local emergency management officials for use at their discretion.

(2) Approved chemical agent safety submission (with amendments) for the site. Protective actions may be prescribed in the chemical agent safety submission (with amendments) approved by the US Army Technical Center for Explosives Safety and/or DDESB.

(3) Agreements with local emergency management officials. Protective actions may be prescribed in written agreements with local emergency management officials. The criteria and rationale should be documented and coordinated with all affected parties.

c. Site emergency response plans may consider populations further out than protective actions are necessary. This is acceptable and demonstrates planning is thorough even if protective actions are deemed to be unnecessary.

## **11–9. Quantity distance criteria specific to chemical munitions**

The following criteria are applicable to chemical munitions:

a. The PED will be applied from chemical facilities, storage, and operations to unrelated facilities and their related support facilities.

b. As a minimum, the IBD will be applied from conventional munitions storage, operations, and facilities to 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 IBD 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 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, based on local risk assessment.

g. Eating, drinking, chewing, and smoking areas must be located at unbarricaded intraline distance.

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

i. For siting chemical facilities and operations, the PED calculated in accordance with paragraph 11–3 will not extend beyond the boundaries of government-controlled land. Operational and meteorological restrictions need to be applied to keep hazard distances on post.

j. The above requirements apply to facilities for which site plans are produced or modified after the publication date of this pamphlet. Site plans that were produced and approved prior to the publication of this pamphlet need not be modified for the sole purpose of adhering to the above requirements.

## **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-series 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.

c. Abbreviations and terms applicable only to the CDTF are listed here. Other abbreviations and terms are listed in the Glossary to this pamphlet.

(1) Short-term Exposure Limit (STEL). As used at the CDTF, this term refers to the worker protection limit that applies to Army toxic agent training operations (the CDTF). This concentration is the same level as the STEL used for non-training operations. At the CDTF, this level of agent concentration is used as an action level, the level at which workers must evacuate or wear respiratory protection.

(2) CDTF Maximum Concentration Limit (CMCL). This is the maximum level at which an air-purifying respirator may be worn for CDTF operations.

## 12-2. Airborne exposure limits

a. Personnel working or training in areas where chemical agent may be present will not be exposed to concentrations exceeding the criteria specified below (see table 12-1).

**Table 12-1**  
**Training airborne exposure limits**

Occupational scenario	Chemical agents	
	GB (mg/m <sup>3</sup> )	VX (mg/m <sup>3</sup> )
Unmasked personnel in work areas monitored at up to the WPL <sup>1</sup>	0.00003	0.000001
Unmasked personnel in areas monitored to the STEL <sup>2,3</sup>	0.0001	0.00001
Masked personnel in the "Hot Area" (Training Bays) monitored to the CMCL <sup>4</sup>	0.2	0.02

Notes:

<sup>1</sup> WPL is an 8-hour TWA. This concentration does not apply to the toxic agent training activities at the CDTF but will be applied to selected cold areas of the training building. At a confirmed 8-hour TWA above the WPL, the area will be restricted until the cause of the excursion has been corrected.

<sup>2</sup> See definition of STEL in paragraph 12-1c. At this level of agent concentration, workers must evacuate or wear respiratory protection.

<sup>3</sup> At any time that a STEL concentration is detected, personnel must evacuate or wear protective masks. A NATO/military approved protective mask may be worn at levels up to CDTF Maximum Concentration Limit (CMCL).

<sup>4</sup> See definition of CMCL in paragraph 12-1c. Personnel in areas exceeding this concentration must either evacuate the area or wear an atmosphere-supplying respirator.

b. Unrelated personnel will not be knowingly exposed to concentrations of GB above 0.000001 mg/m<sup>3</sup> or VX above 0.0000006 mg/m<sup>3</sup>, averaged over 24 hours (GPL).

c. There will be no deliberate release from the facility that exceeds the applicable SEL.

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 appropriately decontaminated.

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

a. A quality assurance plan for monitoring will be developed in accordance with paragraph 3-4a.

b. When monitoring indicates excursions of chemical agent above the 8-hour time-weighted average WPL in areas where excursions are not expected, then the actions in paragraph 3-5, Excursion above the WPL, will be followed.

c. The requirements in paragraph 3-6, Monitoring Support Requirements, will be adhered to.

d. A monitoring plan will be developed in accordance with paragraph 3-8.

e. Records of monitoring will be maintained in accordance with paragraph 3-9.

f. During chemical agent operations, the areas where agents are deliberately introduced will be monitored with near real-time monitors (MINICAMS) to CMCL levels.

g. During chemical agent operations, other locations in the toxic training area (Rotunda, Service Gallery, and so forth), will be monitored with near real-time monitors (MINICAMS) to STEL levels.

h. Monitoring is also required at locations adjacent to toxic training areas (cold areas - for example, cold corridor, lobby, laundry, laboratory, mezzanine, MINICAMS room) to STEL levels.

i. Continuous monitoring with a near real-time monitor will be accomplished for all exhaust air filtration systems from agent operating areas.

j. Periodic historical monitoring to the WPL will be accomplished with DAAMS or other approved historical monitoring method in the non-agent work areas (see para 12-3h).

k. Potentially contaminated equipment and protective clothing will be decontaminated in accordance with chapter 5, and the CDTF decontamination SOP(s) (or decontamination plan) and will be monitored with a near real-time monitor or DAAMS. The equipment/clothing will be certified as decontaminated to 3X level of decontamination (clean for release to chemical agent workers) before removal from the agent operational (hot) areas (including hot decontamination operations laundry area). Equipment and tools that can be certified to meet the definition of clean in accordance with paragraph 5-2d does not have to be monitored.

l. Each worker must be trained to recognize the symptoms and effects of agent exposure in themselves and others and to immediately report suspect conditions to supervisory personnel.

## 12-4. Personal protective clothing and equipment

a. For agent training and support operations, the following levels of protection are defined. Increased levels of protection may be used to support specialized training or high-risk operations, as determined by the CDTF Commander/Director.

b. The following are definitions of levels of protection for chemical personnel:

(1) Level 1: NIOSH-certified or NATO/military-approved mask; approved chemical protective overgarment with hood; coveralls or fatigue pants (optional during warm weather); butyl apron (M2), extending below top of over-boots; over-boots (boot, TAP, safety toe, M2A1, is optimal); chemical protective glove set; undershirt; drawers; socks; combat boots or other foot gear designated as part of the duty uniform for training;

(2) Level 2: NIOSH-certified or NATO/military-approved mask; approved chemical protective overgarment with hood; coveralls or fatigue pants (optional during warm weather); over-boots (boot, TAP, safety toe, M2A1, is optimal); chemical protective glove set; undershirt; drawers; socks; combat boots or other foot gear designated as part of the duty uniform for training;

(3) Level 3: NIOSH-certified or NATO/military-approved mask with hood; coveralls or fatigue pants; butyl apron (M2) extending below top of over-boots (required only when liquid or splash hazards exist); over-boots (boot, TAP, safety toe, M2A1, is optimal); chemical protective glove set; undershirt; drawers; socks; combat boots or other foot gear designated as part of the duty uniform for training.

(4) Level 4: NIOSH-certified or NATO/military-approved mask slung or readily available; coveralls; over-boots (boot, TAP, safety toe, M2A1, is optimal); undershirt; socks; drawers, and gloves as specified in the CDTF Toxicological Chemical Agent Safety Plan or CDTF SOPs.

(5) Level 5: NIOSH-certified or NATO/military-approved mask readily available except when specified elsewhere in this chapter; street clothing. In the laboratory, a lab coat may be worn during agent operations or when required.

(6) Toxic chemical agent protective gloves will be worn when specified in this chapter or in the CDTF Toxicological Chemical Agent Safety Plan or CDTF SOPs.

c. 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 following requirements and in accordance with a locally-approved glove use and change-out plan:

(1) The nonstandard glove selected is limited to use in operations where standard gloves cannot be used because of safety or operational considerations.

(2) The nonstandard glove selected will have its agent penetration resistance ascertained by testing each purchased lot under an AQL plan, as described in paragraph 4-8 of this pamphlet.

(3) Nonstandard gloves will be used only in a manner which does not pose a high probability for liquid agent contamination of the gloves. In the event of actual or potential liquid contamination, the gloves will be decontaminated and removed as soon as feasible. They will be disposed of in accordance with chapter 5 of this pamphlet.

d. Commercially available emergency escape devices may be used under certain conditions for the protection of transient personnel. These devices will normally be used only for protection of transient personnel entering the lab.

(1) They must be oxygen supplying and NIOSH-certified as an escape device.

(2) Upon approval by the Office of the Surgeon General (OTSG), alternative respirators may be substituted, as appropriate.

e. The required level of protection will be determined for each operation and must be specified in an SOP. Conditions under which the various levels of protection are required will be described in the CDTF Toxicological Chemical Agent Safety Program document and local SOPs and will take into account such factors as the level of concentration of agent present, whether liquid or aerosol contact is reasonably possible, and the activity being performed.

f. Local policy will determine required PCE for non-chemical agent workers.

g. A heat stress plan will be developed for CDTF operations and must be approved by the installation MEDDAC and the MANSCEN Safety Office. This plan will include guidance for maximum wear times for chemical protective clothing and equipment.

h. For CDTF operations, the M40-series mask may be worn in agent environments up to the CMCL concentration levels (2000 X STEL).

i. Care of protective clothing must be in serviceable condition and properly fit the wearer. Unserviceable clothing will not be used for toxic agent training.

j. All TAP clothing used in agent operations must be sent to the laundry for inspection and testing semiannually. All TAP gloves and boots will be leak tested prior to issue and use in any of the following circumstances:

(1) When they are newly removed from stock.

(2) After each laundering.

(3) When they have not been tested within the previous 6-month period.

(4) Whenever there is evidence of deterioration or damage that might cause leakage.

k. The glove set, glove box gloves, and military approved chemical over-boots will be leak tested in accordance with

local procedures and technical manuals. Masks, coveralls, 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 technical manuals. Each wearer is to assure serviceability of their PCE by visual inspection before use.

*l.* Unserviceable TAP items and chemical protective overgarments (MOPP) being used for non-agent operations will be clearly, conspicuously, and permanently marked as unserviceable for chemical agent use. If they have never been contaminated, they will be treated as clean, in accordance with chapter 5. When they have been contaminated, they will be decontaminated, monitored to STEL, and treated as 3X items and will be used only by chemical agent workers.

*m.* The requirements for decontamination and laundering of protective clothing will be as follows:

(1) The TAP clothing, worn in known or suspected chemical agent vapor contaminated areas, will be decontaminated in accordance with locally approved procedures.

(2) Clothing will be placed in a container or bag sealed to prevent escape of chemical agent vapors.

(3) 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 monitored for chemical agent contamination. Monitoring will be done using an approved method to verify that chemical agent vapor concentrations do not exceed the STEL concentrations specified in table 12-1.

(4) If chemical agent concentrations above the STEL concentration are detected, the clothing will be further monitored, or it will be further decontaminated, in accordance with locally approved procedures, and then further monitored.

(5) The CDTF will inspect the integrity of protective clothing in accordance with appropriate TMs.

*n.* Autoclaving overgarments and reissue of chemical protective clothing and equipment for toxic training is authorized within the limits of approval granted to the CDTF by the Training and Doctrine Command (TRADOC) and OTSG.

*o.* Chemical protective overgarments that have been exposed to liquid chemical agent or are otherwise unserviceable will be bagged, monitored, containerized and treated as waste.

*p.* Butyl rubber protective clothing contaminated with petroleum base products, including solvents or lubricants, will be disposed of as waste.

*q.* Respiratory protection program. In activities where respiratory protection is required, a program for selection, use, inspection, testing, and maintenance that complies with AR 11-34, TB Med 502, TM 3-4240-349-12&P and other applicable guidance will be established. The program will include the following essential elements:

(1) Selection. The mask 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) The Army six-step quantitative fit-test will be performed for the NATO/military-approved masks that are used at the CDTF.

(b) Canister or filter elements must be approved for their intended use and meet serviceability requirements of applicable TMs and SBs. The canisters or filters for M40-series masks may be used for up to 6 continuous hours with no reuse. The 6-hour time limit begins upon first entering into a confirmed agent environment (that is, at or above the STEL concentration or that could reasonably be above the STEL concentration). The canister must be replaced within six hours of the initial agent exposure.

(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.

(3) Mask seal checks, to ensure proper seal of masks prior to entering areas of known or suspected agent contamination, will be conducted in accordance with local procedures and any applicable regulatory guidance.

## **12-5. Decontamination**

*a.* Marking, tracking, and segregation of potentially contaminated tools, items, and equipment.

(1) The CDTF may use the X method of marking and tracking decontaminated tools and equipment or another locally approved method that is in accordance with the guidance in chapter 5 of this PAM. The method used will be defined in a CDTF equipment decontamination plan or SOP.

(2) Any item taken into the hot area will be considered to be exposed above STEL, unless it is documented that the item was never in an area with concentration above STEL (for example, through use of air monitoring records, tracking logs for its movement within the hot area, and so forth). Such items will be treated as a 3X (XXX) items, once decontaminated. These items will be tracked, as below, and segregated to ensure that they are used only by chemical agent workers. If an item is to be released to non-chemical agent workers or to the public, it must be monitored to the level prescribed elsewhere in this pamphlet (for example, monitored to below WPL concentration for release to non-chemical agent workers).

(3) The tracking will include identification of the item in some manner (for example, by use of a serial number, paint, or other means). Smaller items, which cannot reasonably be marked or etched with a serial number or other marking, may be identified by a written description of the item. The tracking of items will also include a computer entry indicating date and time when it was first exposed to an agent environment (taken into the hot area). Before being removed from the hot area, all such items will be decontaminated and monitored in accordance with CDTF SOPs and/

or a CDTF equipment decontamination plan. The items will then be logged and/or marked to indicate the degree of decontamination and personnel to whom the items may be released. Subsequent entries of the item into the hot area do not have to be logged or tracked, because, when in the hot area, the item will be assumed to be contaminated to at least STEL level and the item will not be removed from the hot area without first being decontaminated and monitored. Additional entries are only required when the level of decontamination is changed or the item is to be released to non-chemical agent workers or to the public or is removed from the facility for disposal.

(4) Items decontaminated and monitored to the STEL level will be segregated from non-contaminated items and handled only by chemical workers.

(5) If an item is very small (for example, small tools or pens used in training) and is a part of a tool kit or other assembly of items, it may be tracked by including its identification (description or other means of identification) in the tracking log. The larger item (for example, a tool box) will be marked appropriately (once removed from the hot area), and the assembly of items (for example, tool box and items in it) will be segregated according to its degree of decontamination/monitoring.

(6) Any item that has been exposed to a concentration above STEL may only be handled by chemical workers. To allow non-chemical workers to use it, it must be monitored to below WPL.

*b.* Decontamination agents. Standard decontaminating agents that are acceptable for decontaminating equipment or spills include, but are not limited to the following:

(1) The STB slurry or HTH solution for agent VX.

(2) 10 percent sodium hydroxide or sodium carbonate solution for agent GB.

(3) Commercial liquid bleach (nominal 5 percent solution of sodium hypochlorite) for either GB or VX.

(4) NATO-approved decontaminants.

*c.* Decontamination equipment. Decontamination equipment procedures will be in accordance with applicable TMs and locally-approved procedures.

*d.* Training-facility staff personnel will verify the serviceability of decontaminating equipment.

*e.* Decontamination equipment will be positioned in locations that allow ready access to decontamination and emergency response personnel.

*f.* Chlorine-based decontaminants will be tested in accordance with chapter 5 of this pamphlet.

## **12-6. Additional safety criteria for training facilities**

*a.* Hazard analyses will be completed in accordance with this PAM and local guidance.

*b.* Standing operating procedures.

(1) The SOPs will be prepared in accordance with this PAM and local guidance.

(2) 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).

*c.* Criteria for containment of agent training operations. All bays 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 table 12-1.

*d.* To prevent the possibility of a contaminated item being removed from government control, personal items (for example, watches, rings, hair pins, money, earrings, body piercings, and so forth) will not be taken into the contaminated area of the CDTF (hot area). Any such items taken into the contaminated area will be decontaminated, monitored to a level below STEL concentration, and disposed of as waste. The only hairpieces or hair extensions that may be worn into the hot area are those which are permanently attached, made from natural hair, and not attached using glue or another substance which may absorb agent at a greater rate than natural hair. Fake fingernails or toenails or fingernail or toenail polish may not be worn into the hot area, due to the possibility that these items may absorb agent.

*e.* Hairstyles that prevent thorough washing of the scalp and hair (for example, tight braids) may not be worn into the hot area.

## **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 a 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 to render first aid.

(6) One MARK 1 nerve-agent antidote kit (NAAK) per person with assigned escape mask. When conducting training Instructors/Support personnel will carry three MARK 1 NAAKs on their person in the toxic training area.

(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 removal from agent containment engineering controls. When chemical agent must be removed from the containment provided by engineering controls, the provisions of paragraph 8-1 apply:

- (1) For quantities of 1 milliliter (ml) or less of neat 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 neat chemical agent, a double containment system is required.

b. *Monitors.* The MINICAMS and DAAMS sample analyses may be conducted outside the ventilation hood.

c. *Agent monitoring.*

(1) A detection capability for GB/VX with sensitivity equal to or better than the M22 ACADA must be maintained within the laboratory or readily available outside.

(2) During the first five days of new chemical agent operations, MINICAMS monitoring to the STEL will be conducted to verify the adequacy of engineering controls. Additional monitoring 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.

(3) 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 STEL. If continuous chemical agent monitoring by MINICAMS to the STEL is not in effect, the following conditions require first entry monitoring:

(a) Chemical agent spill outside of agent containment (engineering) controls.

(b) Major chemical agent spill within laboratory ventilation hood (20 ml or more).

(c) Ventilation failure of laboratory ventilation hood, with uncontained chemical agent present within hood.

(d) Ventilation failure of a laboratory ventilation hood, containing any amount of chemical agent, lasting longer than 24 hours.

d. *Protective clothing and equipment (see paras 4-12, 8-6, and 12-4).* Personal protective clothing, such as butyl gloves, aprons, and MOPP clothing necessary to protect personnel during chemical agent operations and for use in case of an emergency, will be kept within the training building and readily available.

e. *Labeling containers.* 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. Chemical agent storage requirements**

The CDTF will implement the following storage procedures:

a. Agent-filled containers will be stored only in specifically designated locations.

b. Storage locations will have floor surfaces that can be decontaminated.

c. Agent may be transferred to smaller containers, and stored in these containers. The quantity of agent will not exceed 1 liter per container.

d. Agent containers will be stored in a single containment system within a laboratory hood or in a double containment system.

e. Only authorized personnel who have been instructed and are qualified to perform the appropriate procedures will handle leaking containers.

f. 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-certified 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 CAIRO.

b. In cases where firefighters are responding to a chemical agent incident for rescue or reconnaissance rather than firefighting, they will wear appropriate levels of PCE as described in paragraph 4-2a (level A), or as specified by the

CAIRO. For accident/incident situations, the CAIRO 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.

c. When firefighters respond to a chemical agent spill or other chemical agent incident, while wearing fully encapsulated (Level A) personal PCE, the clothing and equipment worn under the Level A suits will be considered clean (never contaminated), provided that the Level A PCE has not been breached, is properly decontaminated prior to removal, and that removal takes place in an environment below STEL concentration. The PCE worn under the Level A may be reused.

#### **12-11. Emergency response for rescue purposes**

a. The CDTF non-medical personnel designated to perform emergency rescue operations in the event of an exposure or potential exposure of one or more personnel to chemical warfare agent at the CDTF will meet the following requirements:

(1) They will perform only emergency rescue actions (for example, removal of an exposed student from a training bay or an exposed lab technician from the laboratory, cutting the person out of their PCE, decontamination of the persons clothing and skin, and delivery of the person to awaiting medical personnel). Spill clean-up or remediation will only be undertaken within the toxic training bays, rotunda, or service gallery area by CDTF personnel.

(2) They will wear Level 1 PCE (equivalent to military MOPP IV level).

(3) They will meet the training/experience requirements for First Responder Operations Level personnel, under OSHAs Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, at least eight hours of training or sufficient experience to objectively demonstrate competency in the areas listed in 29 CFR 1910.120(q)(6)(ii).

(4) They will not enter the contaminated area (training bay, lab, and so forth) if the concentration of agent in the area exceeds the CMCL, the maximum limit at which use of the M40 mask is authorized.

(5) If, due to failure of or lack of monitoring equipment, the concentration of agent in the area is unknown, they will not enter the contaminated area.

b. Spill clean-up or remediation of contaminated areas, outside of the toxic training bays, rotunda, and service gallery, will be performed by the installation Fire Department personnel, outfitted in OSHA Level A PCE, including SCBAs.

## **Appendix A References**

### **Section I Required Publications**

#### **ANSI/ASQ Z1.42003**

Sampling Tables for Inspection by Attributes (Cited in para 4-8*b*.)

#### **AR 11-34**

The Army Respiratory Protection Program (Cited in paras 4-1, 12-4*q*.)

#### **AR 50-6**

Chemical Surety (Cited in paras 8-1*e*, 6-8*e*(2), 10-1*a*.)

#### **AR 385-10**

The Army Safety Program (Cited in para 1-9*b*.)

#### **AR 700-68**

Storage and Handling of Liquefied and Gaseous Compressed Gases and their Fill and Empty Cylinders (Cited in para 8-7*g*.)

#### **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 4-7*b*, 6-8*d*, 6-8*e*, 7-2*d*, 7-5*b*.)

#### **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 4-7*b*, 6-8*d*, 6-8*e*, 7-2*d*, and 7-5*b*.)

#### **DA Pam 385-30**

Mishap Risk Management (Cited in paras 1-6*b*, 1-9*b*, 6-6*b*, 6-6*d*, and 8-1*a*.)

#### **DA Pam 385-64**

Ammunition and Explosives Safety Standards (Cited in paras 4-9, 8-8*e*, 9-5*e*(6), 11-6, and 11-7.)

#### **DA Pam 385-65**

Explosive and Chemical Site Plan Development and Submission (Cited in paras 1-1*f*, 6-9*a*.)

#### **DOD 6055.09-STD**

DOD Ammunition and Explosives Safety Standards (Cited in para 11-8*a*.) (Available at <http://www.dtic.mil/whs/directives/>.)

#### **MIL-STD-105E**

Sampling Procedures and Tables for Inspection by Attributes (Cited in para 4-8*b*.) (Available at <http://assist.daps.dla.mil/quicksearch/>.)

#### **SB 742-1**

Inspection of Supplies and Equipment: Ammunition Surveillance Procedures (Cited in paras 6-4*c*, 9-4*b*.)

#### **TB Med 502**

Occupational and Environmental Health and Respiratory Program (Cited in para 12-4*q*.)

#### **TM 3-4240-349-12&P**

Protection Assessment Test System, M41 (Cited in para 12-4*q*.)

#### **TM 3-4240-346-10**

Chemical Biological Masks: Field M40A1; Combat Vehicle M42A2d, M40 (Cited in para 4-5*e*(6).)

**TM 38–250**

Preparing Hazardous Materials for Military Air Shipments (Cited in para 10–1a.)

**29 CFR 1910**

Occupational Safety and Health Standards (Cited in paras 8–1a, 8–10b, 8–10a.) (Available at [www.osha.gov](http://www.osha.gov).)

**Section II**

**Related Publications**

A related publication is a source of additional information. The user does not have to read it to understand the publication. Code of Federal Regulations are available at [www.gpoaccess.gov/cfr/index.html](http://www.gpoaccess.gov/cfr/index.html).

**AR 40–5**

Preventive Medicine

**AR 70–1**

Army Acquisition Policy

**AR 75–15**

Policy for Explosive Ordnance Disposal (available ONLY from Army Knowledge Online)

**AR 420–1**

Army Facilities Management

**AR 740–1**

Storage and Supply Activity Operations

**DA Pam 50–6**

Chemical Accident or Incident Response and Assistance (CAIRA)

**DA Pam 385–16**

System Safety Management Guide

**DOD 4500.9–R**

Defense Transportation Regulation Part II: Cargo Movement (Available at <http://www.dtic.mil/whs/directives/>).

**FM 3–11.3**

Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Contamination Avoidance

**FM 21–10**

Field Hygiene and Sanitation

**MIL–STD–282**

DOD Test Method Standard-Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance Test Methods (Available at <http://assist.daps.dla.mil/quicksearch/>).

**TB Med 507**

Heat Stress Control and Heat Casualty Management

**TB Med 577**

Sanitary Control and Surveillance of Field Water Supplies

**TM 3–250**

Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals

**TM 3–4230–209–10**

Decontaminating Apparatus: Gasoline Power Driven, Skid Mounted, Multipurpose Nonintegral 500 Gallon, M12A1

**TM 3–4230–237–10**

Decontaminating Apparatus: Diesel Engine Driven (DED), Skid Mounted, 500-gallon, M12A1

**TM 3-4240-279-20&P**

Unit Maintenance Manual for Mask, Chemical-Biological; Field ABCM17, -M17A1, -M17A2

**TM 3-6665-254-12**

Detector Kit, Chemical Agent ABC-M18A2

**TM 3-6665-307-10**

Chemical Agent Detector Kit, M256 and M256A1

**TM 3-6665-311-10**

Chemical Agent Detector: M9

**TM 3-6665-312-12&P**

M8A1 Automatic Chemical Agent Alarm and Auxiliary Equipment

**TM 10-8415-210-13&P**

Toxicological Agent Protective (TAP) Ensemble

**29 CFR 1910.119**

Hazardous Material-Process Safety Management of Highly Hazardous Chemicals

**29 CFR 1910.120**

Hazardous Material-Hazardous Waste Operations and Emergency Response

**29 CFR 1910.134**

Hazardous Material-Respiration Protection

**29 CFR 1910.1450**

Hazardous Material-Occupational Exposure to Hazardous Chemicals in Laboratories

**29 CFR 1910.120**

Hazardous Material-Hazardous Waste Operations and Emergency Response

**40 CFR**

Protection of the Environment

**49 CFR**

Transportation

**50 USC 1512a**

War and National Defense: Transportation of Chemical Munitions (Available at [www.gpoaccess.gov/uscode](http://www.gpoaccess.gov/uscode))

**Section III**

**Prescribed Forms**

**DA Form 7632**

Certificate of Risk Acceptance (Prescribed in para 6-6c.)

**Section IV**

**Referenced Forms**

**DA Form 7566**

Composite Risk Management Worksheet

## **Appendix B Engineering Design Guidance for Facilities**

### **B-1. Minimum engineering**

Minimum engineering design guidance is set forth 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.

### **B-2. Ventilation systems**

Ventilation systems will be designed to ensure that control of agent-contaminated exhaust will not exceed SELs and will be designed to maintain negative pressure throughout the system. 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 SELs 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. At a minimum, high efficiency particulate air filters also will be used in the air ventilation systems upstream from the carbon filter beds. 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 in accordance with federal, state, and local requirements. A bag-in, bag-out type filter system should be considered for new facilities.

*b.* The ventilation system, that is, ductwork and blower housing, will be sealed to preclude leakage.

*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 airflow 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 prevent agent vapor exposure to unprotected workers above permissible limits. 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 non-agent 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 the WPL 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.

### **B-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 to allow for ease of decontamination of surfaces. Flooring will be covered 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 will 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 non-agent areas will be located so that air flows toward agent operating areas. Access to these non-agent 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 agent rooms or areas, to include agent operating hoods or gloveboxes will be designed 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 release limits in accordance with local, state, and federal laws. 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 or discharged into agent air exhaust systems. 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 processes before release.

g. When operations require work assignments to be conducted at exposure levels above or potentially above the WPL, decontamination change facilities with showers will be provided.

#### **B-4. General design considerations**

a. *Facility alarms.* Facility alarms and monitors for engineering systems.

(1) 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 non-agent) 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.

(2) 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 appropriate 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 420-1.

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 as required by local permits.

f. *Agent operational areas.*

(1) 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.

(2) 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.

(3) Air flow in facility cascade ventilation systems will be from the areas of least contamination (hazard) to areas of increasing contamination (that is, clean to dirty), whereby the flow is controlled by differential in negative pressure.

(4) Appropriate containment facilities will be used as necessary during ammunition maintenance procedures.

g. *Utility area.*

(1) Electrical control panels, hot water heaters, and vacuum pumps will be located in a utility area.

(2) Compressed air, argon, and nitrogen may be supplied to the facility from gas bottle manifolds in a utility area.

(a) 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.

(b) For these facilities, manifold systems are too small and are very labor intensive for the amount of compressed air utilized.

(3) When air-supplied protective clothing and equipment are used, breathing-quality air will be provided with suitable connections throughout the facility.

(4) 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 C**

### **Types of Health-Based Criteria for Determining Suitability for Public Release**

#### **C-1. Purpose and Scope**

Table C-1 summarizes the types of health-based concentration criteria that may be used in risk assessments to determine suitability of public (unrestricted) release of items/equipment/facilities exposed to chemical agent. It also describes the situations and applications when such criteria can be used. The criteria include various air monitoring concentration levels (mg/m<sup>3</sup>) as well as concentration levels that would be used to assess extracts from soil or other solid media (mg/kg). Depending on item/site/scenario, a single criterion may be selected, or a combination of criteria and sampling approaches may be chosen. Specific sampling procedure will typically require item/site specific considerations.

#### **C-2. Introduction**

While DA approaches to managing chemical agent-contaminated items, equipment, facilities and waste have provided adequate and effective protection to workers and the public, the Army has taken steps to expand the mechanisms for ensuring the protection of public health to address evolving concerns, inconsistencies at different Army sites, and alternative decontamination management practices.

*a.* Part of the problem is that Federal, State, and local regulators as well as the public are not generally familiar with DA safety procedures, as these do not always parallel activities associated with toxic industrial compounds. While non-DOD entities often voice concern over DA-unique procedures, some of the criteria used by DA to assess and manage items/waste are actually overly conservative. For other situations the procedures need greater flexibility to address matrix unique issues or local requirements. While DA is committed to ensuring that its activities are performed in a manner that protects and preserves human health and the environment, it also wishes to ensure that environmental management decisions are balanced with appropriate scientific rationale and identified health benefits. This process includes procedures that more closely mirror those used by other Federal and State environmental health agencies.

*b.* Management and disposition of chemical agent contaminated equipment, tools, facilities, and wastes (or even potentially contaminated equipment, tools, facilities and wastes) have often relied on different measures, including concentration limits, analytical sensitivity, and decontamination/ treatment technologies. Quite often, different types of concentration levels and terms have been applied erroneously. The terms that have been associated with some of the concentration levels and procedural requirements for managing contaminated waste or media include: agent free, risk free, zero agent, detection limits, Field Drinking Water Standards (FDWS), Waste Control Limits (WCL), 3X, and 5X, and risk based or health-based. Many of these terms have been or are being used interchangeably, or without clear or uniform definition. The interpretations of these terms have in many cases been negotiated with local regulators for specific purposes, which results in the same term having a different meaning in different states.

#### **C-3. Health-based approach**

This document prescribes future applications of more situation-specific, health-based criteria for assessing the safety and appropriateness of environmental management decisions (see chap 5). Specifically, the use of health-based criteria is required over some of the historical approaches and terms described in paragraph 5, below. Health-based criteria are developed by considering a specific chemical, a specific scenario in which individuals may be exposed, characteristics regarding those individuals and their activities results in an estimate of the overall dose of the chemical they are going to be receiving. That dose is compared with existing reference toxicity thresholds. This comparison allows one to characterize or quantify the degree of risk to which a person is exposed, and allows risk managers to determine how much to limit exposure in order to reduce risk to acceptable levels. In order to address several areas of scientific uncertainty, there are several steps to ensure conservative (protective) criteria are determined through the health risk assessment process. Use of a health-based approach ensures appropriate use of science and consistency with other Federal agency (for example, US EPA) in environmental/health decision-making.

#### **C-4. Existing terminology and applications**

*a.* 3X/5X. As described in chapter 5, the Army's use of these decontamination level terms is no longer prescribed (except as described in para 5-2), largely due to the lack of parallel terminologies/procedures used by regulators and industry for toxic industrial chemicals. The 5X level has historically been the criteria cited for determining suitability

for public/unrestricted release. Meeting this criterion was essentially defined as a specific procedure involving high-temperature incineration to achieve complete decontamination. Other means of ascertaining complete decontamination (sometimes referred to as agent-free-) were alluded to without specific guidance. As a result, the ability to achieve 5X was limited.

*b. Agent-free, risk-free, or zero agent.* The DA, civilian regulators, and the public have not interpreted these terms consistently. The terms agent-free or zero agent can be read as absolutes, and in several instances have been interpreted as removal of every molecule. Likewise, while decisions should be risk-based, it is generally impossible to prove a completely risk-free environment. Thus, risk-free is also seen as too absolute a statement. Despite theoretical beliefs, successful achievement of such absolutes is difficult if not impossible to prove. The only occasions where such terminology may be appropriate is where evidence is available to indicate that no contamination has occurred. In such cases, agent free may be an acceptable description.

*c. Detection/quantification limits.* As detection limits can vary per laboratory, equipment, analytical method, matrix sampled, specific sample, and other factors, use of these criteria requires clarification. More importantly, the use of the detection limit in risk management decisions is not health-based and in some cases could result in significant expenditure of resources for limited or no health benefit. In fact, the USEPA is incorporating health-based approaches in nearly all its new initiatives and only defers to detection limits when a health-based value is below analytical sensitivity. Unless a health-based assessment can delineate the need for specific detection requirements or goals, the detection limit should not be cited as a required standard.

*d. Field drinking water standards and waste control limits.* The field drinking water standards (FDWS) were developed to address the potential intentional contamination of Soldier drinking water supplies on the battlefield (see para C-6a). These levels were based on the assumption that Soldiers consume up to 15 liters for up to 7 days. For many years, the FDWS were the only documented chemical agent concentration limits for media other than air. For lack of an alternative, these concentration levels (20 ppb for nerve agents and 200 ppb for HD) have been used as the acceptable levels for disposal of chemical agent waste off Army sites as well as to ascertain effectiveness of decontamination procedures. These FDWS have also been referred to as waste control limits (WCL). Application of safe *drinking water* levels as the WCLs is overly conservative (overly protective) when applied to a waste stream which is clearly not consumed.

#### **C-5. Specific guidance**

As the term “health-based” refers to criterion that is suited to protecting human health and the environment under a given set of circumstances, it is important not to misapply one set of criteria for an unrelated scenario. As described in the references listed in paragraphs C-6a and d, the use of scientifically accepted, and preferably USEPA endorsed, environmental risk-assessment methodology (for example, USEPA Region IX) is currently recommended as the means to tailor certain criteria to specific applications, such as for waste management decisions and environmental cleanup decisions. The user is referred to table C-1 for key criteria and their particular applications.

#### **C-6. References**

- a.* DA Technical Bulletin -Medical (TB Med) 577, Sanitation and Surveillance of Field Drinking Water.
- b.* Army-proposed Draft Utah Chemical Agent Rule; May 1999.
- c.* Health Based Environmental Screening Levels for Chemical Warfare Agents; USACHPPM/ORNL technical report; March 99.
- d.* DASA (ESOH) AILE Memorandum, Subject: Health Based Environmental Screening Levels for Chemical Warfare Agents, May 1999.

**Table C-5**

**Types of Health-Based Criteria Types of health-based criteria that may be used in risk assessment to determine suitability of public (unrestricted) release of items/equipment/facilities exposed to chemical agent <sup>1,2</sup>**

Criteria name	Description of criteria	Application purpose	Considerations for appropriate use	Example scenarios
GPL (General Population limit)	A highly protective vapor exposure criterion (mg/m <sup>3</sup> ) for 24-hr/daily, lifetime exposure of the general population including those more susceptible individuals: a no observed adverse effect level (NOAEL) - represents an exposure at or below which there are no anticipated adverse health effects from either short or long-term repeated exposures (that is, that occur 24 hrs daily for up to 70yrs).	May be used with appropriate sampling (that is, item is contained, with proper heating/temperature to facilitate off-gassing and collection of potential contaminant release to air) to demonstrate no risk of a continued (daily, multiple year) release of agent at levels of public health concern.	May be particularly useful if there is concern that a matrix/item of porous/semi porous material that may (theoretically) contain absorbed residual agent that could off-gas over time at low concentrations. Also, if item or equipment includes complex surface or construction (composites, different parts with crevices, and so forth) that may at least theoretically contain residual agent deposits. Particularly appropriate application if such (porous/complex) items have been in contact with liquid/aerosol agent.	Facility or equipment routinely exposed to agent vapors and potential liquid agent, decontaminated by involving many parts or types of material - use proper sampling and use of GPL as screening criteria for unrestricted release.
AEGL-1 (Acute Exposure Guideline Level- 1) - 8 hour	A protective vapor exposure criterion (mg/m <sup>3</sup> ) for a one-time exposure of the general population including those more susceptible individuals: based on estimate of No Observed Effect Level (NOEL) or threshold at or below which there are no anticipated noticeable effects	May be used with appropriate sampling (that is, item is contained with proper heating/temperature to facilitate off-gassing and collection of potential contaminant release to air) to demonstrate unlikelihood of chemical agent being released from item at levels of public health concern.	Can be an appropriately protective health based vapor screening criteria for releasing items/equipment/ facilities that have not been contaminated by liquid/ aerosol agent or which includes simple non-porous items/surfaces that have undergone decontamination. Based on material/ construction, such decontaminated items would not be expected to have absorbed significant agent that would pose contact hazard or that would be continuously released over period of time.	If an accidental release occurred and no liquid but vapors were detected in area otherwise not routinely exposed containing equipment or vehicles - could use AEGL 1- 8 hr to ensure area/items cleared for unrestricted public use.
HBESL <sup>3</sup> (Health-Based Environmental Screening Level) - residential	A highly protective soil/solid matrix exposure criterion (mg/kg) for 24-hr/daily, lifetime exposure of the general population including those more susceptible individuals: a no observed adverse effect level (NOAEL) - represents an exposure at or below which there are no anticipated adverse health effects from either short or long-term repeated exposures (that is, that occur 24 hrs daily up to 70 yrs).	May be used alone or in conjunction with vapor exposure criteria described above (GPL or AEGL-1) to assess possible existence of residual agent in semi-porous or porous media and demonstrate unlikelihood of chemical agent being present in/on an item/material at levels of public health concern.	May be particularly useful if vapor off-gassing is not considered adequate or appropriate. Sampling should include procedures to ensure representative samples of media are obtained from specific media/area of concern.	Facilities/areas with concentrate or soil of potential (liquid) contamination or adsorption from extended high vapor concentrations could be sampled and extract analyzed (for example, through GC/MS) for presence of agents. This approach also allows assessment of potential breakdown products as well.

**Table C-5****Types of Health-Based Criteria Types of health-based criteria that may be used in risk assessment to determine suitability of public (unrestricted) release of items/equipment/facilities exposed to chemical agent <sup>1,2</sup>—Continued**

NHWCL <sup>4</sup> (non-hazardous waste exemption level)	A soil/solid matrix exposure criterion (mg/kg) derived as an estimate at or below which a worker at a municipal landfill/ construction debris facility (non-hazardous waste) would not be expected to have adverse health effect even from occasional repeated exposures over several years	For WASTE management - to support release to a non-RCRA permitted TSDF - may be used alone or in conjunction with vapor exposure criteria.	May be particularly useful if vapor off-gassing is not considered adequate or appropriate. Sampling should include procedures to ensure representative samples of media are obtained from specific media/area of concern.	To support decision* to manage and dispose of concrete, pallets as a non-hazardous waste. * Ultimately waste management decisions are subject to state specific laws and regulations.
---	---	--	---	--

## Notes:

<sup>1</sup> Not all inclusive - other health based criteria may be applicable for various situations, these represent most commonly anticipated.

<sup>2</sup> Specific selection of a criteria is site/scenario dependent and must be assessed in accordance with specific sampling procedures and anticipated use knowledge.

<sup>3</sup> Health-Based Environmental Screening Levels for Chemical Warfare Agents, USACHPPM/ORNL Technical Report, March 1999.

<sup>4</sup> Memorandum, Dept of Army Ctr for Health Promotion and Preventive Medicine, MCHB-EES; SUBJ: Response to State of Oregon Comments on the Proposed Utah Chemical Agent Rule, 23 October 2000 and associated attachments: USACHPPM Information Paper "Management Criteria for Chemical Warfare Agent Contaminated Waste and Media," October 2000, and USACHPPM Technical Paper "Chemical Warfare Agent Health-Based Waste Control Limits," September 2000.

## **Glossary**

### **Section I Abbreviations**

#### **ACAMS**

Automatic Continuous Air Monitoring System

#### **ACGIH**

American Conference of Governmental Industrial Hygienists

#### **ACOM**

Army Command

#### **AEL**

airborne exposure limits

#### **AMC**

U.S. Army Materiel Command

#### **APE**

ammunition peculiar equipment

#### **ASCC**

Army Service Component Command

#### **AQL**

acceptable quality level/limit

#### **CAI**

chemical accident incident

#### **CAIS**

chemical agent identification sets

#### **CAIRO**

chemical accident incident response officer

#### **CAIRA**

chemical accident and incident response and assistance

#### **CAM**

chemical agent monitor

#### **CAS**

chemical abstracts service

#### **CASARM**

chemical agent standard analytical reference material

#### **CCL**

contamination control line

#### **CDTF**

chemical defense training facility

#### **CFR**

Code of Federal Regulations

#### **CPR**

cardiopulmonary resuscitation

**CPU**

chemical protective undergarment

**CRA**

contamination reduction area

**CRM**

composite risk management

**CSP**

chemical site plan

**CSS**

chemical safety submission

**CWM**

chemical warfare materiel

**DA**

Department of the Army

**DAAMS**

Depot Area Air Monitoring System

**DCAC**

demilitarization chemical agent concentrator

**DDESB**

Department of Defense Explosives Safety Board

**DRU**

Direct Reporting Unit

**DOT**

Department of Transportation

**DPE**

demilitarization protective ensemble

**EOD**

explosive ordnance disposal

**EPA**

Environmental Protection Agency

**FM**

field manual

**GPL**

general population limit

**HQDA**

Headquarters, Department of the Army

**HTH**

high test hypochlorite

**HYFED**

hydrogen flame photometric emission detector

**IBD**

inhabited building distance

**ID**

induced draft

**IDLH**

immediately dangerous to life or health

**lfpm**

linear feet per minute

**IH**

industrial hygiene

**LPG**

liquefied petroleum gas

**LSC**

laboratory sample container

**MCE**

maximum credible event

**MEDDAC**

medical department activity

**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

**PCE**

protective clothing and equipment

**PED**

public exclusion distance

**PDS**

personnel decontamination station

**ppm**

parts per million

**QC**

quality control

**RAC**

risk assessment code

**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

**STEL**

short-term exposure limit

**TAP**

toxicological agent protective

**TAPES**

toxicological agent protective ensemble, self-contained

**TB**

technical bulletin

**TM**

technical manual

**TSG**

The Surgeon General

**TWA**

time-weighted average

**UBID**

unbarricaded intraline distance

**USAMRICD**

U.S. Army Medical Research Institute of Chemical Defense

**WPL**

worker population limit

**Section II****Terms****Activity commander**

The military or civilian responsible for the installation executing an assigned mission.

**Administrative control**

Policies and procedures used to limit access and/or to reduce chemical exposures.

**Aerosol**

Micron-size liquid droplets or solid particles dispersed in air. When liquid droplets reach micron dimensions, their behavior becomes similar to solid particles of the same size. A suspension or dispersion of small particles (solids or liquids) in a gaseous medium (air).

**Agent activity/operation**

Any operation that involves chemical agent, including storage, shipping, handling, manufacturing, maintenance, test chamber activities, laboratory/monitoring group 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 operating area**

That portion of an agent area where workers are actively conducting chemical agent operations.

**Airborne exposure limits (AELs)**

Allowable concentrations in the air for workplace and general population exposures. AELs include worker population limits (WPLs), short-term exposure limits (STELs), immediately dangerous to life or health values (IDLHs), and general population limits (GPLs).

**Allowable stack concentration (ASC)**

A non-regulatory ceiling value that serves as a source emission limit (SEL) and not as a health standard. It is used for monitoring the furnace ducts and common stack.

**Annual basis or annually**

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.

**Binary chemical munitions**

Munitions designed to use two relatively nontoxic chemicals that combine during functioning of the weapon system to produce chemical warfare materiel (CWM) for release on target.

**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. For practical purposes, it may be an average value over the minimum time required to detect the specified concentration.

**Certifying official**

For military and Army civilian personnel, the commander/director or supervisor responsible for chemical agent operations and having sufficient personal contact with all subordinate personnel reliability program (PRP) employees to permit continuing evaluation of their performance and reliability. For Army contractor personnel, the COR designated by the contracting officer is the certifying official. The certifying official certifies that personnel being considered for assignment to chemical duties meet the requirements of the PRP.

**Chemical agent**

A chemical compound (to include experimental compounds) that, through its chemical properties, produces lethal or other damaging effects on human beings, and is intended for use in military operations to kill, seriously injure, or incapacitate persons through its physiological effects. Excluded are RDTE dilute solutions, riot control agents, chemical defoliants and herbicides, smoke and other obscuration materials, flame and incendiary materials, and industrial chemicals.

**Chemical agent identification sets (CAIS)**

Also known as war gas identification sets, training sets produced and widely distributed by the DOD between the 1930's and 1960's for use by the military to train military personnel (for example, Soldiers) safely to identify, handle, and decontaminate chemical agents. The CAIS components are glass ampules or bottles that contain small amounts of both neat and dilute chemical agents and/or industrial chemicals that simulate chemical agents.

**Chemical agent worker**

An employee who by virtue of duties, duty locations, job description, and operations, could reasonably be exposed to chemical agent above the Worker Population Limit (WPL) from normal or emergency workplace activities. These employees are provided: Chemical agent training; Chemical agent workplace monitoring; and Medical surveillance appropriate with the probability of agent exposure.

**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<sup>2</sup>, g/m<sup>2</sup>) or in pounds per hectare (lb/ha). Hectare is 10,000 square meters.

**Chemical Defense Training Facility (CDTF) maximum concentration limit (CMCL)**

The maximum concentration of nerve agent to which personnel conducting toxic agent training operations may be exposed while wearing a full-face air-purifying chemical protective mask, such as the M40 mask. At concentrations above the CMCL, personnel must wear either a full-face positive-pressure SCBA or a positive-pressure airline respirator with an auxiliary SCBA. For practical purpose, the CMCL concentrations replace the IDLH concentrations for chemical agent training purposes. The CMCL agent levels are as follows:

- a. VX: 0.02 mg/m<sup>3</sup>.
- b. GB: 0.2 mg/m<sup>3</sup>.

### **Chemical limited area**

For nerve agent medical surveillance purposes in this document, the chemical limited area is defined as the area between the boundaries of the exclusion areas and the perimeter boundary (such as the inner fence at a chemical storage activity or demilitarization facility). For laboratory facilities, the chemical limited area is the inside of a laboratory room and/or where nerve agents (surety or dilute materials) are stored in secure containers. For non-stockpile operations, the chemical limited area will be considered an operating area or physical location where entry and exit are restricted and controlled, and where nerve agents are being recovered, processed, analyzed, packaged, handled, stored and/or disposed of. For live agent training facilities, the chemical limited area will be the laboratory, indoor training areas, or other areas of the training facility designated as red or hot on the live agent training facility model. For mustard agent medical surveillance purposes in this document, the chemical limited area is defined as the area between the boundaries of the exclusion areas and the perimeter boundary (such as the inner fence at a chemical storage activity or demilitarization facility). For laboratory facilities, the chemical limited area is the inside of a laboratory room and/or where mustard agents (surety or dilute materials) are stored in secure containers. For non-stockpile operations, the chemical limited area will be considered an operating area or physical location where entry and exit are restricted and controlled, and where mustard agents are being recovered, processed, analyzed, packaged, handled, stored and/or disposed of.

### **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 warfare materiel (CWM)**

For the purposes of this Pam, an item configured as a munition containing a chemical substance that is intended to kill, seriously injure, or incapacitate a person through its physiological effects. Also includes V- and G-series nerve agent, H-series blister agent, and L in other-than-munition configurations. Due to their hazards, prevalence, and military unique application, only CAIS that contain neat agent or dilute nerve agent are considered CWM. CWM does not include riot control agents, chemical herbicides, industrial chemicals (for example, hydrogen cyanide (AC), cyanogen chloride (CK), or carbonyl dichloride (CG)) not configured as a munition, smoke and other obscuration producing items, flame and incendiary producing items, or soil, water, debris or other media contaminated with low concentrations of chemical agents where no chemical agent hazards exist. (Soil, water, debris, or other media contaminated with dispersed V- and G- series nerve agent, H- and HN-series blister agent, or L will be considered and managed in accordance with 40 CFR 266 Subpart M.)

### **Chemical weapons system**

An integrated relationship of chemical agents, munitions or spraying devices and their mode of delivery to the target.

### **Chloroform**

Chloroform, CAS number 67-66-3, is a solvent that produces hydrogen chloride, chlorine, and CG when burned. In addition to being a carcinogen, inhalation may be fatal.

### **Class 6.1 poison**

As defined by 49 CFR 173.132, a division of toxic chemicals that are known or presumed to afford a hazard to health during transportation.

### **Clean**

Free of chemical agent contamination by either never having been exposed to liquid or aerosol chemical agent and to vapor concentrations exceeding the STEL concentration or where air concentrations have been monitored and verified to be below the suitable chemical agent exposure limit for the appropriate population.

### **Clean (for unrestricted use)**

A condition where an item has been shown to be free of chemical warfare agent at levels that are safe for unrestricted human use applications. This classification can be given to items/facilities not considered to have ever been contaminated, or to previously contaminated items/facilities that have undergone decontamination, monitoring, and risk assessment to ensure agent residue has been removed.

**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 protection**

A shelter, with filtered air, that provides a contamination-free working environment for selected personnel and allows relief from continuous wear of protective gear.

**Competent medical authority**

A physician, physician assistant or nurse practitioner (military, civilian or contract), appropriately trained and privileged, to provide medical services or clinical evaluations in support of the chemical surety program. Physician assistants and nurse practitioners must be supervised by licensed physicians

**Concentration**

The amount of a chemical agent present in a unit volume of air. Usually expressed in milligrams per cubic meter (mg/m<sup>3</sup>).

**Conditionally clean**

A condition where an item has been shown to be free of chemical warfare agent at levels that are considered appropriately safe for a certain set of assumed human exposure conditions (such as for adult workers with limited exposure potential) that can (will) be achieved through a controlled (restricted) use environment

**Confirmation**

The process of validating or invalidating a positive response.

**Contaminated**

A general term referring to a condition where an item, facility, or waste is considered or known to have chemical warfare agent at some level of potential health concern on or contained in the matrix.

**Continuously controlled**

A situation where the atmosphere is continuously monitored during the presence of chemical agent to determine concentration levels, the type of agent hazard (vapor, aerosol, liquid) is known e.g., unpack room at demilitarization facility.

**Contracting officers representative (COR)**

The individual who has primary responsibility for awarding, monitoring, administering, and ensuring compliance with a contract. The COR may also serve as certifying official.

**Corrective action**

Any action taken to rectify adverse conditions, and where possible, to preclude their recurrence.

**Decontaminating material**

Any substance used to chemically destroy, physically remove, seal, or otherwise make harmless a chemical agent.

**Decontamination**

The process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing the chemical agent on that person, object, or area. Physical or chemical means to remove, deactivate, or destroy chemical agents in the surface and in the matrix of protective clothing, object or equipment.

**Demilitarization**

The mutilation, destruction, or neutralization of chemical materiel, rendering it harmless and ineffectual for military purposes.

**Detection**

The determination of the presence of a chemical agent.

**Dilute research, development, test, and evaluation (RDTE) solutions**

Solutions in concentrations and quantities not exceeding the levels defined in AR 50-6.

**Egress, emergency**

The unplanned exiting from an operational area when a medical necessity occurs (that is, an immediately life-

threatening or serious medical condition) to one or more of the workers requiring removal for immediate medical attention.

### **Egress, Non-routine**

The unplanned exiting from an operational area due to one or more of the following conditions: 1. Damage and/or malfunction of PCE; 2. The measured level of chemical agent concentration exceeds the design capability of PCE being used; 3. Unplanned removal of PCE due to an unusual occurrence, that is; cannot decontaminate to the appropriate level; 4. An unacceptable risk occurs to the worker placing the worker in a situation, which necessitates immediate egress, but not requiring emergency medical response

### **Egress, routine**

Exiting from an operational area after completion of mission, planned activity, task, or end-of-shift (for example, exiting where no mask or wearing PCE was required and personnel were not exposed to the chemical agent concentrations at or above the STEL, chemical agent concentration did not exceed PCE capability, and end of stay-time.)

### **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.

### **Engineering controls, primary**

The device, room or structure immediately surrounding the agent source that provides the primary protection to the workers from the chemical agent hazard and is under negative pressure relative to the location of unprotected workers. Examples of primary controls are hoods, gloveboxes, or rooms under negative pressure relative to the adjacent vestibule, corridor, or room. The chemical agent container (for example, projectile shell, rocket-casing) is considered as a primary engineering control.

### **Engineering controls, secondary**

The area containing or adjacent to the primary engineering control that will prevent the further release or migration of chemical agent (to adjacent areas or the environment) if released from primary control. Examples of secondary controls are the lab room in which a hood/glovebox is located or a corridor/observation vestibule adjacent to an agent storage/operations room. This includes closed system (filtered bunkers, filtered igloos, overpack containers, on site containers, demilitarization operating facilities and outdoor glovebox operations) designed to protect unprotected workers or the ambient environment.

### **EOD procedures**

Those particular courses or modes of action for access to, recovery, rendering safe and final disposal of explosive ordnance or any hazardous material associated with an EOD incident.

### **Equipment decontamination plan**

A plan developed and approved for decontaminating and releasing tools, supplies, equipment and facilities to the public.

### **Exceedance**

The measured amount of chemical agent concentration above a given agent concentration reference point, for example, the measured concentration of  $5 \times 10^{-5}$  (0.00005) goes above the WPL's 8-hour TWA concentration of GB of  $3 \times 10^{-5}$  (0.00003000) mg/m<sup>3</sup> by  $2 \times 10^{-5}$  (.00002) mg/m<sup>3</sup>. Therefore the exceedance is  $2 \times 10^{-5}$  (.00002) mg/m<sup>3</sup>.

### **Exception**

A determination approved by the Secretary of the Army or his or her designee, waiving for a limited time or purpose, a policy or procedure contained in a DA publication.

### **Excursion**

An increase in the concentration of chemical agent present in an environment above a given agent concentration reference point, for example, the concentration goes above the WPL's 8-hour TWA concentration of GB of  $3 \times 10^{-5}$  (0.00003) mg/m<sup>3</sup>.

**Exposed worker - NERVE AGENT**

An exposed worker is defined as an individual (with a nerve agent exposure potential) who exhibits clinical signs or symptoms of nerve agent intoxication. In addition, a worker is presumed to have been exposed to nerve agents (even if asymptomatic) if he or she- (1) has a confirmed acute depression in RBCChE activity (greater than 10 percent) from baseline following work activities in a nerve agent chemical limited area; and (2) has had no immediate history of contact with other cholinesterase-inhibiting substances, such as carbamates or organophosphate pesticides; and (3) has nerve agent urinary metabolites, as identified by the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) on GC/MS analysis (see TB MED 296), or other validated nerve agent-specific biomarkers.

**Exposed worker -/H, HT, HD**

An exposed worker is defined as an individual (with a mustard agent exposure potential) who exhibits clinical signs or symptoms consistent with a vesicant exposure effect (for example, skin erythema, or erythema followed by blistering, after a latent period). This diagnosis should be confirmed by the presence of laboratory-significant quantities of thiodiglycol and related metabolites in the urine, OR the presence of mustard-protein/mustard-DNA adducts in the urine, blood, or blister fluid. The characteristic mustard histopathology of a blister on skin biopsy (i.e., dermal - epidermal separation with pyknotic nuclei in the germinal epithelium) should also be considered as strongly supportive of the diagnosis of mustard vesication.

**Exposure potential**

Refers to workplace conditions in which chemical agent (either surety or non-surety materiel) may be present in a liquid or vapor form, in varying quantities and concentrations, due to the nature of storage, disposal, training, testing, recovery, remediation, or laboratory operations.

**Field operations**

Operations conducted outdoors or outside of fabricated enclosures or structures that contain built-in alarms or engineered chemical agent controls. Short-term operations in storage structures are also considered field operations.

**GA (Tabun)**

The chemical ethyl-N, N-dimethylphosphoramidocyanidate, CAS number 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. GA is a lethal anticholinesterase agent similar in action to GB. GA vapor does not penetrate the skin, but GA liquid penetrates rapidly. The toxic hazard is high for inhalation, ingestion, and skin and eye exposure.

**GB (Sarin)**

The chemical isopropyl methylphosphonofluoridate, CAS number 107448, in pure form and in the various impure forms that may be found in storage as well as in industrial, depot, or laboratory operations. GB is a lethal anticholinesterase agent. Its toxic hazard is high for inhalation, ingestion, and eye and skin exposure. Due to its high volatility, it is mainly an inhalation threat.

**GD (Soman)**

The chemical methyl-1,2,2,-trimethylpropylphosphonofluoridate, CAS number 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. GD is a lethal anticholinesterase agent. Its toxic hazard is high for inhalation, ingestion, and eye and skin exposure, although it is primarily a vapor hazard.

**General population limit (GPL)**

A time weighted average that represents the maximum concentration to which the general population may be exposed 24 hours per day, 7 days a week, for a 70-year lifetime. Applies to the entire general population, including all ages and medical conditions.

**GF**

The chemical methylphosphonofluoridic acid, cyclohexyl ester, also known as cyclosarin, CAS registry number 329-99-7, in pure form and in the various impure forms that may be found in storage as well as in industrial, depot, or laboratory operations.

**Government control**

Refers to items which are under direct government control, (for example, property book item), used by an operator under a government contract operating on a government facility (for example, government furnished equipment), under control of a transportation agent hired by the government, (for example, contract carrier) or control of a service provider contractor (for example, off installation specialty repair shop)

## **H**

The chemical called Levinstein mustard, consisting of a mixture of 70 percent bis(2-chloroethyl) sulfide and 30 percent sulfur impurities produced by the Levinstein process.

### **Hazardous waste**

A solid waste as defined in 40 Code of Federal Regulations (CFR) 261.2 is a hazardous waste if it is not excluded from regulation as a hazardous waste under 40 CFR 261.4(b) and it meets any of the criteria listed in 40 CFR 261.3(a)(2)i through v.

## **HD**

Distilled mustard or bis(2-chloroethyl) sulfide, CAS number 505–60–2. HD is H that has been purified by washing and vacuum distillation to reduce sulfur impurities. It is a vesicant (blister agent) and alkylating agent, producing cytotoxic action on the hematopoietic (blood-forming) tissues. The rate of detoxification of HD in the body is very slow, and repeated exposures produce a cumulative effect. Its toxic hazard is high for inhalation, ingestion, and skin and eye absorption, but the most common acute hazard is from liquid contact with eyes or skin.

### **HL (Mustard-Lewisite Mixture)**

A mixture of 37 percent HD and 63 percent L; the mixture forms a lethal vesicant and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues, which are especially sensitive.

## **HT**

A lethal vesicant composed of approximately 60 percent HD [bis(2-chloroethyl) sulfide] and 40 percent agent T {bis[2-(2-chloroethylthio)ethyl]ether}. Both HD and T are alkylating agents. HT is monitored as HD. It is expected that the effects of HT would encompass those of both HD and T.

### **Immediately Dangerous to Life or Health (IDLH)**

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 PCE use. For planning purposes, the respirator wearer will 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 than 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.

### **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.

### **Industrial hygiene best practices**

The science and practice of anticipating, recognizing, evaluating, and controlling workplace conditions that may cause workers' injury or illness. This is accomplished through surveys and evaluations of worksites to assess both chemical and physical occupational hazards, risk assessment and worker awareness training, and consultation on matters regarding occupational health and safety regulations and requirements. Best practices incorporate environmental monitoring and analytical methods to detect the extent of worker exposure and employ engineering controls, work practice controls, and other methods to control potential health hazards. Examples of these practices are described in the Fundamentals of Industrial Hygiene published by the National Safety Council or in other literature recommended by the American Board of Industrial Hygiene.

## **L (Lewisite)**

The chemical dichloro-(2-chlorovinyl)-arsine, CAS number 541–25–3, in pure form and in the various impure forms that may be found in storage as well as in industrial, depot, or laboratory operations. L is a lethal vesicant (blister agent). The toxic hazard of L is high for inhalation, ingestion, and skin and eye exposure, although the most severe effects occur from liquid contact with eyes or skin.

### **Laboratory**

A location or facility where engineering controls may include a glove box 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/monitoring group**

Person or person(s) responsible for performing environmental, analytical, and safety laboratory/monitoring activities at a given site. This group has the responsibility to collect, analyze, and document samples, preserve samples, prepare samples for offsite transportation, calibrate and challenge monitoring instruments, review sample analysis results, and report sample analysis results from laboratory/monitoring instruments.

**Laboratory-type hood**

An enclosed ventilation device that does not require the insertion of any portion of an individuals body other than the hands and arms, and that is designed, constructed, and maintained as described in appropriate portions of this pamphlet.

**Matrix**

The component or substrate that contains the analyte of interest.

**Maximum Credible Event (MCE)**

In hazards evaluation, the MCE from a hypothesized accidental explosion, fire, or toxic chemical agent release (with explosives contribution) is the worst single event that is likely to occur from a given quantity and disposition of ammunition or explosives. The event must be realistic with a reasonable probability of occurrence considering the explosion propagation, burning rate characteristics, and physical protection given to the items involved. The MCE evaluated on this basis may then be used as a basis for effects calculations and casualty predictions.

**Method**

A set of procedures and techniques for systematically performing an activity (for example, sampling, chemical analysis, quantification). A method will encompass certain parameters that, when changed significantly, may result in a new method. Methods will be placed under configuration control and critical parameters will identify tolerances that, when exceeded, will result in a new method.

**Method detection limit (MDL)**

The MDL refers to waste methods only. The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyzed concentration is greater than zero and is determined from analysis of a sample in a given waste matrix containing the analyte. The MDL is the lowest level at which an analyte may be reported using that method (source is 40 CFR, Part 136).

**Mission commander**

The senior military or civilian responsible for the operational mission directed by ACOM, ASCC, DRU or Headquarters, Department of the Army.

**Monitor, historical**

An environmental sample of the work place, which may possibly contain chemical agents, collected at a fixed point in that work place. Determination of the presences or concentrations of chemical agent requires processing of the sample away from the collection point, for example, Depot Area Air Monitoring System (DAAMS). Therefore, the results are derived later, possibly hours or even days later. Consequently, they cannot be used at the work place to make decisions on the workers environment or safety.

**Monitor, Real or Near-Real Time**

An environmental sample of the work place, which may possibly contain chemical agents, systematically collected at a fixed point in the work place and then analyzed in or near the work place indicating the presence and concentration of chemical agent within seconds or minutes depending upon the monitoring device being used, e.g. MINICAMS. Consequently, the results can be used at the work place to make decisions on the workers environment or safety.

**Monitoring**

The continued or periodic act of seeking to determine whether a chemical agent is present.

**Monitoring level**

The level to which monitoring is performed. Responses at or above the monitoring level indicate the monitoring level has been met or exceeded and corrective actions are required. For waste screening purposes, the monitoring level is the negotiated treatment value for a specific analyte within a specific matrix.

**Monitoring plan**

A detailed, site-specific plan that covers all laboratory and monitoring objectives and strategies for a given site. The plan describes methods and equipment used, locations, number and type of samples, safety requirements, transportation and shipping instructions, scheduling, and any other site-related monitoring requirements.

**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.

**MUC**

The maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator, and is determined by the APF of the respirator or class of respirators and the exposure limit of hazardous substance. The MUC can usually be determined mathematically by multiplying the APF specified for a respirator by the permissible exposure limit (PEL), short-term exposure limit (STEL), ceiling limit, peak limit or any other exposure limit used for the hazardous substance.

**Mustard**

The chemical bis(2-chloroethyl)sulfide, CAS number 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.

**Near real-time monitor**

A non-portable continuous air-sampling device normally used in operational facilities for the detection of chemical agents. The near, real-time monitor will provide a direct read, an audible alarm, and sampling results in less than or equal to 15 minutes.

**Neat chemical agent**

An undiluted, full-strength (as manufactured) chemical agent or agent at concentrations above RDTE dilutes level. Chemical agent manufactured by the binary synthesis route will also be considered a neat agent, regardless of purity.

**Nerve Agent**

A lethal agent that causes casualties by interfering with the ability of muscles to relax after stimulation by associated nerves.

**Neutralization**

The act of altering the chemical, physical, and toxicological properties to render the chemical agent ineffective for use as intended.

**Unrelated personnel**

All personnel who are not directly involved with a chemical agent operation.

**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 ACOM, ASCC or DRU.

**Non-Stockpile**

Refers to the mission of the Product Manager for Non-Stockpile Chemical Materiel (PMNSCM), which includes the assessment and disposal of recovered chemical warfare materiel, binary chemical warfare materiel, former chemical weapons production facilities, and miscellaneous CWM (including delivery systems, contaminated metal parts, etc.).

**Oxygen deficient atmosphere/Oxygen deficiency**

An atmosphere containing less than 19.5 percent oxygen by volume at sea level.

**Permissible or published exposure limit (PEL)**

The exposure, inhalation, or dermal PEL specified in 29 CFR Part 1910, Subparts G and Z.

**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 non-persistent should not be used to denote classes of chemical agents.

**Potential exposure evaluation**

A medical evaluation conducted by a competent medical authority, which documents workplace exposure activities, concentrations of chemical agent, levels of protective equipment worn, medical review of systems, and relevant physical examination results on a potentially exposed worker.

**Potentially exposed worker - nerve agent**

A potentially exposed worker is defined as an individual (with a nerve agent exposure potential) who is present within a chemical limited area or exclusion area where levels of nerve agent – (1) exceed the respiratory or dermal protective capability of intact PCE or (2) are detectable at the established dermal threshold concentrations for specific nerve agents and there is a breach in PCE; or (3) exceed the STEL and there is a failure in engineering controls involving unprotected personnel.

**Potentially exposed worker - mustard**

A potentially exposed worker is defined as an individual (with a mustard agent exposure potential) who is present within a chemical limited area or exclusion area where levels of mustard agent – (1) exceed the respiratory or dermal protective capability of intact PCE or (2) are detectable at the established dermal threshold concentrations for mustard agents and there is a breach in PCE; or (3) exceed the STEL and there is a failure in engineering controls involving unprotected personnel.

**Protected worker**

A worker in the appropriate level and ensemble of PCE based upon an analysis of the hazards involved with the task being performed.

**RDTE solution**

Solutions of chemical agent 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**

For the purposes of this pamphlet, a period of less than 15 minutes.

**Reportable limit**

A predetermined value for historical method that when equaled or exceeded will be reported as chemical materiel that may have exceeded the monitoring level.

**Sample**

Physical evidence collected for environmental measuring and monitoring.

**Sampling**

The physical collection of a representative portion of the population, universe, or environment.

**Sampling plan**

A detailed, site-specific plan that covers all sampling objectives and strategies for a given site. The plan describes methods and equipment used, locations, number and type of samples, safety requirements, transportation and shipping instructions, scheduling, and any other site-related sampling requirements.

**Self/buddy aid**

Administration of a chemical agent antidote to ones self or to a co-worker upon experiencing early symptoms of chemical agent poisoning.

**Service response**

Force commander.

**Short-term exposure limit (STEL)**

The maximum concentration to which unprotected chemical workers may be exposed to for up to 15 minutes continuously.

**Solid waste**

Discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved materials in irrigation return flows or industrial discharges that are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended.

**Source emission limit (SEL)**

Source Emission Limit is a non-regulatory ceiling value that serves as a source emission limit and not as a health standard. The SEL is used for monitoring the furnaces ducts and common stack. The SEL replaces the previously used allowable stack concentration (ASC). SELs are identified in table 6-1.

**Standard**

A known concentration of a known chemical that is used to perform quantitative analysis.

**Standard glove**

All gloves covered by a military specification (for example, TAP and glove set glove).

**Standing operating procedure (SOP)**

A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and that is officially approved as the method for performing certain routine or repetitive tasks.

**T**

Agent T is a vesicant, CAS number 63918-89-8, with an estimated human lethal dose for inhalation that is much less than that for HD. The biological effects observed after animal exposure to HT are similar to those induced by HD, although induction following HT exposure is more rapid and/or severe. This greater activity is a result of the presence of stable agent T in the mixture; the more volatile HD dissipates and leaves a reactive blend containing a higher concentration of T.

**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.

**Time weighted average (TWA)**

A maximum level or concentration of a chemical agent, averaged over a specified length of time, to which employees may be exposed, for example, STEL is a 15-minute time-weighted average.

**Uncontrolled environment**

A situation where the atmosphere is not continuously monitored during the presence of chemical agent to determine concentration levels or the type of agent hazard (vapor, aerosol, liquid) is unknown or cannot be identified, e.g.: a storage magazine.

**Vapor screening level (VSL)**

The level to which an item is monitored to determine the level of cleanliness. Typically done by containing the item in an enclosed space to limit incoming dilution.

**Vapor screening procedure**

A defined process for isolating and then monitoring for chemical agent vapor concentrations in air around the isolated object, equipment, or portions of a facility based on the type of object, equipment or facility, considering such factors as ambient temperature, material composition, type of monitoring equipment and selected health-based criteria.

**Vesicant agent**

Agent that acts on the eyes and lungs and blisters the skin.

**VX**

The chemical O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate, CAS 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. VX is a lethal anticholinesterase chemical materiel. Its toxic hazard is high for inhalation, ingestion, and eye and skin exposure, but due to its low volatility, the primary route of exposure is through ingestion or skin contact.

**Worker population limits (WPL)**

Maximum allowable 8 hr TWA concentration that an unmasked worker could be exposed to for an 8 hour workday and 40 hour week for 30 years without adverse effect.

**Section III****Special Abbreviations and Terms**

This section contains no entries.

**UNCLASSIFIED**

**PIN 074858-000**

# USAPD

ELECTRONIC PUBLISHING SYSTEM  
OneCol FORMATTER WIN32 Version 253

PIN: 074858-000

DATE: 12-17-08

TIME: 08:31:27

PAGES SET: 78

---

DATA FILE: C:\wincomp\p385-61.fil

DOCUMENT: DA PAM 385-61

SECURITY: UNCLASSIFIED

DOC STATUS: REVISION