GUIDELINES
FOR
MANAGING AN RDTE DILUTE SOLUTION LABORATORY
AT THE MEDICAL RESEARCH AND EVALUATION FACILITY

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GUIDELINES FOR MANAGING AN RDTE DILUTE SOLUTION LABORATORY

AT THE MEDICAL RESEARCH AND EVALUATION FACILITY

1. GUIDELINES POLICY:

a. The Department of Defense (DOD) requires contractors to prevent sabotage, theft, diversion or unauthorized access to, or use of any RDTE Dilute Solutions provided to, or produced by them in RDTE Dilute Solution laboratories. Contractors shall develop and implement procedures to provide for the security of RDTE Dilute Solutions; and provide for the safety of contractor personnel, the general public, and the environment. Contractors shall also develop and implement a quality assurance/quality control program that establishes standards that insure the accuracy and precision of the data produced.

b. Responsibilities: The Commander, U.S. Army Medical Research Institute of Chemical Defense (USAMRICD), has the designated responsibility to manage the U.S. Army Materiel Research and Materiel Command's (USAMRMC) RDTE Dilute Solution contractor program. Execution shall be accomplished by the USAMRICD Safety and Chemical Operations Branch (SCOB). The Commander, USAMRICD, through SCOB, shall as appropriate:

1. Establish, publish and revise as required, regulatory policies and procedures through the Guidelines.

2. Develop contract clauses and guidance for implementation of the Guidelines.

3. Certify that RDTE laboratories can safely and securely use and store RDTE Dilute Solutions.

4. Assess contractor performance against the Guidelines standards.

5. Provide guidance and counsel to contractors on meeting Guidelines standards.

c. Participating USAMRMC agencies are responsible for supporting the RDTE Dilute Solution Laboratory Program. The USAMRICD SCOB shall provide guidance and requirements to agencies who, in turn, shall provide resources and personnel for program execution. A government team shall assess the total contractor operation prior to initiation of RDTE Dilute Solution operations and schedule periodic assessments thereafter. This assessment will generally be part of the evaluation of the neat chemical agent operation.

The MREF shall:

1. Ensure that all RDTE Dilute Solution work is conducted in full compliance with Guidelines standards and all contractual agreements.

2. Prepare and implement a Chemical Hygiene Plan (CHP) or a section of the corporate CHP addressing RDTE Dilute Solutions.

3. Ensure that the CHP is reviewed annually.

4. Interact with laboratory management and personnel to ensure that CHP procedures are understood and followed, and assistance is provided.

5. Ensure that all staff receive appropriate training for assigned duties.

6. Ensure that operating procedures for safely conducting each RDTE Dilute Solution operation are written and followed.

7. Prepare a Physical Security Plan.

8. Review the Physical Security Plan annually.

9. Report all unusual activities, losses of RDTE Dilute Solutions (actual or suspected), recovery of RDTE Dilute Solutions, or attempts to steal RDTE Dilute Solutions to law enforcement authorities and to the COR as expeditiously as possible.

10. Designate a Chemical Hygiene Officer who shall:

    a. Work with administrators to develop policies and practices for safe handling of chemicals.

    b. Ensure that required inspections are conducted and records are kept.

    c. Assist laboratory supervisors with safety matters and provide technical assistance when needed.

    d. Review the CHP annually and make necessary revisions.

    e. Serve as advisor to the safety committee if such a committee is established.

f. Provide technical guidance in the development and implementation of the provisions of the CHP.

g. Observe dry runs (if required) and approve readiness to conduct RDTE Dilute Solution operations.

h. Determine the level and types of required personal protective equipment.

2. GENERAL REQUIREMENTS:

a. These standards and practices represent the minimum requirements to provide a safe and healthful work place. They do not excuse contractor's independent responsibility to comply with federal, state, and local regulatory requirements for employee and work place safety. Each contractor is responsible for health, safety, and the environment in all phases of operations, transportation, storage, and disposal of RDTE Dilute Solutions (hereinafter referred to as RDTE Solutions), hazardous materials, wastes, and emission sources. The contractor will comply with all state and federal EPA regulations. The Chemical Hygiene Plan will be in compliance with all 29 CFR 1910.1450 requirements. In addition to meeting the Guidelines criteria, the contractor must also comply with all other federal, state, and local regulatory requirements.

b. Record Retention and Inspection. The contractor shall develop a records retention plan that is in compliance with all state and federal regulations. These records shall be available for inspection by the Contracting Officer or his/her representative(s).

3. CHEMICAL HYGIENE PLAN REQUIREMENTS:

a. Chemical Hygiene Plan (CHP). The contractor shall prepare a Chemical Hygiene Plan for RDTE Solutions operations addressing safety, occupational health and the environment. This plan shall detail the following requirements:

(1) A safety training program for all individuals with access to RDTE Solutions.

(2) A designated individual responsible for the entire safety program with full authority to prepare and enforce contractor safety policies.

(3) Detailed policies for storage and handling of RDTE solutions within the contractor's facilities.

(4) Process and criteria for establishing standard operating procedures (SOP).

Facility engineering drawings and specifications for all RDTE Solution areas, associated ventilation systems, and RDTE Solution handling systems shall be on file at the contractor facility. Test data verifying adequacy of all systems, as well as test methods for periodic recertification of the system, shall also be on file.

b. Employee Communication Program. All employees performing work on government-sponsored projects as well as support personnel shall be apprised of the hazards of the chemicals in their work area at the time of their initial assignment and whenever a new hazard is introduced.

c. Criteria for Containment of Operations.

(1) Personnel responsible for planning, designing and accomplishing the laboratory operations shall ensure adequate safety is provided by incorporating the appropriate type of hazard containment. Operations using RDTE solutions may be conducted in a ventilated laboratory room with unfiltered laboratory hoods. (NOTE: Use of filtered exhaust is recommended.)

(2) Vapor containment shall be provided by facilities or equipment designed to ensure exposures are controlled or maintained below the AEL.

(3) Airborne exposure limits for the chemical agents are as follows:

Table 1. Airborne Exposure Limits

	Chemical Agents (mg/m^3)				
	GD	GA/GB	VX	H, HD, HT	L[1]
8-hour TWA in any work shift	.00003	.0001	.00001	.003[2]	.003[2]
General Population 72-hour TWA Ceiling Value*	.000003 .00003	.000003 .0001	.000003 .00001	.0001 .003[2]	.003[2] .003[2]
Source Emission Limit[3]	.0001	.0003	.0003	.03	.03

*Ceiling value normally refers to the maximum exposure concentration at any time, for any duration. Practically, it is the average value over the minimum time to determine a specified concentration.

[1]All concentrations measured as Lewisite.
[2]This value also represents the technologically feasible real time detection limit. HT is measured as HD.
[3]Source emissions limits are primarily an engineering guideline. These limits should:
a. be attainable by a well designed and well operated filtration system or incinerator.
b. give an early indication of upset conditions
c. be accurately measurable in a timely manner.

(4) The selection of the type of containment is dependent upon the nature of the operation involved.

d. Air Ventilation System.

(1) General. Ventilating systems shall be designed so a system failure will not result in migration of the RDTE Solution (vapors) into areas occupied by unprotected personnel. Ventilation shall exhaust to the exterior of the building and not be recirculated or used as make-up air.

(2) Work Area Ventilation. RDTE Solution work areas shall be provided with an appropriate ventilation system to (a) collect and exhaust vapors from the work area, (b) provide make up air, and (c) provide a negative pressure within the work area to prevent escape of RDTE Solutions vapors. Local exhaust ventilation is the most effective method of controlling vapor released into the general work area. Differential pressure airflow gauges or alarms shall be used to verify proper ventilation conditions. The design should be based on recommended practices published in the latest edition of Industrial Ventilation Manual, published by American Conference of Governmental Industrial Hygienists.

(3) Ventilation Hoods.

(a) Laboratories shall be equipped with either laboratory type ventilation hoods or glove boxes to provide the

engineering controls necessary to contain RDTE Solutions during operations. Hood and glove box material should be chemically resistant and easy to decontaminate.

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

(c) Hoods and glove boxes, containing RDTE solutions, shall be equipped with flow sensors with audible and visual alarms indicating improper flow conditions.

e. Other Facility Requirements.

(1) To further decrease the possibility of exposure to RDTE Solutions, each facility shall be designed so that equipment shall require only minimum handling by operational personnel.

(2) Exits shall be sufficient in size and number to permit rapid evacuation of all personnel in the event of fire, explosion or spill (National Fire Protection Code 101, Life Safety Code).

(3) Personnel deluge-showers and eye-wash devices shall meet OSHA standards and be readily accessible to all work situations within the laboratory.

(4) Facilities for washing hands and arms prior to leaving the RDTE Solution area shall be available.

(5) A supply of decontaminants and equipment for applying them shall be located such that it is immediately available for routine decontamination procedures and emergencies.

(6) Fire protection shall be provided as required in the National Fire Protection Association Codes or the Uniform Fire Code and applicable local fire regulations.

f. Personnel Protective Equipment (PPE):

(1) Respiratory Protection. In case of ventilation system failure or release of RDTE Solutions outside of engineering controls, a sufficient number of appropriate NIOSH-approved respirators shall be available. Use of these respirators will be in conformance with a 29CFR1910.134, Respiratory Protection. See Table 2. Use of respiratory protection shall be delineated in the CHP or SOPs.

(2) Protective Clothing. In addition to protective masks/respirators, supplies of protective clothing necessary to protect personnel during operations and during emergencies) shall be provided and maintained at the RDTE Solutions facility.

Protective clothing requirements shall be specified in individual SOPs.

(3) Eye/Face Protection. Eye and face protection shall be in accordance with 29 CFR1910.133.

Table 2. PPE Requirements for Emergency Response

EMERGENCY SCENARIO	Employee Exposure Potential				
	Agents (mg/m^3)				
	GD	GA/GB	VX	H, HD, HT	L
Airborne Levels Above AEL and Below IDLH	>.00003 to ≤.06	>.0001 to ≤.2	>.00001 to ≤.02	>.003	>.003
A NIOSH/MSHA approved pressure demand self-contained breathing apparatus (SCBA) or supplied air respirator (SAR) with escape air cylinder and chemically imprevious clothing					
Airborne Levels Above IDLH or Unknown	>.06*	>.2*	>.02*	>.003	>.003
NIOSH/MSHA approved pressure demand SCBA or SAR with escape air cylinder and fully encapsulating suit. EBA may be used for emergency/escape purposes. *IDLH levels					

g. Decontamination. The following standards and practices represent the minimum decontamination requirements.

(1) General. A supply of decontaminants appropriate to the specific RDTE Solution shall be readily available in the immediate vicinity of all RDTE Solution and decontamination operations. The quantity on hand shall be sufficient to decontaminate the entire stock of RDTE Solutions in the event of an emergency. Procedures shall be established and personnel shall be trained in the proper decontamination of personnel, equipment, and facilities.

(2) Procedures shall be established to assure that reusable equipment is monitored to below the following limits prior to release from government/contractor control:

(a) Nerve agent - 0.1 AEL

(b) Mustard/Lewisite - 0 (For these agents, the only acceptable method prior to release is heating to 1,000 degrees F for 15 minutes).

(3) Decontaminants. Standard decontaminants include, but are not limited to, the following:

(a) Super Tropical Bleach (STB) slurry or High Test Hypochlorite (HTH) for RDTE Solution VX.

(b) Ten percent solution sodium hydroxide or 10% sodium carbonate solution for RDTE Solutions GB and GD.

(c) Commercial liquid bleach (nominal 5% sodium hypochlorite) can be used for small spills of RDTE Solutions. Bleach is the preferred decontaminant for V and H materiel.

(4) Emergency Contingencies. The contractor is responsible for having adequate plans and resources for the safeguarding, detoxification, and decontamination of the RDTE Solutions in the event of a fire, explosion, or other emergency situation.

h. Disposal. Handling and disposal of all waste RDTE Solutions, expendable supplies, contaminated equipment components and decontamination solutions shall be in accordance with federal and state environmental regulations.

i. Training. The contractor shall assure that all personnel involved in RDTE Solution operations are properly trained.

(1) Training shall be conducted prior to assignment to RDTE Solutions operations and shall include, as a minimum, the following:

(a) The effects of the chemical agents used in RDTE Solutions

(b) Potential routes of exposure and symptoms of agent toxicity (agents in solution)

(c) Purpose of medical surveillance

(d) Use of engineering controls and procedure controls

(e) Use of personal protective equipment (PPE).

(f) Use of decontaminants

(g) Emergency procedures

(h) Procedures for specific use of RDTE Solutions.

(2) Refresher training shall be repeated at least annually.

(3) A written record of the safety training, the dates the training was provided, the names of individuals receiving the training, and a summary of the training itself, shall be maintained by the contractor and shall be made available to government personnel as requested. Records will be maintained for duration of employment plus 3 years.

j. Standard Operating Procedures.

(1) SOPs shall be prepared in advance of operations and shall be in sufficient detail to outline the necessary safety and operational requirements, including checkout of all facilities and equipment involved. Copies of the applicable SOP shall be available at the worksite for personnel information, guidance, and compliance. At a minimum, SOPs shall address the following elements, as applicable, and shall be reviewed for their accuracy annually.

a. Steps for each operating phase

b. Operating limits (unless already covered in the hazard analysis)

c. Safety and health considerations

d. Emergency procedures.

Standard operating procedures shall be readily accessible to employees. The Chemical Hygiene Officer shall approve all new or revised SOPs that include safety issues.

Personnel shall be thoroughly trained in the procedures and requirements of the SOP. At the discretion of the Chemical Hygiene Officer, a dry run may be required prior to an established operation or a slightly modified current operation. The dry run shall be performed in the presence of contractor safety and supervisory personnel. Employees shall sign the SOP stating that they have been thoroughly trained and understand the SOP. Supervisors shall sign each SOP, verifying that the individuals who will conduct the operations have been trained and that they have demonstrated proficiency in the specific operation. If the contractor does not have a locally promulgated format, one may be obtained by writing; Chief, SCOB, USAMRICD, ATTN: MCMR-UV-RS, 3100 Ricketts Point Road, Aberdeen Proving Ground, MD 21010-5400. Copies of the applicable SOP shall be readily available at the worksite for personnel information, guidance and compliance.

(2) The contractor shall show evidence of employee participation in the process of developing SOPs and in identifying and rectifying hazards associated with the operating procedures.

k. Medical Services.

(1) Emergency Medical Facilities. Emergency medical facilities shall be available to the contractor. The contractor shall keep the facility emergency treatment personnel apprised of the class(es) of compound(s) to which exposure is possible. In the absence of an infirmary, clinic, or hospital in near proximity to the work place which is used for the treatment of all injured employees, a person or persons shall be adequately trained to render first aid. First aid supplies approved by the consulting physican shall be readily available.

(2) Surveillance. Medical surveillance for personnel with potential for exposure to RDTE Solutions shall include the following as a minimum:

(a) A medical examination shall be conducted prior to assignment to working with RDTE Solutions and upon contract termination as follows:

Occupational History
Medical History
Personal Protective Equipment Evaluation
(Emergency Responders)
Baseline Red Blood Cell - Cholinesterase

(b) Annual occupational history/update

(c) Red blood cell cholinesterase (RBC-ChE) testing (for anticholinesterase agent workers only) which will include baseline and termination of contract/employment. A determination of the individual's baseline RBC-ChE activity as required is defined by the average value of two separate measurements obtained at least 24 hours and no more than 14 working days apart. During the time between the two RBC-ChE measurements, the individual should not be allowed to enter RDTE Solution operating areas and should be warned to avoid exposure to any cholinesterase-inhibiting substances. If these two determinations vary by more than 0.05 delta pH units, obtain a third determination. In that case, the baseline RBC-ChE activity will then be the average value of all three measurements. CHPPM will be used for these services.

l. Monitoring of RDTE Solutions Operations.

(1) Monitoring. Monitoring at 0.5 AEL shall be conducted for the duration of potential exposure up to 8 hours under the following conditions:

(a) At the beginning of a new operation

(b) Following significant changes in an ongoing operation e.g., an agent of higher volatility

(c) Following any significant change or damage to the ventilation system.

If the agent concentration is 0.5 of the AEL or above, the operation shall be suspended, reevaluated, and any subsequent corrective actions performed before that operation can resume.

(2) Loss of Engineering Controls. Monitoring must also be conducted when the following occurs:

(a) RDTE Solution release outside of engineering control.

(b) Ventilation failure of hood with uncontained RDTE Solution.

(c) Ventilation failure of a hood with contained RDTE Solution that lasts longer than 24 hours. If ventilation is lost when all solution is in double containment, monitoring is not required provided that re-entry is not attempted until ventilation has been restored for a minimum of 1 hour.

(3) Contamination Control. When setting up alarms, gas chromatographs, or other RDTE Solution monitoring equipment, 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 deliver more sample volume than is required by the monitoring device. This excess, which is then bypassed or exhausted, must remain within engineering controls.

m. General Safety Criteria.

(1) Good laboratory housekeeping shall be maintained and practiced.

(2) Contractor support personnel (such as fire-fighters and security guards, if applicable to the contract operation) shall be notified of the presence and class(es) of RDTE Solutions, and building/room in which it is located. Local support personnel responding to emergency situations shall be likewise notified immediately upon their arrival.

(3) Mechanical pipetting aids shall be used for all pipetting of RDTE Solutions.

(4) The storage or consumption of food or tobacco products; storage or use of beverage containers, or storage or application of cosmetics are not permitted within the RDTE Solution use or storage area(s).

(5) A health provider shall be available for immediate call when RDTE Solution laboratory operations are in progress.

(6) Any RDTE Solution exposure, suspected exposure, RDTE Solution spill or release, or other abnormal situation that may result in personnel injury shall be reported to supervisory personnel immediately after taking necessary emergency actions. Personnel with possible RDTE Solution exposures shall report for medical evaluation to the medical authority retained by the contractor to treat chemical injuries.

(7) All means of emergency egress from the RDTE Solution facility shall be labeled, free of obstructions and shall exit into an area of lesser hazard.

(8) Clerical/administrative space and functions shall not be maintained within an RDTE Solution laboratory or storage rooms.

(9) A chemical incident response procedure shall be developed to assure proper employee assistance decontamination and notification.

(10) Safety, occupational health and industrial hygiene services provided in support of government-sponsored projects shall be furnished by competent supplier(s).

(11) For medical chemical defense efforts, all RDTE solutions shall be stored at depressed temperature, the degree of depression determined in consideration of the solvent.

n. Facilities Decontamination. The following facilities decontamination standards and practices apply upon contract completion and are the responsibility of the contractor.

(1) To achieve the status of a decontaminated laboratory/facility, all RDTE Solutions used/stored in the specified area must be decontaminated. Hoods and working surfaces which have been exposed to RDTE Solutions shall be decontaminated with the appropriate decontamination solution. The contractor shall submit a statement of decontaminated status to the Contracting Officer which shall include the following: (1) Contractor's certification that all RDTE Solutions in accessible form has been decontaminated; (2) The contractor's certification that the facilities that have been potentially exposed to RDTE Solutions have been decontaminated with the appropriate decontamination solution; (3) RDTE Solution monitoring results following decontamination; and (4) Certification of the removal and proper disposal of filters, if present.

(2) The dismantling, testing, handling, and disposal of decontaminated RDTE Solutions and facilities is the responsibility of the contractor.

4. SECURITY REQUIREMENTS:

a. General. The security provisions of this section set forth physical security standards and criteria for the protection of RDTE Solutions. These provisions apply to contracts regardless of the origin or source of the RDTE Solutions (i.e., receipt, purchase, synthesis, etc.) and shall be in force while RDTE Solutions remain under the control of the contractor/ subcontractor regardless of contract expiration or termination. These provisions are equally applicable to subcontractors requiring access to RDTE Solutions and shall be included by the prime contractor as a provision of the subcontract. RDTE Solutions operations are authorized only for the location(s) specified in the CHP and will be conducted only at that location(s).

b. Security Plan (SP). The contractor shall prepare a security plan outlining specific plans of action to be taken to implement these security provisions.

c. Physical Security Requirements. Access to RDTE Solutions shall be prevented by at least two physical barriers. The first barrier shall be, as a minimum, the storage container or personnel having physical custody of the RDTE Solutions.

(1) RDTE Solutions Storage.

(a) When not in use, all RDTE Solutions will be stored within a locked security container (normally a refrigerator) which, in turn, is stored in a locked hood, chemical storage room or laboratory.

(b) The storage room or laboratory shall be posted, so that access is limited, with an "AUTHORIZED PERSONNEL ONLY" sign.

(2) Security Design Criteria. The RDTE Solutions storage facility shall be constructed of material which provides adequate protection against surreptitious entry and unauthorized access to RDTE Solutions.

(a) Doors. The doors shall be closed and locked at all times when authorized personnel are not present within the storage area or laboratory.

(b) Hinges. Hinges for RDTE Solutions security structure doors shall be mounted so they are concealed by the door structure or otherwise tamper-protected when the door is in the closed position and so that the door cannot be removed from the frame.

(c) Key and Lock Control System. A key and lock control system, including an issue and turn-in procedure, shall be established. Access to keys/combinations for locks shall be held to an absolute minimum and records shall be kept of all personnel possessing keys and/or combination. When combinations and codes are used in lieu of keys, similar control procedures shall be developed to assure the integrity of the combinations and codes.

(d) Entry Control. Access to the RDTE Solutions storage room or laboratory shall be limited to individuals authorized to the room. All visitors will be escorted. During operations the AUTHORIZED PERSONNEL ONLY sign and a CAUTION sign with the hazard indicated shall be posted at the entrance to the room. A list of personnel to be notified in the event of an emergency as well as emergency phone numbers shall be posted at the entrance to the room at all times. The room shall be locked after close of business.

(e) Accountability. Individuals authorized by the laboratory manager as custodians for RDTE Solutions shall be responsible for maintaining records of use. Spills and authorized destruction will also be recorded. Final disposition such as use in an experimental procedure will be documented in an official laboratory notebook. Entries in laboratory notebooks are considered sufficient for documentation.

(f) Security Checks. The RDTE Solutions storage area and container shall be checked by authorized personnel at least

once each work day, normally at the close of the business day, to ensure that the RDTE Solutions are secure and the room is locked.

(g) Inquiries. The contractor shall immediately notify the Contracting Officer of inquiries which originate outside of Government/Contractor/ Subcontractor/Client Channels concerning the use of RDTE Solutions.

5. CHEMICAL EVENT.

a. Criteria. A chemical event for a laboratory is defined as:

(1) - One sample cycle which exceeds 5 times the AEL value.
- Several sample cycles totaling 30 minutes during the workday which exceeds 3 times the AEL value
- 8 hours TWA exceeds the AEL
- Any known or suspected release of RDTE Solutions which results in personnel exhibiting signs or symptoms associated with RDTE Solutions exposure.

(2) Any media attention directed at the laboratory

(3) Any deliberate release of RDTE Solutions resulting from a terrorist or criminal act (including employment of an improvised chemical device intended to disperse RDTE Solutions, regardless or whether the device has functioned or not.)

(4) Loss of RDTE Solutions (other than deliberate destruction by approved, laboratory and demilitarization processes, including training.)

b. Reporting. Chemical events shall be reported as specified by the Contracting Officer.

c. Chemical Event Investigations.

(1) The contractor is responsible for conducting a full investigation into the chemical event. A copy of the investigation report shall be forwarded to the Contracting Officer, within 30 days following the chemical event.

(2) Chief, SCOB will evaluate the contractor investigation report, and may or may not perform an additional investigation.

APPENDIX A

AGENT HAZARDS AND EFFECTS

APPENDIX A

Agent Hazards and Effects

MUSTARD

Mustard is an insidious vesicant agent that has been identified as carcinogenic and mutagenic. The agent's garlic-like odor quickly becomes unnoticeable after the first detection because the agent causes the olfactory nerves to become insensitive. This phenomenon is known as "olfactory fatigue". 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, eyes and if ingested, through the gastrointestinal tract. With regard to skin exposure, the presence of moisture or perspiration on the skin tends to increase the effect of exposure to this agent. 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. 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 on non-porous surfaces as liquid contamination for long periods because of their low volatilities. They can also wick into porous surfaces and emit vapor over a long period of time. Mustard agents on contaminated surfaces can be transferred to personnel by direct contact.

LEWISITE

Lewisite is a vesicant agent and is considered a suspect carcinogen. Exposure to Lewisite causes intense pain on contact. 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. Exposure to the eyes, if not decontaminated immediately, will result in permanent injury or possible blindness within 1 minute. Injury to the respiratory tract due to vapor exposure is similar to that of mustard, however, edema of the lungs is more marked and frequently accompanied by pleural fluid. Lewisite on the skin, as well as inhaled vapor, is absorbed and may cause systemic poisoning. Lewisite can cause sensitization and chronic lung impairment. When inhaled in high concentrations, it may be fatal in as short a time as 10 minutes.

G AGENTS

G agents (GA, GB, GD, GF) 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. The hazard from G agents (GA, GB, GD) is primarily that of vapor inhalation through the respiratory tract although it may be absorbed through the eyes or skin. As a liquid, G agents are hazardous by skin or eye contact and by ingestion. They are 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.

AGENT VX

VX is an anticholinesterase compound similar to GB in mechanism of action and effects. Since VX has a low volatility, percutaneous absorption is enhanced because liquid droplets on the skin do not evaporate quickly. 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. 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 may persist as a liquid for several days.

SIGNS AND SYMPTOMS

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 which 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.

Lewisite. The signs and symptoms of Lewisite exposure are similar to those of mustard, but occur more rapidly. As with mustard agents, the eye is vulnerable. Mild exposure of 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 2-3 days. Skin burns are much deeper than with HD. Tender and moist skin (mucous membranes or perspiration covered skin) absorbs Lewisite more readily and the effects are more serious. Lewisite is irritating to nasal passages and produces a burning sensation followed by a profuse nasal secretion and violent sneezing. Prolonged exposure causes coughing and production of large quantities of froth mucus. Lewisite acts as a systemic poison, causing pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure.

Nerve Agents (G and VX). The first indication of exposure to liquid G agents or VX 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 can be expected, the number and severity of which will depend upon the degree of exposure:

1. If exposure is from aerosol or vapor, early signs and symptoms are pinpointing of eye pupils and dimness of vision, runny nose and a tightness of the chest.
2. If exposure is by skin contact, early signs and symptoms may be sweating and muscular twitching.
3. 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. Nerve 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. If the dose is large, the response can be very rapid. The intact skin acts as a barrier to nerve 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 nerve agent. The rate of regeneration of ChE within the body is slow.

RATE OF ACTION

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. 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 nerve agents have been absorbed if death is to be averted.

DOSAGE

Vapor dosage is the concentration of a chemical agent in the atmosphere multiplied by the time the concentration remains, expressed as mg-min/m^3. The dosage received by a person depends upon how long they are exposed to the concentration. That is, the respiratory dosage in mg-min/m^3 is equal to the time in minutes an unprotected individual is in an agent cloud multiplied by the concentration of the cloud. The skin dosage is equal to the time of exposure in minutes of an individual's unprotected skin multiplied by the concentration of the agent cloud. (This is generally understood as being the effect

upon the whole body.) The physiological effectiveness of skin and respiratory aerosol dosages are influenced by particle size as well as time and concentration, since retention by the lungs and impingement upon the skin are functions of particle size. They are usually expressed in mg-min/m^3 for a particle size.

1. Liquid dosage is the weight of liquid CSM received by a person on his skin and is usually expressed as dosage in milligrams of contaminant per kilogram of body weight (mg/kg).
2. An individual may show signs and symptoms after exposure to a chemical agent which are less or more than expected for a given dosage, depending upon some of the following variables:
   a. How long the breath was held during short exposure.
   b. Speed with which mask was donned.
   c. Ability to fit mask and mask leakage factors.
   d. Whether the CSM was also absorbed through the skin.
   e. Whether the chemical agent stimulated the rate of breathing.
   f. Rate and depth of breathing of the individual at the time of exposure.
   g. Amount of physical exertion of the individual at the time of exposure.
   h. Rate of detoxification, especially if exposure was long.

The chemical and physical properties of the various agents are provided in Table B-1 in Appendix B.

APPENDIX B

AGENT CHEMICALS AND PHYSICAL PROPERTIES

Table B-1. Agent Chemicals and Physical Properties

	Boiling Pt	Freezing Pt	Flammability	Color	Odor	Vapor Pressure
H, HD Mustard	217 °C 423 °F	14.5 °C 58 °F	Class III B Combustible liquid	Clear thru amber to dark brown	Garlic	0.072 mm Hg at 20 °C 68 °F
HT Mustard	No constant point above 228 °C	0.0 to 1.3 °C 32 °F	NA	Clear to pale yellow	Garlic like	0.014 mm Hg at 25 °C
L	190 °C 374 °F	NA	NA	Pure-Colorless	Geranium like, pure - very little	0.35 mm Hg at 25 °C
GA	274 °C 476 °F	-50 °C	NA	Colorless to brown liquid	Faintly fruity, pure - none	0.07 mm Hg at 24 °C
GB	158 °C 316 °F	-56 °C	Non-flammable	Colorless	Pure - none	2.9 mm Hg at 25 °C 77 °F
				Pure - colorless	Pure -	0.40 mm Hg at 25

GD	198 °C 388 °F	NA	NA	Amber or dark brown	fruity, Oil of Camphor	°C
GF	80 °C at 4.0 torr	-30 °C -38 °F	NA	Clear	None	0.0700 mm Hg at 25 °C
VX	300 °C 572 °F	-39 °C -38 °F	Class III B Combustible liquid	Clear to straw-colored	None	0.0007 mm Hg at 25 °C 77 °F