

**APPENDIX A**  
**MATERIAL SAFETY DATA SHEETS FOR CHEMICAL AGENTS PRESENT AT**  
**FORT McCLELLAN, ALABAMA**



DATE: 3 Dec 1990  
HCSDS NO: 20058A

U.S. ARMY CHEMICAL  
RESEARCH, DEVELOPMENT  
AND ENGINEERING CENTER

Emergency Telephone #s:  
CRDEC Safety Office  
301-671-4411 0700-1700  
EST After normal duty  
hours: 301-278-5201  
Ask for CRDEC Staff  
Duty Officer

HD, AND THD (See Addendum A)

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND  
CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING  
CENTER  
ATTN: SMCCR-CMS-E  
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: 505-60-2, 39472-40-7, 68157-62-0

CHEMICAL NAME AND SYNONYMS:

Sulfide, bis (2-chloroethyl)  
Bis(beta-chloroethyl)sulfide  
Bis(2-chloroethyl)sulfide  
1-chloro-2(beta-chloroethylthio)ethane  
beta, beta'-dichlorodiethyl sulfide  
2,2'-dichlorodiethyl sulfide  
Di-2-chloroethyl sulfide  
beta, beta'-dichloroethyl sulfide  
2,2'-dichloroethyl sulfide

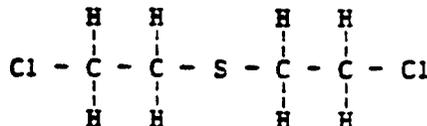
TRADE NAME AND SYNONYMS:

HD	Senfgas	H
Sulfur mustard	S-lost	HS
Iprit	Sulphur mustard gas	
Kampstoff "Lost"	S-yperite	
Lost	Yellow Cross Liquid	
Mustard Gas	Yperite	

CHEMICAL FAMILY: chlorinated sulfur compound

FORMULA/CHEMICAL STRUCTURE:

C4(H8)Cl2(S)



NFPA 704 SIGNAL: Health - 4  
Flammability - 1  
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
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Sulfur Mustard

C4(H8)Cl2(S)

100

0.003 mg/m3 (8 hr-TWA)

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### SECTION III - PHYSICAL DATA

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BOILING POINT DEG F (DEG C): 422 DEG F (217 DEG C)

VAPOR PRESSURE (mm Hg): 0.072 mm Hg @ 20 DEG C (0.11 mm Hg @ 25 DEG C)

VAPOR DENSITY (AIR=1): 5.5

SOLUBILITY IN WATER: Negligible. Soluble in acetone, CH3(Cl), tetrachloroethane, ethylbenzoate, and ether.

SPECIFIC GRAVITY (H2O=1): 1.27 @ 20 DEG C

VOLATILITY: 610 mg/m3 @ 20 DEG C  
920 mg/m3 @ 25 DEG C

APPEARANCE AND ODOR: Water clear if pure. Normally pale yellow to black. Slight garlic type odor. The odor threshold for HD is 0.0006 mg/m3

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### SECTION IV - FIRE AND EXPLOSION DATA

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FLASHPOINT (METHOD USED): 105 DEG C (ignited by large explosive charges)

FLAMMABILITY LIMITS (% by volume): Unknown

EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing methods that will splash or spread mustard.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HD should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece. NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

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### SECTION V - HEALTH HAZARD DATA

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AIRBORNE EXPOSURE LIMIT (AEL): The AEL for HD is 0.003 mg/m3 as proposed in the USAEHA Technical Guide No. 173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT". No individual should be intentionally exposed to any direct skin or eye contact.

EFFECTS OF OVEREXPOSURE: HD is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HD in the body is very slow and repeated exposures produce a cumulative effect. HD has been found to be a human carcinogen by the International Agency for Research on Cancer (IARC).

Median doses of HD in man are:

LD50 (skin) = 100 mg/kg

ICt50 (skin) = 2000 mg-min/m3 at 70 - 80 DEG F (humid environment)

= 1000 mg-min/m<sup>3</sup> at 90 DEG F (dry environment)  
ICt50 (eyes) = 200 mg-min/m<sup>3</sup>  
ICt50 (inhalation) = 1500 mg-min/m<sup>3</sup> (Ct unchanged with time)  
LD50 (oral) = 0.7 mg/kg

Maximum safe Ct for skin and eyes are 5 and 2 mg-min/m<sup>3</sup>, respectively.

ACUTE PHYSIOLOGICAL ACTION OF HD IS CLASSIFIED AS LOCAL AND SYSTEMIC.

LOCALLY, HD affects both the eyes and the skin. SKIN damage occurs after percutaneous resorption. Being lipid soluble, HD can be resorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4-24 hours following the exposure, depending on degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membrane and perspiration covered skin are more sensitive to the effects of HD. HD's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of eyes to HD vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.

SYSTEMIC ACTIONS occur primarily through inhalation and ingestion. The HD vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal dose of HD can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count and, therefore, results in increased susceptibility to local and systemic infections. Ingestion of HD will produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

CHRONIC EXPOSURE to HD can cause sensitization, chronic lung impairment, (cough, shortness of breath, chest pain), and cancer of the mouth, throat, respiratory tract, skin, and leukemia. It may also cause birth defects.

#### EMERGENCY AND FIRST AID PROCEDURES:

**INHALATION.** Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

**EYE CONTACT.** Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source. flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.

**SKIN CONTACT.** Don respiratory protective mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility. If the skin becomes contaminated with a thickened agent, blot/wipe the material off immediately with an absorbent pad/paper towel prior to using decontaminating solution.

**INGESTION.** Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

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#### SECTION VI - REACTIVITY DATA

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**STABILITY:** Stable at ambient temperatures. Decomposition temperature is 149 DEG C to 177 DEG C. Mustard is a persistent agent depending on pH and moisture, and has been known to remain active for up to three years in soil.

**INCOMPATIBILITY:** Conditions to avoid. Rapidly corrosive to brass @ 65 DEG

C. Will corrode steel at a rate of .0001 in. of steel per month @ 65 DEG C.

**HAZARDOUS DECOMPOSITION:** Mustard will hydrolyze to form HCl and thiodiglycol.

**HAZARDOUS POLYMERIZATION:** Will not occur.

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### SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

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**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:** Only personnel in full protective clothing (see Section 8) will be allowed in an area where mustard is spilled.

**RECOMMENDED FIELD PROCEDURES:**

The mustard should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of 5.25 percent Sodium Hypochlorite solution.

Scoop up all material and place in an approved DOT container. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

If 5.25 percent Sodium Hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Calcium Hypochlorite, Decontamination Solution No. 2 (DS2), and Super Tropical Bleach Slurry (STB). **WARNING:** Pure, undiluted Calcium Hypochlorite (HTH) will burn on contact with liquid blister agent.

**RECOMMENDED LABORATORY PROCEDURES:**

A minimum of 65 grams of decon solution per gram of HD is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution shall be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 ml of the decontaminate in a test tube. Add several crystals of Potassium Iodine and swirl to dissolve. Add 3 ml of 50 wt percent Sulfuric Acid:water and swirl. **IMMEDIATE** iodine color indicates the presence of active chlorine. If negative, add additional 5.25 percent Sodium Hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution.

A 10 wt percent Calcium hypochlorite (HTH) mixture may be substituted for Sodium Hypochlorite. Use 65 grams of decon per gram of HD and continue the test as described for Sodium Hypochlorite.

Scoop up all material and place in approved DOT containers. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (see Section 8).

**NOTE:** Surfaces contaminated with HD and then rinse-decontaminated may evolve sufficient mustard vapor to produce a physiological response.

**WASTE DISPOSAL METHOD:** All decontaminated material should be collected,

contained and chemically decontaminated or thermally decomposed in an EPA approved incinerator, which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the procedures outlined above with the following exception:

---- HD on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

Open pit burning or burying of HD or items containing or contaminated with HD in any quantity is prohibited.

NOTE: Some states define decontaminated surety material as a RCRA hazardous waste.

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### SECTION VIII - SPECIAL PROTECTION INFORMATION

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#### RESPIRATORY PROTECTION:

Concentration  
mg/m<sup>3</sup>

Respiratory Protection/Ensemble Required

Less than or equal  
to 0.003 as an  
8-hr TWA

Protective mask not required provided that:

- (a) Continuous real-time monitoring (with alarm capability) is conducted in the work area at the 0.003 mg/m<sup>3</sup> level of detection.
- (b) M9, M17 or M40 mask is available and donned if ceiling concentrations exceed 0.003 mg/m<sup>3</sup>.
- (c) Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices.

If these conditions are not met then the following applies:

Full facepiece, chemical canister, air-purifying respirators. (The M9, M17, or M40 series or other certified equivalent masks are acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.)

Greater than  
0.003 as an  
8-hr TWA

The Demilitarization Protective Ensemble (DPE), 30 mil, may be used with prior approval from the AMC Field Safety Activity. Use time for the 30 mil DPE must be restricted to two hours or less.

NOTE: When 30 mil DPE is not available the M9 or M40 series mask with Level A protective ensemble including impregnated innerwear can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

## VENTILATION:

Local Exhaust. Mandatory. Must be filtered or scrubbed.

Special. Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in assessing the ability of the hood to contain agent HD.

Other. Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods.

PROTECTIVE GLOVES: MANDATORY. Butyl toxicological agent protective gloves (M3, M4, gloveset).

EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazard use goggles and face-shield.

OTHER PROTECTIVE EQUIPMENT: Full protective clothing will consist of the M3 butyl rubber suit with hood, M2A1 boots, M3 gloves, impregnated underwear, M9 series mask and coveralls (if desired), or the Demilitarization Protective Ensemble (DPE). For general lab work, gloves and lab coat shall be worn with M9 or M17 mask readily available.

In addition, when handling contaminated lab animals, a daily clean smock, foot covers, and head covers are required.

MONITORING: Available monitoring equipment for agent HD is the M8/M9 detector paper, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACAMS), CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), and the Miniature Chemical Agent Monitor (MINICAM).

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## SECTION IX - SPECIAL PRECAUTIONS

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### PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

During handling, the "buddy" (two-man) system will be used. Containers should be periodically inspected for leaks, either visually or using a detector kit, and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HD must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Each worker will wash their hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap before leaving at the end of the work day. No smoking, eating, or drinking is permitted at the work site. Decontaminating equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HD should be stored in containers made of glass for Research, Development, Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

OTHER PRECAUTIONS: For additional information see AMC-R 385-131, "Safety Regulations for Chemical Agents H, HD, HT, GB and VX" and USAEHA Technical Guide No.173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT".

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## SECTION X - TRANSPORTATION DATA

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PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

DOT HAZARD CLASS: Poison A

DOT LABEL: Poison Gas

DOT MARKING: Poisonous liquid, n.o.s. (Sulfide, bis 2-chloroethyl)) NA 1955

DOT PLACARD: POISON GAS

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

While the Chemical Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

ADDENDUM A  
ADDITIONAL INFORMATION FOR THICKENED HD

TRADE NAME AND SYNONYMS: Thickened HD, THD

HAZARDOUS INGREDIENTS: K125 (acryloid copolymer, 5%) is used to thicken HD. K125 is not known to be hazardous except in a finely-divided, powder form.

PHYSICAL DATA: Essentially the same as HD except for viscosity. The viscosity of HV is between 1000 and 1200 centistokes @ 25 DEG C.

FIRE AND EXPLOSION DATA: Same as HD.

HEALTH HAZARD DATA: Same as HD except for skin contact. For skin contact, don respiratory protective mask and remove contaminated clothing IMMEDIATELY. IMMEDIATELY scrape the HV from the skin surface, then wash the contaminated surface with acetone. Seek medical attention IMMEDIATELY.

SPILL, LEAK, AND DISPOSAL PROCEDURES: If spills or leaks of HV occur, follow the same procedures as those for HD, but dissolve the THD in acetone prior to introducing any decontaminating solution. Containment of THD is generally not necessary. Spilled THD can be carefully scraped off the contaminated surface and placed in a fully removable head drum with a high density, polyethylene lining. The THD can then be decontaminated, after it has been dissolved in acetone, using the same procedures used for HD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as those used for HD.

NOTE: Surfaces contaminated with THD or HD and then rinse-decontaminated may evolve sufficient mustard vapor to produce a physiological response.

SPECIAL PROTECTION INFORMATION: Same as HD.

SPECIAL PRECAUTIONS: Same as HD with the following addition. Handling the THD requires careful observation of the "stringers" (elastic, thread-like attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a

working surface will result.

TRANSPORTATION DATA: Same as HD.

DATE: 3 Dec 1990



U.S. ARMY CHEMICAL  
RESEARCH, DEVELOPMENT  
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Emergency Telephone #s:  
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301-671-4411 0700-1700  
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hours: 301-278-5201  
Ask for CRDEC Staff  
Duty Officer

MATERIAL SAFETY DATA SHEET

LETHAL NERVE AGENT (GB)

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND  
Chemical Research, Development and Engineering  
Center  
ATTN: SMCCR-CMS-E  
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: 107-44-8 or 50642-23-4

CHEMICAL NAME AND SYNONYMS:

Phosphonofluoridic acid, methyl-, isopropyl ester  
Phosphonofluoridic acid, methyl-, 1-methylethyl ester

ALTERNATE CHEMICAL NAMES:

Isopropyl methylphosphonofluoridate  
Isopropyl ester of methylphosphonofluoridic acid  
Methylisopropoxfluorophosphine oxide  
Isopropyl Methylfluorophosphonate  
O-Isopropyl Methylisopropoxfluorophosphine oxide  
O-Isopropyl Methylphosphonofluoridate  
Methylfluorophosphonic acid, isopropyl ester  
Isopropoxymethylphosphonyl fluoride

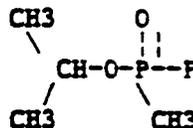
TRADE NAME AND SYNONYMS:

GB Sarin  
Zarin

CHEMICAL FAMILY: Fluorinated organophosphorous compound

FORMULA/CHEMICAL STRUCTURE:

C4 H10 FO2 P



NFPA 704 SIGNAL: Health - 4  
Flammability- 1  
Reactivity- 1



SECTION II - COMPOSITION

INGREDIENTS	FORMULA	PERCENTAGE	AIRBORNE
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NAME	BY WEIGHT	EXPOSURE LIMIT (AEL)
GB	C4 H10 FO2 P 100	.0001 mg/m3

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### SECTION III - PHYSICAL DATA

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BOILING POINT DEG F (DEG C): 316 (158)

VAPOR PRESSURE (mm Hg): 2.9 @ 25 DEG C

VAPOR DENSITY (AIR=1): 4.86

SOLUBILITY IN WATER: Complete

SPECIFIC GRAVITY (H2O=1): 1.0887 @ 25 DEG C

APPEARANCE AND ODOR: Colorless liquid  
Odorless in pure form

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### SECTION IV - FIRE AND EXPLOSION DATA

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FLASH POINT (METHOD USED): Did not flash to 280 DEG F

FLAMMABLE LIMIT: Not applicable

LOWER EMPLOSIVE LIMIT: Not available

UPPER EXPLOSIVE LIMIT: Not available

EXTINGUISHING MEDIA: Water mist, fog, foam, CO2 - Avoid using extinguishing methods that will cause splashing or spreading of the GB.

SPECIAL FIRE FIGHTING PROCEDURES: GB will react with steam or water to produce toxic & corrosive vapors. All persons not engaged in extinguishing the fire should be evacuated. Fires involving GB should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

UNUSUAL FIRE AND EXPLOSION HAZARDS: Hydrogen may be present.

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### SECTION V - HEALTH HAZARD DATA

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AIRBORNE EXPOSURE LIMIT (AEL): The suggested permissible airborne exposure concentration for GB for an 8-hour workday or a 40 hour work week is an 8-hour time weight average (TWA) of 0.0001 mg/m3 (2X10<sup>-5</sup> ppm). This value is based on the TWA of GB as proposed in the USAEHA Technical Guide No. 169, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX". To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated permissible exposure concentration for GB.

#### EFFECTS OF OVEREXPOSURE:

It is a lethal anticholinergic agent with median dose in man being:

LD50 (Skin) = 24 mg/kg

ICT50 (Skin) = 8000 mg-min/m3

LCt50 (inhalation) = 70 mg-min/m<sup>3</sup> (t=0.5-2 min) (inhalation)

\*a. One to several minutes after overexposure to airborne GB, the following acute symptoms appear:

(1) Local effects (lasting 1-15 days, increases with dose):

a. On eyes: Miosis (constriction of pupils); redness, pressure and heaviness in and behind the eyes.

b. By inhalation: Rhinorrhea (runny nose), nasal congestion, tightness in chest, wheezing, salivation, nausea, vomiting.

(2) Systemic effects (increases with dose): By inhalation - excessive secretion causing coughing/breathing difficulty; salivation and sweating; vomiting, diarrhea; stomach cramps; involuntary urination/defecation; generalized muscle twitching/muscle cramps; CNS depression including anxiety; restlessness, giddiness, insomnia, excessive dreaming and nightmares. With more severe exposure, also headache, tremor, drowsiness, concentration difficulty, memory impairment, confusion, unsteadiness on standing or walking.

b. After overexposure to liquid GB, the following acute symptoms appear:

(1) Local Effects:

a. On eyes; Miosis, redness, pressure sensation on eyes.

b. By ingestion: Salivation, anorexia, nausea, vomiting, abdominal cramps, diarrhea, involuntary defecation, heartburn.

c. On skin: Sweating, muscle twitching.

(2) Systemic Effects: Similar to generalized effects from exposure to airborne GB.

c. Chronic overexposure to GB causes forgetfulness, thinking difficulty, vision disturbances, muscular aches/pains. Although certain organophosphate pesticides have been shown to be teratogenic in animals, these effects have not been documented in carefully controlled toxicological evaluations for GB.

GB is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

\*\* See addendum A for detailed information. \*\*

#### \*EMERGENCY AND FIRST AID PROCEDURES:

**INHALATION:** Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

**EYE CONTACT:** Immediately flush eyes with water for 10-15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to the medical treatment facility for observation.

**SKIN CONTACT:** Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminant. Administer an intramuscular injection with the MARK I kit injectors only if local sweating and muscular twitching symptoms are observed. **SEEK MEDICAL ATTENTION IMMEDIATELY.**

**INGESTION:** Do not induce vomiting. First symptoms are likely to be gastrointestinal. Immediately administer an intramuscular injection of the MARK I kit auto-injectors. **SEEK MEDICAL ATTENTION IMMEDIATELY.**

\*\* See addendum B for detailed instructions. \*\*

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## SECTION VI - REACTIVITY DATA

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**STABILITY:** Stable when pure.

**INCOMPATIBILITY:** Attacks tin, magnesium, cadmium plated steel, some aluminums. Slight attack on copper, brass, lead, practically no attack on 1020 steel, Inconel & K-monel.

Hydrolyzes to form HF under acid conditions and isopropyl alcohol & polymers under basic conditions.

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## SECTION VII - SPILL, LEAK AND DISPOSAL PROCEDURES

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**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:** If leak or spills occur, only personnel in full protective clothing (see section 8 ) will remain in area. In case of personnel contamination see section V "Emergency and First Aid Instructions".

**RECOMMENDED FIELD PROCEDURES:** Spills must be contained by covering with vermiculite, diatomaceous earth clay, fine sand, sponges, and paper or cloth towels. Decontaminate with copious amounts of aqueous Sodium Hydroxide solution (a minimum 10 wt percent). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

If 10 wt percent aqueous Sodium Hydroxide solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontamination Solution No. 2 (DS2), Sodium Carbonate, and Suptropical Bleach Slurry (STB).

**RECOMMENDED LABORATORY PROCEDURES:** A minimum of 56 grams of decon solution is required for each gram of GB. Decontaminant/agent solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour. At the end of the one hour, the resulting solution should be adjusted to a pH greater than 11.5. If the pH is below 11.5, NaOH should be added until a pH above 11.5 can be maintained for 60 minutes.

An alternate solution for the decontamination of GB is 10 wt percent Sodium Carbonate in place of the 10 percent Sodium Hydroxide solution above. Continue with 56 grams of decon to 1 gram of agent. Agitate for one hour but allow three (3) hours for the reaction. The final pH should be adjusted to above 10. It is also permitted to substitute 5.25% Sodium Hypochlorite or 25 wt percent Monoethylamine (MEA) for the 10% Sodium Hydroxide solution above. MEA must be completely dissolved in water prior to addition of the agent. Continue with 56 grams of decon for each gram of GB and provide

agitation for one hour. Continue with same ratios and time stipulations.

Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

**WASTE DISPOSAL METHOD:** Open pit burning or burying of GB or items containing or contaminated with GB in any quantity is prohibited. The detoxified GB using procedures above) can be thermally destroyed by incineration in an EPA approved incinerator in accordance with appropriate provisions of Federal, state and local RCRA regulations.

**NOTE:** Some states define decontaminated surety material as a RCRA Hazardous waste.

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### SECTION VIII - SPECIAL PROTECTION INFORMATION

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#### RESPIRATORY PROTECTION:

##### Concentration

##### Respiratory Protective Equipment

< .0001 mg/m<sup>3</sup>

M9, M17, or M40 series mask shall be available this purpose.

.0001 to 0.2 mg/m<sup>3</sup>

M9, or M40 series mask with Level A or Level B ensemble (see AMCR 385-131 for determination of appropriate level).

Demilitarization Protective Ensemble (DPE), or Toxicological Agent Protective Ensemble Self-Contained (TAPES), used with prior approval from AMC Field Safety Activity.

> 0.2 mg/m<sup>3</sup>  
or unknown

DPE or TAPES used with prior approval from AMC Field Safety Activity.

**NOTE:** When DPE or TAPES is not available the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

**VENTILATION: Local Exhaust:** Mandatory must be filtered or scrubbed to limit exit concentration to < .0001 mg/m<sup>3</sup> averaged over 8 hr/day indefinitely.

**SPECIAL:** Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20 percent of the inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in the assessment of the hood's ability to contain agent GB. Emergency backup power necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hood face.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection is allowed between agent areas and other areas through ventilation system.

**PROTECTIVE GLOVES:** Butyl Glove M3 and M4  
Norton, Chemical Protective Glove Set

**EYE PROTECTION:** Chemical goggles. For splash hazards use goggles and faceshield.

**OTHER PROTECTIVE EQUIPMENT:** Full protective clothing will consist of the M3 Butyl rubber suit with hood, M2A1 boots, M3 gloves, coveralls, fatigues, or similar (with drawers and undershirt) and socks, M9 mask or the Demilitarization Protective Ensemble (DPE). For general lab work, gloves and lab coat shall be worn with M9 or M17 mask readily available.

**MONITORING:** Available monitoring equipment for agent GB is the M8/M9 Detector paper, detector ticket, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAAMS), Automatic Continuous Air Monitoring System (ACAMS), real time monitoring (RTM), Demilitarization Chemical Agent Concentrator (DCAC), M8/M43, M8A1/M43A2, Hydrogen Flame Photometric Emission Detector (HYFED), CAM-M1, and Miniature Chemical Agent Monitor (MINICAM).

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### SECTION IX - SPECIAL PRECAUTIONS

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#### PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

In handling, the buddy system will be incorporated. No smoking, eating and drinking in areas containing agent is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equip shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eye-wash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the work day.

**OTHER PRECAUTIONS:** Agents must be double contained in liquid and vapor tight containers when in storage or when outside of ventilation hood.

For additional information see "AMC-R 385-131, Safety Regulations for Chemical Agents H, HD, HT, GB, and VX" and "USA-EHA Technical Guide No. 169, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX".

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### SECTION X - TRANSPORTATION DATA

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**PROPER SHIPPING NAME:** Poisonous liquid, n.o.s.

**DOT HAZARD CLASSIFICATION:** Poison A

**DOT LABEL:** Poison Gas

**DOT MARKING:** Poisonous liquid, n.o.s. (Isopropyl methylphosphonofluoridate)  
NA1955

**DOT PLACARD:** POISON GAS

**PRECAUTIONS TO BE TAKEN IN TRANSPORTATION:** Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency.

AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

**EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES:** See sections IV, VII, and

VIII.

While the Chemical Research, Development and Engineering Center, Dept. of the Army believes that the data contained herein are factual and the opinion expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research, Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

ADDENDUM A

1. Acute Physiological Effects:

Site of Action	Signs and Symptoms Following Local Exposure
Muscarine-like-	
Pupils	Miosis, marked, usually maximal (pinpoint), sometimes unequal.
Ciliary body	Frontal headache, eye pain on focusing, slight dimness of vision, occasional nausea and vomiting.
Conjunctivae	Hyperemia.
Nasal mucous membranes	Rhinorrhea, hyperemia.
Bronchial tree	Tightness in chest, sometimes with prolonged wheezing expiration suggestive of broncho-constriction or increased secretion, cough.
	Following Systemic Absorption
Bronchial tree	Tightness in chest, with prolonged wheezing, expiration suggestive broncho-constriction or increased secretion, dyspnea, slight pain in chest, increase bronchial secretion, cough, pulmonary edema, cyanosis.
Gastrointestinal	Anorexia, nausea, vomiting, abdominal cramps, epigastric and substernal tightness (cardiospasm) with "heart-burn" and eructation, diarrhea, tenesmus, involuntary defecation.
Sweat glands	Increased sweating.
Salivary glands	Increased salivation.
Lacrimal glands	Increased lacrimation.
Heart	Slight bradycardia.
Pupils	Slight miosis, occasionally unequal, later maximal miosis (pinpoint).

Ciliary body	Blurring of vision.
Bladder	Frequency, involuntary micturition
Nicotine-like-	
Striated muscle	Easy fatigue, mild weakness, muscular twitching, fasciculations, cramps, generalized weakness, including muscles of respiration, with dyspnea and cyanosis.
Sympathetic ganglia	Pallor, occasional elevation of blood pressure.
Central nervous system	Giddiness, tension, anxiety, jitteriness, restlessness, emotional lability, excessive dreaming, insomnia, nightmares, headaches, tremor, withdrawal and depression, bursts of slow waves of elevated voltage in EEG, especially on over-ventilation, drowsiness, difficult concentration, slowness on recall, confusion, slurred speech, ataxia, generalized weakness, coma, with absence of reflexes, Cheyne-Stokes respirations, convulsions, depression of respiratory and circulatory centers, with dyspnea cyanosis, and fall in blood pressure.

## 2. Chronic Physiological Effects:

### a. Acute Exposure.

If recovery from nerve agent poisoning occurs, it will be complete unless anoxia or convulsions have gone unchecked so long that irreversible central nervous system changes due to anoxemia have occurred.

### b. Chronic Exposure.

The inhibition of cholinesterase enzymes throughout the body by nerve agents is more or less irreversible so that their effects are prolonged. Until the tissue cholinesterase enzymes are restored to normal activity, probably by very slow regeneration over a period of weeks or 2 to 3 months if damage is severe, there is a period of increased susceptibility to the effects of another exposure to any nerve agent. During this period the effects of repeated exposures are cumulative; after a single exposure, daily exposure to concentrations of a nerve agent insufficient to produce symptoms may result in the onset of symptoms after several days. Continued daily exposure may be followed by increasingly severe effects. After symptoms subside, increased susceptibility persists for one to several days. The degree of exposure required to produce recurrence of symptoms, and the severity of these symptoms, depend on duration of exposure and time intervals between exposures. Increased susceptibility is not limited to the particular nerve agent initially absorbed.

Estimates have been made for the times at which 50% of exposed subjects would be affected (Et50's) at median incapacitating doses. These are presented below.

Et50	Degree of Effectiveness	ICt50	Exposure Time
min		mg min/m <sup>3</sup>	min

1.5	Moderate	27	0.5
3.0	Incap.	27	2.0
6.0		40	10.0
1.0	Severe	37	0.5
3.8	Incap.	37	2.0
7.8		56	10.0
2.0	Very	47	0.5
4.5	Severe	47	2.0
9.5	Incap.	72	10.0
6.5	Death	70	0.5
9.0		70	2.0
13.5		103	10.0

Exposure to high concentrations of nerve agent may bring on incoordination, mental confusion and collapse so rapidly that the casualty cannot perform self-aid. If this happens, the man nearest to him will give first aid.

#### Onset Time of Symptoms.

Types of Effects	Route of Absorption	Description of Effects	When Effects Appear After Exposure
Vapor Local	Lungs	Rhinorrhea, nasal hyperemia tightness in chest, wheezing	One to several minutes
Vapor Local	Eyes	Miosis, Conjunctival hyperemia eye pain, frontal headache.	One to several minutes
Vapor Systemic	Lungs or eyes	Muscarine-like, nicotine-like and central nervous system effects. (See 2a above)	Less than 1 min to a few min after moderate or marked exposure; about 30 min after mild exposure.
Liquid Local	Eyes	Same as vapor effects.	Instantly
Liquid Local	Ingestion	Gastrointestinal. (See 2a above).	About 30 min. after ingestion.
Liquid Local	Skin	Local sweating and muscular twitching.	3 min to 2 hours
Liquid Systemic	Lungs	See 2a above.	Several minutes
Liquid Systemic	Eyes	Same as for vapor	Several minutes
Liquid Systemic	Skin	Generalized sweating.	15 minutes to 2 hours
Liquid Systemic	Ingestion	Gastrointestinal (See 2a above).	15 minutes to 2 hours

Onset Time of Symptoms. (cont'd)

Types of Effects	Route of Absorption	Duration of Mild Exposure	Effects After Severe Exposure
Vapor Local	Lungs	A few hours	1 to 2 days
Vapor Local	Eyes	Miosis -- 24 hours	3 to 14 days 2 to 5 days
Vapor Systemic	Lungs or eyes	Several hours	8 days
Liquid Local	Eyes	Similar to effects of vapor	
Liquid Local	Ingestion	3 days	5 days
Liquid Local	Skin	3 days	5 days
Liquid Systemic	Lungs		1 to 5 days
Liquid Systemic	Eyes		2 to 4 days
Liquid Systemic	Skin		2 to 5 days
Liquid Systemic	Ingestion		3 to 5 days

ADDENDUM B

First aid procedures.

a. Exposed personnel will be removed immediately to an uncontaminated atmosphere. Personnel handling casualty cases will give consideration to their own safety and will take precautions and employ the prerequisite protective equipment to avoid becoming exposed themselves.

CAUTION: Due to the rapid effects of nerve agents, it is extremely important that decontamination of personnel not be delayed by attempting to blot off excessive agent prior to decontamination with sodium hypochlorite.

b. The casualty will then be decontaminated by washing the contaminated areas with commercial liquid household bleach (nominal 5% solution hypochlorite or 10 percent sodium carbonate solution) and flushing with clean water to remove excess bleach followed by copious soap and water wash. Mask will be left on the victim until decontamination has been completed unless it has been determined that areas of the face were contaminated and the mask must be removed to facilitate decontamination. After decontamination, the contaminated clothing will be removed and skin contamination washed away. If possible, decontamination will be completed before the casualty is taken to the aid station or medical facility.

CAUTION: Care must be taken when decontaminating facial areas to avoid getting the hypochlorite into the eye or mouth. Only clean water shall be

used when flushing the eyes or mouth. Skin surfaces decontaminated with bleach should be thoroughly flushed with water to prevent skin irritation from the bleach.

c. If there is no apparent breathing, artificial resuscitation will be started immediately (mouth-to-mouth, or with mechanical resuscitator). The situation will dictate method of choice, e.g., contaminated face. Do not use mouth-to-mouth resuscitation when facial contamination exists. When appropriate and when trained personnel are available, cardiopulmonary resuscitation (CPR) may be necessary.

d. An individual who has received a known agent exposure or who exhibits definite signs or symptoms of agent exposure shall be given an intramuscular injection immediately with the MARK I kit auto-injectors.

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

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

(3) Although myosis (pin-pointing of the pupils) may be an early sign of agent exposure, an injection shall not be administered when myosis is the only sign present. Instead, the individual shall be taken immediately to the medical facility for observation.

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

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

e. If indicated, CPR should be started immediately. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists.

CAUTION: Atropine does not act as a prophylactic and shall not be administered until an agent exposure has been ascertained.



DATE: 3 Dec 1990

U.S. ARMY CHEMICAL RESEARCH, DEVELOPMENT AND ENGINEERING CENTER MATERIAL SAFETY DATA SHEET

Emergency Telephone #s: CRDEC Safety Office 301-671-4411 0700-1700 EST After normal duty hours: 301-278-5201 Ask for CRDEC Staff Duty Officer

LETHAL NERVE AGENT (VX)

SECTION I - GENERAL INFORMATION

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING CENTER ATTN: SMCCR-CMS-E ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: 50782-69-9, 51848-47-6, 53800-40-1, 70938-84-0

CHEMICAL NAME: Phosphonothioic acid, methyl-, S-(2-bis(1-methylethylamino)ethyl) O-ethyl ester O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate S-2-Diisopropylaminoethyl O-ethyl methylphosphonothioate S-2(2-Diisopropylamino)ethyl O-ethyl methylphosphonothiolate O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate O-ethyl S-(2-diisopropylaminoethyl) methylthiolphosphonate

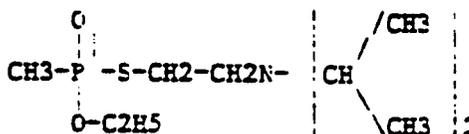
TRADE NAME AND SYNONYMS:

VX EA 1701 TX60

CHEMICAL FAMILY: sulfinated organophosphorus compound

FORMULA/CHEMICAL STRUCTURE:

C11 H26 N O2 P S



NFPA 704 SIGNAL: Health - 4 Flammability - 1 Reactivity - 1



SECTION II - COMPOSITION

Table with 4 columns: INGREDIENTS NAME, FORMULA, PERCENTAGE BY WEIGHT, AIRBORNE EXPOSURE LIMIT. Row 1: VX, C11H26NO2PS, 100%, .00001 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): 568 (298)

VAPOR PRESSURE (mm Hg): 0.0007 @ 25 Deg C

VAPOR DENSITY (AIR=1): 9.2

SOLUBILITY IN WATER: moderate

APPEARANCE AND ODOR: Colorless to straw colored liquid & odorless, similar in appearance to motor oil.

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#### SECTION IV - FIRE AND EXPLOSION DATA

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FLASHPOINT: 159 Deg C (McCutchan - Young)

FLAMMABILITY LIMITS (% by volume): Not Available

LOWER EXPLOSIVE LIMIT: Not Applicable

UPPER EXPLOSIVE LIMIT: Not Applicable

EXTINGUISHING MEDIA: Water mist, fog, foam, CO<sub>2</sub>. Avoid using extinguishing methods that will cause splashing or spreading of the VX.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving VX should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief of chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

Do not breathe fumes. Skin contact with V-agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminated other areas or sewers. Contact with VX or VX vapors can be fatal.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None known.

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#### SECTION V - HEALTH HAZARD DATA

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##### RECOMMENDED EXPOSURE LIMIT (REL):

The suggested permissible airborne exposure concentration for VX for an 8-hour workday of a 40-hour work week is an 8-hour time weighted average (TWA) of 0.00001 mg/m<sup>3</sup> (9X10<sup>-7</sup> ppm). This value is based on the TWA of VX as proposed in the USAEHA Technical Guide 169, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX". To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated permissible exposure concentration for VX.

VX is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

EFFECTS OF OVEREXPOSURE: VX is a lethal anticholinergic agent with median dose in man being: LD<sub>50</sub> (Skin) = 0.135 mg/kg; ID<sub>50</sub> (Skin) = 0.07 - 0.71 mg/kg; LC<sub>t50</sub> (inhalation) = 30 mg min/m<sup>3</sup>; LC<sub>t50</sub> (inhalation) = 24 mg min/m<sup>3</sup>.

a. One to several minutes after overexposure to airborne VX, the

following acute symptoms appear:

(1) Local effects (lasting 1-15 days, increases with dose):

(a) On Eyes: Miosis (constriction of pupils); redness, pressure sensation on eyes.

(b) By Inhalation: Rhinorrhea (runny nose), nasal congestion, tightness in chest, wheezing, salivation, nausea, vomiting.

(2) Systemic Effects (increases with dose): By Inhalation - excessive secretion causing coughing/breathing difficulty; salivation and sweating; vomiting, diarrhea; stomach cramps; involuntary urination/defecation; generalized muscle twitching/muscle cramps; CNS depression including anxiety, restlessness, giddiness, insomnia, excessive dreaming and nightmares. With more severe exposure, also headache, tremor, drowsiness, concentration difficulty, memory impairment, confusion, unsteadiness on standing or walking.

b. After overexposure to liquid VX, the following acute symptoms appear:

(1) Local Effects

(a) On Eyes: Miosis, redness, pressure sensation on eyes.

(b) By Ingestion: Salivation, anorexia, nausea, vomiting, abdominal cramps, diarrhea, involuntary defecation, heartburn.

(c) On Skin: sweating, muscle twitching.

(2) Systemic Effects: similar to generalized effects from exposure to airborne VX.

c. Chronic overexposure to VX causes forgetfulness, thinking difficulty, vision disturbances, muscular aches/pains. Although cer-organophosphate pesticides have been shown to be teratogenic in animals, these effects have not been documented in carefully controlled toxicological evaluations for VX.

\*\* See Addendum A for detailed information. \*\*

#### EMERGENCY AND FIRST AID PROCEDURES:

**INHALATION:** Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

**EYE CONTACT:** IMMEDIATELY flush eyes with water for 10-15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to the medical treatment facility for observation.

**SKIN CONTACT:** Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with a solution of 5% household bleach, rinse well with water to remove excess bleach followed by copious soap and water wash. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

**INGESTION:** Do not induce vomiting. First symptoms are likely to be gastrointestinal. **IMMEDIATELY** administer Nerve Agent Antidote Kit, Mark 1. Seek medical attention **IMMEDIATELY**.

**\*\* See Addendum B for detailed instructions. \*\***

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#### SECTION VI - REACTIVITY DATA

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**STABILITY:** Relatively stable at room temperature. Unstabilized VX of 95% purity decomposed at a rate of 5% a month at 71 Deg C.

**HAZARDOUS DECOMPOSITION PRODUCTS:** During basic hydrolysis of VX up to about 10% of the agent is converted to EA2192 (diisopropylaminoethyl methylphosphonothioic acid). Based on the concentration of EA2192 expected to be formed during hydrolysis and its toxicity (1.4 mg/kg dermal in rabbit at 24 hours in a 10/90 wt% ethanol/water solution), a Class B poison would result.

The large scale decon procedure, which uses both HTH and NaOH, destroys VX by oxidation and hydrolysis. Typically the large scale product contains 0.2 - 0.4 wt% EA2192 at 24 hours. At pH 12, the EA2192 in the large scale product has a half-life of about 14 days. Thus the 90 day holding period at pH 12 results in about a 64-fold reduction of EA2192 (six half-lives). This holding period has been shown to be sufficient to reduce the toxicity of the product below that of a Class B poison.

Other less toxic products are ethyl methylphosphonic acid, methylphosphinic acid, diisopropylaminoethyl mercaptan, diethyl methylphosphonate, and ethanol.

The small scale decontamination procedure uses sufficient HTH to oxidize all VX thus no EA2192 is formed.

**HAZARDOUS POLYMERIZATION:** Will not occur.

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#### SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

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**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:**  
If leaks or spills occur, only personnel in full protective clothing (See Section 8) will remain in area. In case of personnel contamination see Section V "Emergency and First Aid Instructions". Spills must be contained by covering with vermiculite, diatomaceous earth, clay or fine sand. This containment is followed by the following treatment:

**RECOMMENDED LABORATORY PROCEDURES (For Quantities less than 50 grams):**  
If the active chlorine of the Calcium Hypochlorite (HTH) is at least 55 percent, then 80 grams of a 10 percent slurry is required for each gram of VX. Proportionally more HTH is required if the chlorine activity of the HTH is lower than 55 percent. The mixture is agitated as the VX is added and the agitation is maintained for a minimum of one hour. If phasing of the VX/decon solution continues after 5 minutes, an amount of denatured ethanol equal to a 10 wt percent of the total agent/decon shall be added to assist miscibility. **NOTE: ETHANOL SHOULD BE MINIMIZED TO PREVENT THE FORMATION OF A HAZARDOUS WASTE.** Upon completion of the one hour agitation the decon mixture shall be adjusted to a pH between 10 and 11. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

**RECOMMENDED FIELD PROCEDURES (For Quantities greater than 50 grams):**  
(NOTE: These procedures can only be used with the approval of the CRDEC Safety Office.)

An alcoholic HTH mixture is prepared by adding 100 milliliters of denatured ethanol to a 900 milliliter slurry of 10 percent HTH in water. This mixture should be made just prior to use since the HTH can react with the ethanol. Fourteen grams of alcoholic HTH solution is used for each gram of VX. Agi-

tate the decontamination mixture as the VX is added. Continue the agitation for a minimum of one hour. This reaction is reasonable exothermic and evolves substantial off gassing. The evolved reaction gases should be routed through a decontaminate filled scrubber prior to release through filtration systems. After completion of the one hour minimum agitation, 10 percent Sodium Hydroxide is added in a quantity equal to that necessary to assure that a pH of 12.5 is maintained for a period not less than 24 hours. Hold the material at a pH between 10 and 12 for a period not less than 90 days to ensure that a hazardous intermediate material is not formed.

After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

If the alcoholic Calcium Hypochlorite (HTH) mixture is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontamination solution No. 2 (DS2), Supertropical Bleach Slurry (STB), and Sodium Hypochlorite.

**WASTE DISPOSAL METHOD:** Open pit burning or burying of VX or items containing or contaminated with VX in any quantity is prohibited. The detoxified VX (using procedures above) can be thermally destroyed by incineration in an EPA approved incinerator in accordance with appropriate provisions of Federal, State and/or local RCRA regulations.

**NOTE:** Some states define decontaminated surety material as a RCRA Hazardous Waste.

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## SECTION VIII - SPECIAL PROTECTION INFORMATION

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### RESPIRATORY PROTECTION:

#### VX CONCENTRATION

Less than 0.00001 mg/m<sup>3</sup>

0.00001 mg/m<sup>3</sup> to 0.02 mg/m<sup>3</sup>

Greater than 0.02 mg/m<sup>3</sup> or unknown

#### RESPIRATORY PROTECTIVE EQUIPMENT

M9, M17, or M40 series mask shall be available for escape as necessary.

M9 or M40 series mask with Level A or Level B protective ensemble (see AMCR 385-131 for determination of appropriate level).

Demilitarization Protective Ensemble (DPE) or Toxicological Agent Protective Ensemble Self-Contained (TAPES), used with prior approval from AMC Field Safety Activity.

DPE or TAPES used with prior approval from AMC Field Safety Activity.

**NOTE:** When DPE or TAPES is not available the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots to reduce aspiration.

**Local exhaust:** Must be filtered or scrubbed to limit exit conc. to .00001 mg/m<sup>3</sup>.

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) + 10 percent with the velocity at any point not deviating from the average face velocity by more than 20 percent. Laboratory hoods shall be located such that cross-drafts do not exceed 20 percent of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent VX.

Emergency backup power necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hood face.

Other: Recirculation or exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted.

PROTECTIVE GLOVES: Butyl glove M3 and M4  
Norton, Chemical Protective Glove Set

EYE PROTECTION: Chemical goggles. For splash hazards use goggles and face-  
shield.

OTHER PROTECTIVE EQUIPMENT: Full protective clothing will consist of M9 mask and hood, M3 butyl rubber suit, M2A1 butyl boots, M3 or M4 gloves, unimpregnated underwear; or demilitarization protective ensemble (DPE). For laboratory operations, wear lab coats, gloves and mask readily available.

In addition, daily clean smock, foot covers, and head covers will be required when handling contaminated lab animals.

MONITORING: Available monitoring equipment for agent HD is the M8/M9 detector paper, detector ticket, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACAMS), Real-Time Monitor (RTM), Demilitarization Chemical Agent Concentrator (DCAC), M8/M43, M8A1/M43A1, CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), and the Miniature Chemical Agent Monitor (MINICAM).

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#### SECTION IX - SPECIAL PRECAUTIONS

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##### PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

In handling, the buddy system will be incorporated. No smoking, eating, and drinking in areas containing agent is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eye-wash stations and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday.

OTHER PRECAUTIONS: -Agent must be double contained in liquid and vapor tight container when in storage or when outside of ventilation hood.

For additional information see AMC-R 385-131, "Safety Regulations for Chemical Agents H, HD, HT, GB and VX" and "USA-EHA Technical Guide No. 169, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX".

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#### SECTION X - TRANSPORTATION DATA

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PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

DOT HAZARD CLASS: Poison A

DOT LABEL: Poison gas

DOT MARKING: Poisonous liquid, n.o.s. (O-ethyl S-(2-diisopropylaminoethyl) methyl phosphonothioate) NA 1955

DOT PLACARD: POISON GAS

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded, regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR50-6 deals specifically with the shipment of chemical agents. Shipments of agent shall be escorted IAW AR740-32.

While the Chemical Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

#### ADDENDUM A

##### 1. Acute Physiological Effects:

Site of Action	Signs and Symptoms Following Local Exposure
Muscarine-like-	
Pupils	Miosis, marked, usually maximal (pinpoint), sometimes unequal.
Ciliary body	Frontal headache, eye pain on focusing, slight dimness of vision, occasional nausea and vomiting.
Conjunctivae	Hyperemia.
Nasal mucous membranes	Rhinorrhea, hyperemia.
Bronchial tree	Tightness in chest, sometimes with prolonged wheezing expiration suggestive of broncho-constriction or increased secretion, cough.
	Following Systemic Absorption
Bronchial tree	Tightness in chest, with prolonged wheezing, expiration suggestive of broncho-constriction or increased secretion, dyspnea, slight pain in chest, increased bronchial secretion, cough, pulmonary edema, cyanosis.

Gastrointestinal	Anorexia, nausea, vomiting, abdominal cramps, epigastric and substernal tightness (cardiospasm) with "heart-burn" and eructation, diarrhea, tenesmus, involuntary defecation.
Sweat glands	Increased sweating.
Salivary glands	Increased salivation.
Lacrimal glands	Increased lacrimation.
Heart	Slight bradycardia.
Pupils	Slight miosis, occasionally unequal, later maximal miosis (pinpoint).
Ciliary body	Blurring of vision.
Bladder	Frequent, involuntary micturition
Nicotine-like-	
Striated muscle	Easy fatigue, mild weakness, muscular twitching, fasciculations, cramps, generalized weakness, including muscles of respiration, with dyspnea and cyanosis.
Sympathetic ganglia	Pallor, occasional elevation of blood pressure.
Central nervous system	Giddiness, tension, anxiety, jitteriness, restlessness, emotional lability, excessive dreaming, insomnia, nightmares, headaches, tremor, withdrawal and depression, bursts of slow waves of elevated voltage in EEG, especially on over-ventilation, drowsiness, difficult concentration, slowness on recall, confusion, slurred speech, ataxia, generalized weakness, coma, with absence of reflexes, Cheyne-Stokes respirations, convulsions, depression of respiratory and circulatory centers, with dyspnea, cyanosis, and fall in blood pressure.

## 2.- Chronic Physiological Effects:

### a. Acute Exposure.

If recovery from nerve agent poisoning occurs, it will be complete unless anoxia or convulsions have gone unchecked so long that irreversible central nervous system changes due to anoxemia have occurred.

### b. Chronic Exposure.

The inhibition of cholinesterase enzymes throughout the body by nerve agents is more or less irreversible so that their effects are prolonged. Until the tissue cholinesterase enzymes are restored to normal activity, probably by very slow regeneration over a period of weeks or 2 to 3 months if damage is severe there is a period of increased susceptibility to the effects of another exposure to any nerve agent. During this period the effects of repeated exposures are cumulative; after a single exposure, daily exposure to concentrations of a nerve agent insufficient to produce symptoms may result in the onset of symptoms after several days. Continued daily exposure may be followed by increasingly severe effects. After symptoms subside, increased susceptibility persists for one to several days. The degree of exposure required to produce recurrence of symptoms, and the severity of these

symptoms, depend on duration of exposure and time intervals between exposures. Increased susceptibility is not limited to the particular nerve agent initially absorbed.

Estimates have been made for the times as which 50% of exposed subjects would be affected (Et50's) at median incapacitating doses. These are presented below.

Et50	Degree of Effectiveness	ICt50	Exposure Time
min		mg min/m <sup>3</sup>	min
1.5	Moderate	27	0.5
3.0	Incap.	27	2.0
6.0		40	10.0
1.0	Severe	37	0.5
3.8	Incap.	37	2.0
7.8		56	10.0
2.0	Very	47	0.5
4.5	Severe	47	2.0
9.5	Incap.	72	10.0
6.5	Death	70	0.5
9.0		70	2.0
13.5		103	10.0

Exposure to high concentrations of nerve agent may bring on incoordination, mental confusion and collapse so rapidly that the casualty cannot perform self-aid. If this happens, the man nearest to him will give first aid.

#### Onset Time of Symptoms.

Types of Effects	Route of Absorption	Description of Effects	When Effects Appear After Exposure
Vapor Local	Lungs	Rhinorrhea, nasal hyperemia tightness in chest, wheezing	One to several minutes
Vapor Local	Eyes	Miosis, Conjunctival hyperemia eye pain, frontal headache.	One to several minutes
Vapor Systemic	Lungs or eyes	Muscarine-like, nicotine-like and central nervous system effects. (See 2a above)	Less than 1 min to a few min after moderate or marked exposure; about 30 min after mild exposure.
Liquid Local	Eyes	Same as vapor effects.	Instantly
Liquid Local	Ingestion	Gastrointestinal. (See 2a above).	About 30 min. after ingestion.

Liquid Local	Skin	Local sweating and muscular twitching.	3 min to 2 hours
Liquid Systemic	Lungs	See 2a above.	Several minutes
Liquid Systemic	Eyes	Same as for vapor	Several minutes
Liquid Systemic	Skin	Generalized sweating.	15 minutes to 2 hours
Liquid Systemic	Ingestion	Gastrointestinal (See 2a above).	15 minutes to 2 hours

Onset Time of Symptoms. (cont'd)

Types of Effects	Route of Absorption	Duration of Effects After	
		Mild Exposure	Severe Exposure
Vapor Local	Lungs	A few hours	1 to 2 days
Vapor Local	Eyes	Miosis - 24 hours	3 to 14 days 2 to 5 days
Vapor Systemic	Lungs or eyes	Several hours	8 days
Liquid Local	Eyes	Similar to effects of vapor	
Liquid Local	Ingestion	3 days	5 days
Liquid Local	Skin	3 days	5 days
Liquid Systemic	Lungs		1 to 5 days
Liquid Systemic	Eyes		2 to 4 days
Liquid Systemic	Skin		2 to 5 days
Liquid Systemic	Ingestion		3 to 5 days

ADDENDUM B

First Aid Procedures.

a. Exposed personnel will be removed immediately to an uncontaminated atmosphere. Personnel handling casualty cases will give consideration to their own safety and will take precautions and employ the prerequisite protective equipment to avoid becoming exposed themselves.

CAUTION: Due to the rapid effects of nerve agents, it is extremely important that decontamination of personnel not be delayed by attempting to blot off excessive agent prior to decontamination.

b. The casualty will then be decontaminated by immediately removing any contaminated clothing and washing the contaminated areas with copious amounts of soap and water, 5% sodium hypochlorite solution, or liquid household bleach (nominal 5% solution sodium hypochlorite) and flushing with clean water. Mask will be left on the victim until decontamination has been completed unless it has been determined that areas of the face were contaminated and the mask must be removed to facilitate decontamination. After decontamination, the contaminated clothing will be removed and skin contamination washed away. If possible, decontamination will be completed before the casualty is taken to the aid station or medical facility.

**CAUTION:** Care must be taken when decontaminating facial areas to avoid getting the hypochlorite into the eyes or mouth. Only clean water shall be used when flushing the eyes or mouth. Skin surfaces decontaminated with bleach should be thoroughly flushed with water to prevent skin irritation from the bleach.

c. If there is no apparent breathing, artificial resuscitation will be started immediately (mouth-to-mouth, or with mechanical resuscitator). The situation will dictate method of choice, e.g., contaminated face. Do not use mouth-to-mouth resuscitation when facial contamination exists. When appropriate, and when trained personnel are available, cardio-pulmonary resuscitation (CPR) may be necessary.

d. An individual who has received a known agent exposure or who exhibits definite signs or symptoms of agent exposure shall be injected immediately with the Nerve Agent Antidote Kit, MARK I.

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

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

(3) Although myosis (pin-pointing of the pupils) may be an early sign of agent exposure, a MARK I Kit shall not be administered when myosis is the only sign present. Instead, the individual shall be taken immediately to the medical facility for observation.

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

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

**CAUTION:** The Nerve Agent Antidote Kit, MARK I does not act as a prophylactic and shall not be administered until an agent exposure has been ascertained.

e. If indicated, CPR should be started immediately. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists.

# MATERIAL SAFETY DATA SHEET

US-264

IDENTITY: Isopropylmethyl phosphonic acid  
CAS NUMBER: 1832-54-8

## SECTION I

Manufacturer: Radian Corporation  
8501 North Mopac Blvd.  
P.O. Box 201088  
Austin, TX 78720-1088

Emergency Telephone Number: (512) 454-4797

Date Prepared: January 8, 1993

## SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components	OSHA PEL	ACGIH TLV	Other Limits	Z
Isopropylmethyl phosphonic acid	N/A	N/A	---	100

## SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point(degrees C):	102-104 @ 0.1 mmHg	Specific Gravity (Water=1):	1.10
Vapor Pressure (mmHg):	N/A	Melting Point(degrees C):	N/A
Vapor Density (Air=1):	N/A	Evaporation Rate (Butyl Acetate=1):	N/A
Solubility in Water:	N/A		
Appearance and Odor:	Oil		

## SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point:	N/A	Flammable Limits	
Method Used:	N/A	LEL:	N/A
		UFL:	N/A
Extinguishing Media:	Dry chemical, carbon dioxide or Halon extinguisher.		
Special Fire Fighting Procedures:	N/A		
Unusual Fire and Explosion Hazards:	N/A		

\*\*\*\*\*  
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OCCUPATIONAL HEALTH SERVICES, INC. EMERGENCY CONTACT: JOHN S. BRANSFORD, JR. (615) 292-1180  
450 SEVENTH AVENUE, SUITE 2407 NEW YORK, NEW YORK 10123  
(800) 445-HS05 (212) 967-1100

SUBSTANCE IDENTIFICATION

SUBSTANCE: PARA-CHLOROPHENYL METHYL SULFOXIDE CAS-NUMBER 934-73-6

TRADE NAMES/SYNONYMS:

BENZENE, 1-CHLORO-4-(METHYL SULFINYL)-; 1-CHLORO-4-(METHYL SULFINYL) BENZENE; SULFOXIDE, P-CHLOROPHENYL METHYL-; P-CHLOROPHENYL METHYL SULFOXIDE; METHYL-4-CHLOROPHENYL SULFOXIDE; C7H7ClOS; OHS04816

CHEMICAL FAMILY:

HALOGEN COMPOUND, AROMATIC

SULFOXIDE

MOLECULAR FORMULA: CL-C6-H4-S-(O)-C-H3

MOLECULAR WEIGHT: 174.65

OSHA RATINGS (SCALE 0-3): HEALTH=2 FIRE=1 REACTIVITY=0 PERSISTENCE=2

MSHA RATINGS (SCALE 0-4): HEALTH=0 FIRE=1 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: PARA-CHLOROPHENYL METHYL SULFOXIDE PERCENT: 100.0

OTHER CONTAMINANTS: NONE

EXPOSURE LIMITS:

NO OCCUPATIONAL EXPOSURE LIMITS ESTABLISHED BY OSHA, ACGIH, OR NIOSH.

PHYSICAL DATA

DESCRIPTION: SOLID. BOILING POINT: 288-291 F (142-144 C) @ 6 MMHG

MELTING POINT: 115-118 F (46-48 C) SPECIFIC GRAVITY: NOT AVAILABLE

SOLUBILITY IN WATER: NOT AVAILABLE

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD: SLIGHT FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

P-CHLOROPHENYL METHYL SULFOXIDE

FIRE FIGHTING MEDIA:  
DRY CHEMICAL, CARBON DIOXIDE, HALON, WATER SPRAY OR STANDARD FOAM  
(1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR STANDARD FOAM  
(1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FIRE FIGHTING:

MOVE CONTAINER FROM FIRE AREA IF POSSIBLE. DO NOT SCATTER SPILLED MATERIAL WITH HIGH PRESSURE WATER STREAMS. DIKE FIRE CONTROL WATER FOR LATER DISPOSAL  
(1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4, GUIDE PAGE 31).

USE AGENTS SUITABLE FOR TYPE OF SURROUNDING FIRE. AVOID BREATHING HAZARDOUS VAPORS, KEEP UPWIND.

TOXICITY

PARA-CHLOROPHENYL METHYL SULFOXIDE:

IRRITATION DATA: 500 MG/24 HOURS SKIN-RABBIT; 100 MG EYE-RABBIT SEVERE.  
TOXICITY DATA: 543 MG/KG ORAL-RAT LD50; 386 MG/KG ORAL-MOUSE LD50.  
CARCINOGEN STATUS: NONE.

LOCAL EFFECTS: CORROSIVE- EYE.

ACUTE TOXICITY LEVEL: MODERATELY TOXIC BY INGESTION.

TARGET EFFECTS: NO DATA AVAILABLE.

HEALTH EFFECTS AND FIRST AID

INHALATION:

PARA-CHLOROPHENYL METHYL SULFOXIDE:

ACUTE EXPOSURE- NO SPECIFIC DATA AVAILABLE. SOME AROMATIC HALOGENATED HYDROCARBONS MAY BE IRRITATING TO THE MUCOUS MEMBRANES.  
CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST.  
TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:

PARA-CHLOROPHENYL METHYL SULFOXIDE:

ACUTE EXPOSURE- MAY CAUSE MILD SKIN REACTIONS WITH EDEMA, SCALE FORMATION AND BROWNISH DISCOLORATION.  
CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:

PARA-CHLOROPHENYL METHYL SULFOXIDE:

CORROSIVE.

ACUTE EXPOSURE- MAY CAUSE INJURY TO THE IRIS AND CONJUNCTIVA AND IRREVERSIBLE CORNEAL LESIONS AND OPACITIES.

CHRONIC EXPOSURE- EFFECTS DEPEND ON CONCENTRATION AND DURATION OF EXPOSURE. REPEATED OR PROLONGED CONTACT WITH CORROSIVE SUBSTANCES MAY RESULT IN

P-CHLOROPHENYL METHYL SULFOXIDE

CONJUNCTIVITIS OR EFFECTS AS IN ACUTE EXPOSURE.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). CONTINUE IRRIGATING WITH NORMAL SALINE UNTIL THE PH HAS RETURNED TO NORMAL (30-60 MINUTES). COVER WITH STERILE BANDAGES. GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:  
PARA-CHLOROPHENYL METHYL SULFOXIDE:  
ACUTE EXPOSURE- THE LETHAL DOSE IN RATS IS 543 MG/KG.  
CHRONIC EXPOSURE- REPEATED AND PROLONGED FEEDING STUDIES IN RATS AND MICE PRODUCED HEPATIC MEGALOCYTOSIS AND NECROSIS.

FIRST AID- TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. IF VOMITING OCCURS, KEEP HEAD LOWER THAN HIPS TO PREVENT ASPIRATION.

ANTIDOTE:  
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY

REACTIVITY:  
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:  
PARA-CHLOROPHENYL METHYL SULFOXIDE;  
OXIDIZERS (STRONG); FIRE AND EXPLOSION HAZARD.

DECOMPOSITION:  
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF SULFUR AND TOXIC AND CORROSIVE FUMES OF CHLORIDES.

POLYMERIZATION:  
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE AND DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. AVOID CONTACT WITH STRONG OXIDIZERS, EXCESSIVE HEAT, SPARKS, OR OPEN FLAME.

SPILL AND LEAK PROCEDURES

OCCUPATIONAL SPILL:  
SWEEP UP AND PLACE IN SUITABLE CLEAN, DRY CONTAINERS FOR RECLAMATION OR LATER DISPOSAL. DO NOT FLUSH WITH WATER. KEEP UNNECESSARY PEOPLE AWAY.

P-CHLOROPHENYL METHYL SULFOXIDE

PROTECTIVE EQUIPMENT

VENTILATION:  
PROVIDE LOCAL EXHAUST OR GENERAL DILUTION VENTILATION SYSTEM.

RESPIRATOR:

THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON THE CONTAMINATION LEVELS FOUND IN THE WORK PLACE. MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION.

THE FOLLOWING RESPIRATORS ARE RECOMMENDED BASED ON THE DATA FOUND IN THE PHYSICAL DATA, HEALTH EFFECTS AND TOXICITY SECTIONS. THEY ARE RANKED IN ORDER FROM MINIMUM TO MAXIMUM RESPIRATORY PROTECTION:

CHEMICAL CARTRIDGE RESPIRATOR WITH FULL FACEPIECE AND ORGANIC VAPOR CARTRIDGE(S) IN COMBINATION WITH A DUST AND MIST FILTER.

CHEMICAL CARTRIDGE RESPIRATOR WITH FULL FACEPIECE AND ORGANIC VAPOR CARTRIDGE(S) IN COMBINATION WITH A HIGH-EFFICIENCY PARTICULATE FILTER.

GAS MASK WITH ORGANIC VAPOR CANISTER (CHIM-STYLE OR FRONT- OR BACK-MOUNTED CANISTER) WITH A FULL FACEPIECE AND A HIGH-EFFICIENCY PARTICULATE FILTER.

POWERED AIR-PURIFYING RESPIRATOR WITH TIGHT-FITTING FACEPIECE AND ORGANIC VAPOR CARTRIDGE(S) IN COMBINATION WITH A HIGH-EFFICIENCY PARTICULATE FILTER.

TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINUOUS-FLOW MODE.

SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE DEMAND OR OTHER POSITIVE PRESSURE MODE.

SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:

EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:

EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

P-CHLOROPHENYL METHYL SULFOXIDE

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EMERGENCY WASH FACILITIES:  
WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES AND/OR SKIN MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN AND QUICK DRENCH SHOWER WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

**EMERGENCY WASH FACILITIES:**

WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES AND/OR SKIN MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN AND QUICK DRENCH SHOWER WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.  
CREATION DATE: 06/02/89 REVISION DATE: 06/02/89

P-CIOLOROPHENYL METHYL SULFOXIDE

**NOTICE**

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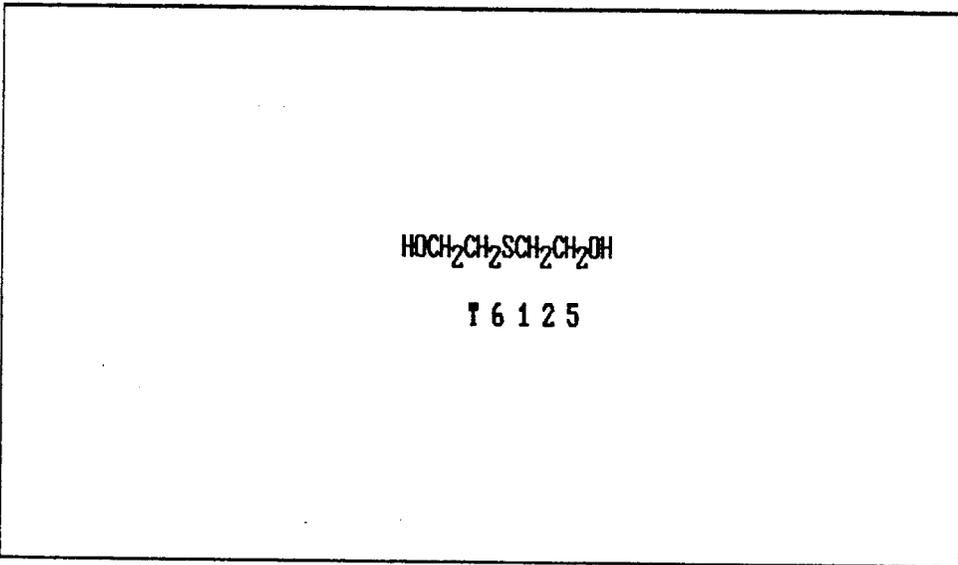
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MATERIAL SAFETY DATA SHEET

Sigma-Aldrich Corporation  
3001 West Saint Paul Ave, Milwaukee, WI 53233 USA

Valid 8/93-10/93

Emergency Contact USA/Canada	Sigma 800-325-5832	Aldrich 800-231-8327
Outside USA/Canada	314-771-5765	414-273-3850



----- IDENTIFICATION -----

PRODUCT #: T6125	NAME: THIODIGLYCOL
CAS #: 111-48-8	
MF: C4H10O2S1	

NONYMS

BIS(BETA-HYDROXYETHYL)SULFIDE \* BIS(2-HYDROXYETHYL)SULFIDE \* BETA,  
 BETA'-DIHYDROXYDIETHYL SULFIDE \* BETA,BETA'-DIHYDROXYETHYL SULFIDE \*  
 GLYCINE A \* BETA-HYDROXYETHYL SULFIDE \* KROMFAX SOLVENT \* SULFIDE,  
 BIS(2-HYDROXYETHYL) \* 2,2'-THIODIETHANOL \* THIODIETHYLENE GLYCOL \*  
 THIODIGLYCOL \* BETA-THIODIGLYCOL \*

----- TOXICITY HAZARDS -----

ECS NO: KM2975000	
ETHANOL, 2,2'-THIODI-	
IRITATION DATA	
SKN-RBT 500 MG OPEN MLD	UCDS** 11/3/71
EYE-RBT 500 MG MOD	AJOPAA 29,1363,46
TOXICITY DATA	
ORL-RAT LD50:6610 MG/KG	JIHTAB 23,259,41
SCU-RAT LD50:4 GM/KG	JPETAB 93,1,48
SCU-MUS LD50:4 GM/KG	JPETAB 93,1,48
IVN-RBT LD50:3 GM/KG	JPETAB 93,1,48
ORL-GPG LD50:3960 MG/KG	JIHTAB 23,259,41

VIEWS, STANDARDS, AND REGULATIONS

NOHS 1974: HZD 82023; NIS 6; TNF 167; NOS 13; TNE 5259

EPA TSCA CHEMICAL INVENTORY, JUNE 1990

ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS)  
DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.

----- HEALTH HAZARD DATA -----

ROUTE EFFECTS

MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION.  
VAPOR OR MIST IS IRRITATING TO THE EYES, MUCOUS MEMBRANES AND UPPER  
RESPIRATORY TRACT.

CAUSES SKIN IRRITATION.

EXPOSURE CAN CAUSE:

NAUSEA, HEADACHE AND VOMITING

TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND  
TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.

FIRST AID

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH COPIOUS AMOUNTS OF  
WATER FOR AT LEAST 15 MINUTES.

IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS  
AMOUNTS OF WATER.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL  
RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.  
CALL A PHYSICIAN.

REMOVE AND WASH CONTAMINATED CLOTHING PROMPTLY.

----- PHYSICAL DATA -----

BOILING PT: 164 C TO 166 C/20MM.

MELTING PT: -16 C

SPECIFIC GRAVITY: 1.221

APPEARANCE AND ODOR

COLORLESS TO PALE YELLOW LIQUID

----- FIRE AND EXPLOSION HAZARD DATA -----

FLASHPOINT: >230 BY:

EXTINGUISHING MEDIA

WATER SPRAY.

CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO  
PREVENT CONTACT WITH SKIN AND EYES.

USUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

----- REACTIVITY DATA -----

COMPATIBILITIES

ACID CHLORIDES

STRONG OXIDIZING AGENTS

ACID ANHYDRIDES

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:

CARBON MONOXIDE, CARBON DIOXIDE

SULFUR OXIDES

HYDROGEN SULFIDE GAS

----- SPILL OR LEAK PROCEDURES -----

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

EVACUATE AREA.

WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY  
RUBBER GLOVES.

COVER WITH DRY LIME OR SODA ASH, PICK UP, KEEP IN A CLOSED CONTAINER AND HOLD FOR WASTE DISPOSAL.

VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

WASTE DISPOSAL METHOD

DISSOLVE OR MIX THE MATERIAL WITH A COMBUSTIBLE SOLVENT AND BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.

OBSERVE ALL FEDERAL, STATE, AND LOCAL LAWS.

----- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE -----

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.

SAFETY SHOWER AND EYE BATH.

USE ONLY IN A CHEMICAL FUME HOOD.

DO NOT BREATHE VAPOR.

AVOID CONTACT WITH EYES, SKIN AND CLOTHING.

AVOID PROLONGED OR REPEATED EXPOSURE.

WASH THOROUGHLY AFTER HANDLING.

IRRITANT.

KEEP TIGHTLY CLOSED.

STENCH.

STORE IN A COOL DRY PLACE.

IRRITATING TO EYES, RESPIRATORY SYSTEM AND SKIN.

IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.

WEAR SUITABLE PROTECTIVE CLOTHING.

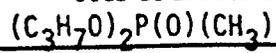
STENCH.

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**MATERIAL SAFETY DATA SHEET**



Alfa Products



PRODUCT NAME: Diisopropylmethylphosphonate (DIMP)

CAS# 1445-75-6

CHEMICAL NATURE: Organophosphonate

% ACTIVITY: 98%

**I. PHYSICAL DATA**

BOILING POINT, 10 mm. Hg	78-79°C	FREEZE POINT	No data
SPECIFIC GRAVITY	.9849g/cm <sup>3</sup>	VAPOR PRESSURE AT 20°C.	No data
VAPOR DENSITY	No data	SOLUBILITY IN H <sub>2</sub> O	No data
PER CENT VOLATILES BY WEIGHT	Not highly volatile	IONIC NATURE	No
APPEARANCE AND ODOR	Colorless liquid		

**II. HAZARDOUS INGREDIENTS**

MATERIAL	%	TLV (Units)
Diisopropylmethylphosphonate	98	Not established
orl-dck LD50:1490 mg/kg		
orl-mam LD50:503mg/kg		
orl-brd LD50:1000 mg/kg (NIOSH/RTECS 1981-82)		

**III. FIRE AND EXPLOSION HAZARD DATA**

FLASH POINT (test method)	No data	AUTOIGNITION TEMPERATURE	No data
FLAMMABLE LIMITS IN AIR, % by volume	No data	LOWER	UPPER
EXTINGUISHING MEDIA	Use water, carbon dioxide, dry chemical extinguishing agents, dry sand, or dry ground dolomite.		
SPECIAL FIRE FIGHTING PROCEDURES	Wear NIOSH/MSHA approved self-contained breathing apparatus. Flame and chemical resistant clothing; hats, boots and gloves. If without risk remove material from fire area. Cool containers with water from maximum distance.		
UNUSUAL FIRE AND EXPLOSION HAZARDS	Toxic fumes may be emitted if thermally decomposed.		

### IV. HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE	Not established
EFFECTS OF OVEREXPOSURE	No data
EMERGENCY AND FIRST AID PROCEDURES	Remove from exposure. Eyes: Flush with copious amounts of water for at least 15 minutes. Skin: Remove any contaminated clothing. Flush skin with large volumes of water for 15 minutes. Ingestion/ inhalation: Seek prompt, competent medical attention.

### V. REACTIVITY DATA

STABILITY		CONDITIONS TO AVOID	Thermal decomposition
UNSTABLE	STABLE		
	X		
INCOMPATIBILITY (materials to avoid)		Oxidizers, acids	
HAZARDOUS DECOMPOSITION PRODUCTS		P <sub>2</sub> O <sub>5</sub> , CO, CO <sub>2</sub>	
HAZARDOUS POLYMERIZATION		CONDITIONS TO AVOID	
May Occur	Will not Occur		
	X		

### VI. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Wearing full protective clothing and respiratory protection (see section VII), eliminate all sources of ignition. Cover spill with dry sand or dry vermiculite, mix well and carefully transfer to a well marked container. <del>Close tightly and submit or retain for disposal</del>
WASTE DISPOSAL METHOD	Consult state, local, and federal regulations for proper disposal of organophosphonates.

### VII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (specify type)	For ordinary use, wear a NIOSH/MSHA approved respirator with an organic vapor cartridge. Emergency, wear a self-contained breathing apparatus		
VENTILATION	Local Exhaust	Acceptable	SPECIAL
	Mechanical		OTHER
PROTECTIVE GLOVES	Rubber	EYE PROTECTION OSHA approved safety goggles	
OTHER PROTECTIVE EQUIPMENT	Lab coat and apron, flame & chemical resistant coveralls, eyewash capable of sustained flushing, safety drench shower and hygienic facilities for washing.		

### VIII. SPECIAL PRECAUTIONS

PRECAUTIONARY LABELING	None
OTHER HANDLING AND STORAGE CONDITIONS	Keep container tightly closed. Store in a cool, dry, well-ventilated area. Wash thoroughly after use.

PRODUCT #: D21770-0      NAME: 1,4-DITHIANE, 97%  
 MATERIAL SAFETY DATA SHEET, Valid 2/94 - 4/94  
 Printed Saturday, March 05, 1994 10:20AM

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 P.O. Box 14508  
 St. Louis, MO 63178  
 Phone: 314-771-5765

Aldrich Chemical Co.  
 1001 West St. Paul  
 Milwaukee, WI 53233  
 Phone: 414-273-3850

Fluka Chemical Corp.  
 980 South Second St.  
 Ronkonkoma, NY 11779  
 Phone: 516-467-3535

SECTION 1. - - - - - CHEMICAL IDENTIFICATION- - - - -

PRODUCT #: D21770-0      NAME: 1,4-DITHIANE, 97%

SECTION 2. - - - - - COMPOSITION/INFORMATION ON INGREDIENTS - - - - -

CAS #:505-29-3  
 MF: C4H8S2

SYNONYMS

DIETHYLENE DISULFIDE \* 1,4-DITHIACYCLOHEXANE \* 1,4-DITHIANE \*

SECTION 3. - - - - - HAZARDS IDENTIFICATION - - - - -

LABEL PRECAUTIONARY STATEMENTS

IRRITANT

IRRITATING TO EYES, RESPIRATORY SYSTEM AND SKIN.

STENCH.

KEEP TIGHTLY CLOSED.

IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF  
 WATER AND SEEK MEDICAL ADVICE.

WEAR SUITABLE GLOVES AND EYE/FACE PROTECTION.

SECTION 4. - - - - - FIRST-AID MEASURES- - - - -

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH COPIOUS AMOUNTS OF  
 WATER FOR AT LEAST 15 MINUTES.

IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS  
 AMOUNTS OF WATER.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL  
 RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.  
 CALL A PHYSICIAN.

REMOVE AND WASH CONTAMINATED CLOTHING PROMPTLY.

SECTION 5. - - - - - FIRE FIGHTING MEASURES - - - - -

EXTINGUISHING MEDIA

WATER SPRAY.

CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO  
 PREVENT CONTACT WITH SKIN AND EYES.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

SECTION 6. - - - - - ACCIDENTAL RELEASE MEASURES- - - - -

EVACUATE AREA.

WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY  
 RUBBER GLOVES.

SWEEP UP, PLACE IN A BAG AND HOLD FOR WASTE DISPOSAL.

AVOID RAISING DUST.

VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

SECTION 7. - - - - - HANDLING AND STORAGE- - - - -

REFER TO SECTION 8.

SECTION 8. - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION- - - - -  
WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT  
GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.  
USE ONLY IN A CHEMICAL FUME HOOD.  
SAFETY SHOWER AND EYE BATH.  
DO NOT BREATHE DUST.  
AVOID CONTACT WITH EYES, SKIN AND CLOTHING.  
AVOID PROLONGED OR REPEATED EXPOSURE.  
WASH THOROUGHLY AFTER HANDLING.  
IRRITANT.  
KEEP TIGHTLY CLOSED.  
STENCH.  
STORE IN A COOL DRY PLACE.

SECTION 9. - - - - - PHYSICAL AND CHEMICAL PROPERTIES - - - - -  
APPEARANCE AND ODOR  
WHITE TO OFF-WHITE CRYSTALS  
BOILING POINT: 200 C *176.1 REFINED*  
MELTING POINT: 110 C TO 112 C *88.61 REFINED*

*5400 mg/L Sol*  
*1P 1.51*  
*L = 2.53 x 10<sup>-5</sup>* *K<sub>oc</sub> = 10,96*

SECTION 10. - - - - - STABILITY AND REACTIVITY- - - - -  
INCOMPATIBILITIES  
STRONG OXIDIZING AGENTS  
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS  
TOXIC FUMES OF:  
CARBON MONOXIDE, CARBON DIOXIDE  
SULFUR OXIDES

SECTION 11. - - - - - TOXICOLOGICAL INFORMATION - - - - -  
ACUTE EFFECTS  
MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION.  
CAUSES EYE AND SKIN IRRITATION.  
MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER  
RESPIRATORY TRACT.  
EXPOSURE CAN CAUSE:  
NAUSEA, HEADACHE AND VOMITING  
TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND  
TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.

RTECS NO: JO5069000  
P-DITHIANE

TOXICITY DATA  
ORL-RAT LD50:2768 MG/KG  
ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES  
(RTECS) DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR  
COMPLETE INFORMATION.

NTIS\*\* AD-A172-647

SECTION 12. - - - - - ECOLOGICAL INFORMATION - - - - -  
DATA NOT YET AVAILABLE.

SECTION 13. - - - - - DISPOSAL CONSIDERATIONS - - - - -  
DISSOLVE OR MIX THE MATERIAL WITH A COMBUSTIBLE SOLVENT AND BURN IN A  
CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.  
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION 14. - - - - - TRANSPORT INFORMATION - - - - -  
CONTACT ALDRICH CHEMICAL COMPANY FOR TRANSPORTATION INFORMATION.

SECTION 15. - - - - - REGULATORY INFORMATION - - - - -

PRODUCT #: D21770-0      NAME: 1,4-DITHIANE, 97%  
MATERIAL SAFETY DATA SHEET, Valid 2/94 - 4/94  
Printed Saturday, March 05, 1994 10:20AM

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REVIEWS, STANDARDS, AND REGULATIONS

NOES 1983: HZD X4362; NIS 1; TNF 7; NOS 1; TNE 28

EPA TSCA CHEMICAL INVENTORY, JANUARY 1993

ON EPA IRIS DATABASE

EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, SEPTEMBER 1993

SECTION 16. - - - - - OTHER INFORMATION- - - - -

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO  
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PRODUCT #: 13197-0 NAME: 1,4-THIOXANE, 98%  
MATERIAL SAFETY DATA SHEET, Valid 2/94 - 4/94  
Printed Saturday, March 05, 1994 2:57PM

Sigma Chemical Co.  
P.O. Box 14508  
St. Louis, MO 63178  
Phone: 314-771-5765

Aldrich Chemical Co.  
1001 West St. Paul  
Milwaukee, WI 53233  
Phone: 414-273-3850

Fluka Chemical Corp.  
980 South Second St.  
Ronkonkoma, NY 11779  
Phone: 516-467-3535

SECTION 1. - - - - - CHEMICAL IDENTIFICATION- - - - -

PRODUCT #: 13197-0 NAME: 1,4-THIOXANE, 98%

SECTION 2. - - - - - COMPOSITION/INFORMATION ON INGREDIENTS - - - - -

CAS #:15980-15-1

MF: C4H8OS

SYNONYMS

OXATHIANE \* P-THIOXANE \* 1,4-THIOXANE \*

SECTION 3. - - - - - HAZARDS IDENTIFICATION - - - - -

LABEL PRECAUTIONARY STATEMENTS

COMBUSTIBLE (USA DEFINITION)

FLAMMABLE (EUROPEAN DEFINITION)

IRRITANT

IRRITATING TO EYES, RESPIRATORY SYSTEM AND SKIN.

STENCH.

KEEP AWAY FROM SOURCES OF IGNITION. NO SMOKING.

IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.

TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING.

WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.

SECTION 4. - - - - - FIRST-AID MEASURES- - - - -

IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS AMOUNTS OF WATER.

CONTAMINATION OF THE EYES SHOULD BE TREATED BY IMMEDIATE AND PROLONGED IRRIGATION WITH COPIOUS AMOUNTS OF WATER.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS. CALL A PHYSICIAN.

REMOVE AND WASH CONTAMINATED CLOTHING PROMPTLY.

DISCARD CONTAMINATED SHOES.

SECTION 5. - - - - - FIRE FIGHTING MEASURES - - - - -

EXTINGUISHING MEDIA

WATER SPRAY.

CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.

COMBUSTIBLE.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

SECTION 6. - - - - - ACCIDENTAL RELEASE MEASURES- - - - -

EVACUATE AREA.

WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY

RUBBER GLOVES.

COVER WITH DRY-LIME, SAND, OR SODA ASH. PLACE IN COVERED CONTAINERS  
USING NON-SPARKING TOOLS AND TRANSPORT OUTDOORS.

VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

SECTION 7. - - - - - HANDLING AND STORAGE - - - - -

REFER TO SECTION 8.

SECTION 8. - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION - - - - -

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT  
GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.

USE ONLY IN A CHEMICAL FUME HOOD.

SAFETY SHOWER AND EYE BATH.

DO NOT BREATHE VAPOR.

AVOID CONTACT WITH EYES, SKIN AND CLOTHING.

WASH THOROUGHLY AFTER HANDLING.

KEEP CONTAINER CLOSED.

IRRITANT.

STENCH.

KEEP AWAY FROM HEAT AND OPEN FLAME.

STORE IN A COOL DRY PLACE.

SECTION 9. - - - - - PHYSICAL AND CHEMICAL PROPERTIES - - - - -

APPEARANCE AND ODOR

COLORLESS LIQUID

BOILING POINT: 147 C/755MM.

FLASHPOINT 108 F  
42C

SPECIFIC GRAVITY: 1.114

SECTION 10. - - - - - STABILITY AND REACTIVITY - - - - -

INCOMPATIBILITIES

OXIDIZING AGENTS

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:

SULFUR OXIDES

SECTION 11. - - - - - TOXICOLOGICAL INFORMATION - - - - -

ACUTE EFFECTS

MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION.

VAPOR OR MIST IS IRRITATING TO THE EYES, MUCOUS MEMBRANES AND UPPER  
RESPIRATORY TRACT.

CAUSES SKIN IRRITATION.

EXPOSURE CAN CAUSE:

NAUSEA, HEADACHE AND VOMITING

RTECS NO: RP4200000

1,4-OXATHIANE

IRRITATION DATA

SKN-RBT 10 MG/24H OPEN MLD

AMIHBC 4,119,51

SKN-RBT 500 MG/24H MLD

85JCAE -,1102,86

EYE-RBT 20 MG OPEN

AMIHBC 4,119,51

EYE-RBT 100 MG/24H MOD

85JCAE -,1102,86

TOXICITY DATA

ORL-RAT LD50:2830 MG/KG

AMIHBC 4,119,51

ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES  
(RTECS) DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR

COMPLETE INFORMATION.

SECTION 12. - - - - - ECOLOGICAL INFORMATION - - - - -  
DATA NOT YET AVAILABLE.

SECTION 13. - - - - - DISPOSAL CONSIDERATIONS - - - - -  
THIS COMBUSTIBLE MATERIAL MAY BE BURNED IN A CHEMICAL INCINERATOR  
EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.  
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION 14. - - - - - TRANSPORT INFORMATION - - - - -  
CONTACT ALDRICH CHEMICAL COMPANY FOR TRANSPORTATION INFORMATION.

SECTION 15. - - - - - REGULATORY INFORMATION - - - - -  
REVIEWS, STANDARDS, AND REGULATIONS

EPA TSCA CHEMICAL INVENTORY, JANUARY 1993

EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, SEPTEMBER 1993

SECTION 16. - - - - - OTHER INFORMATION - - - - -

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P.O. Box 14508  
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1001 West St. Paul  
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Phone: 414-273-3850

Fluka Chemical Corp.  
980 South Second St.  
Ronkonkoma, NY 11779  
Phone: 516-467-3535

SECTION 1. - - - - - CHEMICAL IDENTIFICATION- - - - -

PRODUCT #: 64259 NAME: METHYLPHOSPHONIC ACID 98%

SECTION 2. - - - - - COMPOSITION/INFORMATION ON INGREDIENTS - - - - -

CAS #:993-13-5

MF: CH5O3P

SECTION 3. - - - - - HAZARDS IDENTIFICATION - - - - -

LABEL PRECAUTIONARY STATEMENTS

CORROSIVE

CAUSES BURNS.

IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.

AFTER CONTACT WITH SKIN, WASH IMMEDIATELY WITH PLENTY OF WATER.

TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING.

WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.

SECTION 4. - - - - - FIRST-AID MEASURES- - - - -

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.

ASSURE ADEQUATE FLUSHING OF THE EYES BY SEPARATING THE EYELIDS WITH FINGERS.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS. CALL A PHYSICIAN.

WASH CONTAMINATED CLOTHING BEFORE REUSE.

DISCARD CONTAMINATED SHOES.

SECTION 5. - - - - - FIRE FIGHTING MEASURES - - - - -

EXTINGUISHING MEDIA

CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

SECTION 6. - - - - - ACCIDENTAL RELEASE MEASURES- - - - -

EVACUATE AREA.

WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY RUBBER GLOVES.

COVER WITH DRY LIME OR SODA ASH, PICK UP, KEEP IN A CLOSED CONTAINER AND HOLD FOR WASTE DISPOSAL.

VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

SECTION 7. - - - - - HANDLING AND STORAGE- - - - -

REFER TO SECTION 8.

SECTION 8. - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION- - - - -  
WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT  
GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.  
SAFETY SHOWER AND EYE BATH.  
USE ONLY IN A CHEMICAL FUME HOOD.  
FACESHIELD (8-INCH MINIMUM).  
DO NOT BREATHE DUST.  
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.  
AVOID PROLONGED OR REPEATED EXPOSURE.  
WASH THOROUGHLY AFTER HANDLING.  
CORROSIVE.  
KEEP TIGHTLY CLOSED.  
STORE IN A COOL DRY PLACE.

SECTION 9. - - - - - PHYSICAL AND CHEMICAL PROPERTIES - - - - -  
APPEARANCE AND ODOR  
WHITE CRYSTALLINE FLAKES  
MELTING POINT: 105 C TO 107 C

SECTION 10. - - - - - STABILITY AND REACTIVITY- - - - -  
INCOMPATIBILITIES  
STRONG OXIDIZING AGENTS  
STRONG BASES

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS  
TOXIC FUMES OF:  
CARBON MONOXIDE, CARBON DIOXIDE  
THERMAL DECOMPOSITION MAY PRODUCE TOXIC FUMES OF PHOSPHORUS OXIDES  
AND/OR PHOSPHINE.

SECTION 11. - - - - - TOXICOLOGICAL INFORMATION - - - - -  
ACUTE EFFECTS  
HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN.  
MATERIAL IS EXTREMELY DESTRUCTIVE TO TISSUE OF THE MUCOUS MEMBRANES  
AND UPPER RESPIRATORY TRACT, EYES AND SKIN.  
INHALATION MAY BE FATAL AS A RESULT OF SPASM, INFLAMMATION AND EDEMA  
OF THE LARYNX AND BRONCHI, CHEMICAL PNEUMONITIS AND PULMONARY EDEMA.  
SYMPTOMS OF EXPOSURE MAY INCLUDE BURNING SENSATION, COUGHING,  
WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA AND  
VOMITING.  
TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND  
TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.

SECTION 12. - - - - - ECOLOGICAL INFORMATION - - - - -  
DATA NOT YET AVAILABLE.

SECTION 13. - - - - - DISPOSAL CONSIDERATIONS - - - - -  
DISSOLVE OR MIX THE MATERIAL WITH A COMBUSTIBLE SOLVENT AND BURN IN A  
CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.  
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION 14. - - - - - TRANSPORT INFORMATION - - - - -  
CONTACT FLUKA CHEMICAL COMPANY FOR TRANSPORTATION INFORMATION.

SECTION 15. - - - - - REGULATORY INFORMATION - - - - -  
DATA NOT AVAILABLE

SECTION 16. - - - - - OTHER INFORMATION- - - - -  
THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO  
BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA, ALDRICH,

PRODUCT #: 64259            NAME: METHYLPHOSPHONIC ACID    98%  
MATERIAL SAFETY DATA SHEET, Valid 2/94 - 4/94  
Printed Saturday, March 05, 1994 10:26AM

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FLUKA CHEMIE AG

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PRODUCT #: 38656-1 NAME: ETHYL METHYLPHOSPHONATE, 98%  
MATERIAL SAFETY DATA SHEET, Valid 2/94 - 4/94  
Printed Saturday, March 05, 1994 6:08PM

Sigma Chemical Co.  
P.O. Box 14508  
St. Louis, MO 63178  
Phone: 314-771-5765

Aldrich Chemical Co.  
1001 West St. Paul  
Milwaukee, WI 53233  
Phone: 414-273-3850

Fluka Chemical Corp.  
980 South Second St.  
Ronkonkoma, NY 11779  
Phone: 516-467-3535

SECTION 1. - - - - - CHEMICAL IDENTIFICATION- - - - -

PRODUCT #: 38656-1 NAME: ETHYL METHYLPHOSPHONATE, 98%

SECTION 2. - - - - - COMPOSITION/INFORMATION ON INGREDIENTS - - - - -

CAS #: 1832-53-7

MF: C3H9O3P

SECTION 3. - - - - - HAZARDS IDENTIFICATION - - - - -

LABEL PRECAUTIONARY STATEMENTS

IRRITANT

CAUSES SEVERE IRRITATION.

IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.

WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.

SECTION 4. - - - - - FIRST-AID MEASURES- - - - -

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.

ASSURE ADEQUATE FLUSHING OF THE EYES BY SEPARATING THE EYELIDS WITH FINGERS.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS. CALL A PHYSICIAN.

WASH CONTAMINATED CLOTHING BEFORE REUSE.

SECTION 5. - - - - - FIRE FIGHTING MEASURES - - - - -

EXTINGUISHING MEDIA

WATER SPRAY.

CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

SECTION 6. - - - - - ACCIDENTAL RELEASE MEASURES- - - - -

EVACUATE AREA.

WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY RUBBER GLOVES.

ABSORB ON SAND OR VERMICULITE AND PLACE IN CLOSED CONTAINERS FOR DISPOSAL.

VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

SECTION 7. - - - - - HANDLING AND STORAGE- - - - -

REFER TO SECTION 8.

SECTION 8. - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION- - - - -

CHEMICAL SAFETY GOGGLES.

COMPATIBLE CHEMICAL-RESISTANT GLOVES.  
NIOSH/MSHA-APPROVED RESPIRATOR.  
SAFETY SHOWER AND EYE BATH.  
USE ONLY IN A CHEMICAL FUME HOOD.  
DO NOT BREATHE VAPOR.  
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.  
WASH THOROUGHLY AFTER HANDLING.  
SEVERE IRRITANT.  
KEEP TIGHTLY CLOSED.  
STORE IN A COOL DRY PLACE.

SECTION 9. - - - - - PHYSICAL AND CHEMICAL PROPERTIES - - - - -

APPEARANCE AND ODOR  
COLORLESS LIQUID  
FLASHPOINT >230  
> 109C

SPECIFIC GRAVITY: 1.172

SECTION 10. - - - - - STABILITY AND REACTIVITY- - - - -

INCOMPATIBILITIES  
STRONG OXIDIZING AGENTS  
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:  
CARBON MONOXIDE, CARBON DIOXIDE  
THERMAL DECOMPOSITION MAY PRODUCE TOXIC FUMES OF PHOSPHORUS OXIDES  
AND/OR PHOSPHINE.

SECTION 11. - - - - - TOXICOLOGICAL INFORMATION - - - - -

ACUTE EFFECTS  
HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN.  
CAUSES SEVERE IRRITATION.  
HIGH CONCENTRATIONS ARE EXTREMELY DESTRUCTIVE TO TISSUES OF THE MUCOUS  
MEMBRANES AND UPPER RESPIRATORY TRACT, EYES AND SKIN.  
SYMPTOMS OF EXPOSURE MAY INCLUDE BURNING SENSATION, COUGHING,  
WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA AND  
VOMITING.  
TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND  
TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.

SECTION 12. - - - - - ECOLOGICAL INFORMATION - - - - -

DATA NOT YET AVAILABLE.

SECTION 13. - - - - - DISPOSAL CONSIDERATIONS - - - - -

DISSOLVE OR MIX THE MATERIAL WITH A COMBUSTIBLE SOLVENT AND BURN IN A  
CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.  
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION 14. - - - - - TRANSPORT INFORMATION - - - - -

CONTACT ALDRICH CHEMICAL COMPANY FOR TRANSPORTATION INFORMATION.

SECTION 15. - - - - - REGULATORY INFORMATION - - - - -

DATA NOT AVAILABLE

SECTION 16. - - - - - OTHER INFORMATION- - - - -

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BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA, ALDRICH,  
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OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR  
PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE.

PRODUCT #: 38656-1      NAME: ETHYL METHYLPHOSPHONATE, 98%  
MATERIAL SAFETY DATA SHEET, Valid 2/94 - 4/94  
Printed Saturday, March 05, 1994 6:08PM

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**Lancaster Synthesis Ltd.**

P.O. Box 1000  
Windham  
New Hampshire  
03067

Tel: (603)-889-3306

\*\*\*\*\* HAZARD DATA SHEET \*\*\*\*\*

Product 0994 4-Chlorophenyl methyl sulphone

Molecular Wt. 190.66

CAS Number 98-57-7

Physical State SOLID, Melting point typically 95-96°C

Fire Hazard Although presenting no special hazard in normal use, this product will burn and could contribute to an existing fire.

In the event of a fire involving this product, either alone or in combination with other materials, use dry powder or carbon dioxide extinguishers (NOT WATER).

Toxicity & Handling Although not presenting a serious hazard in normal use, this product should be handled with care and in accordance with the advice given under "General Information", below.

Storage Store in closed vessels, in a cool dry place.

Disposal In accordance with local regulations

General Information This product should be handled only by those properly qualified in the handling and use of potentially hazardous chemicals. It should always be handled in an efficient fume hood or equivalent system. It should be borne in mind that the toxicological and physiological properties of many compounds are not yet well defined and that hazardous products may arise from reactions between chemicals.

Protective clothing should always be worn, including gloves and eye protection. In the event of contact occurring, prolonged irrigation with water of the affected area should take place.

THIS PRODUCT IS SUPPLIED FOR RESEARCH AND DEVELOPMENT PURPOSES ONLY

PRODUCT #: 64258 NAME: DIMETHYL METHYLPHOSPHONATE  
MATERIAL SAFETY DATA SHEET, Valid 2/94 - 4/94  
Printed Thursday, March 03, 1994 11:02AM

Sigma Chemical Co.  
P.O. Box 14508  
St. Louis, MO 63178  
Phone: 314-771-5765

Aldrich Chemical Co.  
1001 West St. Paul  
Milwaukee, WI 53233  
Phone: 414-273-3850

Fluka Chemical Corp.  
980 South Second St.  
Ronkonkoma, NY 11779  
Phone: 516-467-3535

SECTION 1. - - - - - CHEMICAL IDENTIFICATION- - - - -  
PRODUCT #: 64258 NAME: DIMETHYL METHYLPHOSPHONATE

SECTION 2. - - - - - COMPOSITION/INFORMATION ON INGREDIENTS - - - - -  
CAS #: 756-79-6  
MF: C3H9O3P

SYNONYMS

DIMETHYL METHYLPHOSPHONATE \* DMMP \* FYROL DMMP \* METHANEPHOSPHONIC  
ACID DIMETHYL ESTER \* METHYL PHOSPHONIC ACID, DIMETHYL ESTER \* NCI-  
C54762 \*

SECTION 3. - - - - - HAZARDS IDENTIFICATION - - - - -  
LABEL PRECAUTIONARY STATEMENTS

HARMFUL

HARMFUL BY INHALATION, IN CONTACT WITH SKIN AND IF SWALLOWED.  
IRRITATING TO EYES, RESPIRATORY SYSTEM AND SKIN.

POSSIBLE RISK OF IRREVERSIBLE EFFECTS.

POSSIBLE CARCINOGEN.

COMBUSTIBLE.

KEEP AWAY FROM HEAT AND OPEN FLAME.

STENCH.

DO NOT BREATHE VAPOR.

IF YOU FEEL UNWELL, SEEK MEDICAL ADVICE (SHOW THE LABEL WHERE  
POSSIBLE).

IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF  
WATER AND SEEK MEDICAL ADVICE.

WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE  
PROTECTION.

SECTION 4. - - - - - FIRST-AID MEASURES- - - - -

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH COPIOUS AMOUNTS OF  
WATER FOR AT LEAST 15 MINUTES.

IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS  
AMOUNTS OF WATER.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL  
RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.  
CALL A PHYSICIAN.

WASH CONTAMINATED CLOTHING BEFORE REUSE.

SECTION 5. - - - - - FIRE FIGHTING MEASURES - - - - -  
EXTINGUISHING MEDIA

WATER SPRAY.

CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO  
PREVENT CONTACT WITH SKIN AND EYES.

COMBUSTIBLE LIQUID.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.  
VAPOR MAY TRAVEL CONSIDERABLE DISTANCE TO SOURCE OF IGNITION AND  
FLASH BACK.

SECTION 6. - - - - - ACCIDENTAL RELEASE MEASURES- - - - -  
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY  
RUBBER GLOVES.

COVER WITH DRY LIME OR SODA ASH, PICK UP, KEEP IN A CLOSED CONTAINER  
AND HOLD FOR WASTE DISPOSAL.

VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

SECTION 7. - - - - - HANDLING AND STORAGE- - - - -  
REFER TO SECTION 8.

SECTION 8. - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION- - - - -  
CHEMICAL SAFETY GOGGLES.

RUBBER GLOVES.  
NIOSH/MSHA-APPROVED RESPIRATOR.  
SAFETY SHOWER AND EYE BATH.  
USE ONLY IN A CHEMICAL FUME HOOD.  
AVOID INHALATION.  
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.  
AVOID PROLONGED OR REPEATED EXPOSURE.  
WASH THOROUGHLY AFTER HANDLING.

IRRITANT.  
POSSIBLE CARCINOGEN.  
KEEP TIGHTLY CLOSED.  
KEEP AWAY FROM HEAT AND OPEN FLAME.  
STENCH.

STORE IN A COOL DRY PLACE.

SECTION 9. - - - - - PHYSICAL AND CHEMICAL PROPERTIES - - - - -  
APPEARANCE AND ODOR

COLORLESS LIQUID  
BOILING POINT: 181 C  
FLASHPOINT 156 F  
68C

VAPOR PRESSURE: <0.1MM 20 C  
SPECIFIC GRAVITY: 1.145

SECTION 10. - - - - - STABILITY AND REACTIVITY- - - - -  
INCOMPATIBILITIES

STRONG OXIDIZING AGENTS  
STRONG BASES

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:  
CARBON MONOXIDE, CARBON DIOXIDE  
THERMAL DECOMPOSITION MAY PRODUCE TOXIC FUMES OF PHOSPHORUS OXIDES  
AND/OR PHOSPHINE.

SECTION 11. - - - - - TOXICOLOGICAL INFORMATION - - - - -  
ACUTE EFFECTS

HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN.  
VAPOR OR MIST IS IRRITATING TO THE EYES, MUCOUS MEMBRANES AND UPPER  
RESPIRATORY TRACT.  
CAUSES SKIN IRRITATION.

EXPOSURE CAN CAUSE:  
NAUSEA, HEADACHE AND VOMITING

CHRONIC EFFECTS

POSSIBLE CARCINOGEN.  
TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND  
TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.

RTECS NO: SZ9120000

PHOSPHONIC ACID, METHYL-, DIMETHYL ESTER

TOXICITY DATA

ORL-RAT LD50:8210 MG/KG	TSCAT*
FYI-OTS-0483-0242	
IVN-RAT LD50:1050 MG/KG	TSCAT*
FYI-OTS-0483-0242	
IVN-MUS LD50:912 MG/KG	TSCAT*
FYI-OTS-0483-0242	
ORL-CKN LD50:3998 MG/KG	TSCAT*
FYI-OTS-0483-0242	

TARGET ORGAN DATA

BEHAVIORAL (MUSCLE WEAKNESS)  
LUNGS, THORAX OR RESPIRATION (RESPIRATORY DEPRESSION)  
LUNGS, THORAX OR RESPIRATION (OTHER CHANGES)  
ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES  
(RTECS) DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR  
COMPLETE INFORMATION.

SECTION 12. - - - - - ECOLOGICAL INFORMATION - - - - -  
DATA NOT YET AVAILABLE.

SECTION 13. - - - - - DISPOSAL CONSIDERATIONS - - - - -  
THIS COMBUSTIBLE MATERIAL MAY BE BURNED IN A CHEMICAL INCINERATOR  
EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.  
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION 14. - - - - - TRANSPORT INFORMATION - - - - -  
CONTACT FLUKA CHEMICAL COMPANY FOR TRANSPORTATION INFORMATION.

SECTION 15. - - - - - REGULATORY INFORMATION - - - - -

REVIEWS, STANDARDS, AND REGULATIONS

NOHS 1974: HZD A1091; NIS 2; TNF 35; NOS 4; TNE 204  
NOES 1983: HZD A1091; NIS 5; TNF 53; NOS 8; TNE 2134; TFE 763  
EPA TSCA CHEMICAL INVENTORY, JANUARY 1993  
ON EPA IRIS DATABASE  
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, SEPTEMBER 1993  
NTP CARCINOGENESIS STUDIES (GAVAGE);SOME EVIDENCE:RAT  
NTPTR\* NTP-TR-323,87  
NTP CARCINOGENESIS STUDIES (GAVAGE);INADEQUATE EVIDENCE:MOUSE  
NTPTR\* NTP-TR-323,87

SECTION 16. - - - - - OTHER INFORMATION- - - - -

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DATE: 3 Dec 1990

U.S. ARMY CHEMICAL  
RESEARCH, DEVELOPMENT  
AND ENGINEERING CENTER

Emergency Telephone #s:  
CRDEC Safety Office  
301-671-4411 0700-1700  
EST After normal duty  
hours: 301-278-5201  
Ask for CRDEC Staff  
Duty Officer

HT MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND  
CHEMICAL RESEARCH, DEVELOPMENT AND ENGINEERING  
CENTER  
ATTN: SMCCR-CMS-E  
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: Not Available

CHEMICAL NAME:

HD : Bis-(2-chloroethyl) sulfide  
T : Bis-[2-(2-chloroethylthio)-ethyl] ether

Alternate chemical names:

See components (HD, T)

TRADE NAME AND SYNONYMS:

HT  
Sulfur - Mustard (Vesicant)

CHEMICAL FAMILY: Chlorinated sulfur compound

FORMULA/CHEMICAL STRUCTURE: Mixture of 60% Sulfur Mustard (HD) and 40%  
Sulfur Mustard (T) by weight  
HD: C4 H8 Cl2 S  
T: C8 H16 Cl2 O S2

NFPA 704 SIGNAL: Health - 4  
Flammability - 1  
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
HT	*	100	0.003 mg/m3

\* See Section I

SECTION III - PHYSICAL DATA

BOILING POINT: No constant boiling point. Above 228 DEG C  
VAPOR PRESSURE (torr): 0.104 @ 25 DEG C  
VAPOR DENSITY (AIR=1): 6.92  
SOLUBILITY IN WATER: Practically insoluble.  
SPECIFIC GRAVITY (H2O=1): 1.265 at 20 DEG C  
FREEZING (MELTING) POINT: 0.0 to 1.3 DEG C  
AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available  
VISCOSITY (CENTISTOKES): 6.05 @ 20 DEG C  
VOLATILITY (mg/m3): 831 @ 25 DEG C  
EVAPORATION RATE: Data not available  
APPEARANCE & ODOR: Odor: Garlic-like  
Appearance: Highly viscous clear to pale yellow liquid

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#### SECTION IV - FIRE AND EXPLOSION DATA

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FLASHPOINT: (METHOD USED): approximately 100 DEG C (method unknown)  
FLAMMABILITY LIMITS (% by volume): Data not available  
EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing methods that will splash or spread mustard.  
UNUSUAL FIRE & EXPLOSION HAZARDS: May produce hydrogen chloride and sulfur oxides in a fire. Unburned agent vapors may be present and can cause toxic and vesicant effects.  
SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HT should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger on oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

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#### SECTION V - HEALTH HAZARD DATA

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AIRBORNE EXPOSURE LIMIT (AEL): The AEL for HT is 0.003 mg/m3 as proposed in the USAEHA Technical Guide No. 173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT". No individual should be intentionally exposed to any direct skin or eye contact.

HD, a component of HT, is recognized as a human carcinogen by the International Agency for Research on Cancer (IARC).

EFFECTS OF OVEREXPOSURE: HT is a vesicant (causing blisters). Since HT contains HD, HT is an alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HT in the body is very slow and repeated exposure

produce a cumulative effect. Median lethal and incapacitating doses of HT in man have not been established. However, the inhalation LCt50s in certain animal species have been established as follows:

Dog:	100 - 200 mg-min/m <sup>3</sup>
Guinea Pig:	3000 - 6000 mg-min/m <sup>3</sup>
Rabbit:	3000 - 6000 mg-min/m <sup>3</sup>
Mouse:	820 mg-min/m <sup>3</sup>

Maximum safe Ct for HD for skin and eyes are 5 and 2 mg-min/m<sup>3</sup>, respectively.

ACUTE PHYSIOLOGICAL ACTION OF HT IS CLASSIFIED AS LOCAL AND SYSTEMIC.

LOCALLY, HT affects both the eyes and the skin. SKIN damage occurs after percutaneous resorption. Being lipid soluble, HT can be resorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4-24 hours following the exposure, depending on the degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membranes, and perspiration covered skin are more sensitive to the effects of HT. HT's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of eyes to HT vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.

SYSTEMIC ACTIONS occur primarily through inhalation and ingestion. The HT vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal doses of HT can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count and, therefore, results in an increased susceptibility to local and systemic infections. Ingestion of HT will produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

CHRONIC EXPOSURE to HT can cause sensitization, chronic lung impairment, (cough, shortness of breath, chest pain) and cancer of the mouth, throat, respiratory tract, and skin, and leukemia. It may also cause birth defects.

#### EMERGENCY AND FIRST AID PROCEDURES:

**INHALATION:** Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

**EYE CONTACT:** Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source. Flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the victim to the medical facility IMMEDIATELY.

**SKIN CONTACT:** Don respiratory protection mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent sodium hypochlorite solution or liquid household bleach, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility IMMEDIATELY.

**INGESTION:** Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

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#### SECTION VI - REACTIVITY DATA

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**STABILITY:** Stable at ambient temperatures. Decomposition temperature is 165 DEG C to 185 DEG C. HT is a persistent agent depending on pH and moisture, and has been known to remain active for up to three years in soil.

**INCOMPATIBILITY:** Conditions to avoid. Rapidly corrosive to brass @ 65 DEG

C. Will corrode steel at a rate of .0001 in. of steel per month @ 65 DEG C.

**HAZARDOUS DECOMPOSITION:** HT will hydrolyze to form HCl, thiodiglycol, and bis-(2-(2-hydroxyethylthio) ethyl ether.

**HAZARDOUS POLYMERIZATION:** Will not occur.

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### SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

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**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:** Only personnel in full protective clothing will be allowed in an area where HT is spilled (See section 8). In case of personnel contamination see section V "Emergency and First Aid Instructions."

**RECOMMENDED FIELD PROCEDURES:** Spills of HT must be contained by using vermiculite, diatomaceous earth, clay or fine sand and neutralized as possible using copious amounts of 5.25 percent Sodium Hypochlorite solution. Scoop up all material and place in approved DOT containers. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

If 5.25 percent Sodium Hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Calcium Hypochlorite, Decontamination Solution No. 2 (DS2) and Super Tropical Bleach Slurry (STB). **WARNING:** Pure, undiluted Calcium Hypochlorite (HTH) will burn on contact with liquid blister agent.

**RECOMMENDED LABORATORY PROCEDURES:** A minimum of 65 grams of decon solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours the resulting solution shall be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 ml of the decontaminate in a test tube. Add several crystals of Potassium Iodine and swirl to dissolve. Add 3 ml of 50 wt percent Sulfuric Acid:water and swirl. **IMMEDIATE** Iodine color indicates the presence of active chlorine. If negative, add additional 5.25 percent Sodium Hypochlorite solution to the decontamination solution. wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution.

A 10 wt percent HTH (calcium hypochlorite) mixture may be substituted for Sodium Hypochlorite. Use 65 grams of decon per gram of HT and continue the test as described for Sodium Hypochlorite.

Scoop up all material and place in approved DOT containers. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (see Section 8).

**NOTE:** Surfaces contaminated with HT and then rinse-decontaminated may evolve sufficient HT vapor to produce a physiological response.

**WASTE DISPOSAL METHOD:** All neutralized material should be collected, contained and thermally decomposed in an EPA permitted incinerator for decontaminated HT (see note), which will filter or scrub toxic by-products from ef-

fluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the following procedure outlined above with the following exception:

--- HT on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

Open pit burning or burying of HT or items containing or contaminated with HT in any quantity is prohibited.

Note: Some states consider certain decontaminated surety agents as RCRA hazardous waste. Local regulations must be considered before disposal action is taken.

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### SECTION VIII - SPECIAL PROTECTION INFORMATION

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#### RESPIRATORY PROTECTION:

<u>Concentration (mg/m3)</u>	<u>Respiratory Protection/Ensemble Required</u>
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Less than or equal  
to 0.003 as an  
8-hr TWA

Protective mask not required provided that:

- Continuous real-time monitoring (with alarm capability) is conducted in the work area at the 0.003 mg/m3 level of detection.
- M9, M17 or M40 mask is available and donned if concentrations exceed 0.003 mg/m3.
- Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices.

If these conditions are not met then the following applies:

Full facepiece, chemical canister, air-purifying respirators. (The M9, M17, or M40 series or other certified equivalent masks acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.)

Greater than  
0.003 as an  
8-hr TWA

The Demilitarization Protective Ensemble (DPE), 30 mil, may be used with prior approval from the AMC Field Safety Activity. Use time for the 30 mil DPE must be restricted to two hours or less.

NOTE: When 30 mil DPE is not available the M9 or M40 series mask with Level A protective ensemble including impregnated innerwear can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots to reduce aspiration.

#### VENTILATION:

Special. Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20% of inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in assessing the ability of the hood to contain agent HT.

Other. Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods.

PROTECTIVE GLOVES: MANDATORY. Butyl Toxicological Agent Protective gloves (M3, M4, gloveset).

EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazard use goggles and face-shield.

OTHER PROTECTIVE EQUIPMENT: Full protective clothing will consist of the M3 butyl rubber suit with hood, M2A1 boots, M3 gloves, impregnated underwear, M9 series mask and coveralls (if desired), or the Demilitarization Protective Ensemble (DPE). For general lab work, gloves and lab coat shall be worn with M9 or M17 mask readily available.

In addition, when handling contaminated lab animals, a daily clean smock, foot covers, and head covers are required.

MONITORING: Available monitoring equipment for agent HT is the M8/M9 detector paper, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACAMS), CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), and the Miniature Chemical Agent Monitor (MINICAM).

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## SECTION IX - SPECIAL PRECAUTIONS

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### PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

During handling, the "buddy" (two-man) system will be used. Containers should be periodically inspected for leaks, either visually or using a detector kit, and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HT must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday. No smoking, eating, or drinking is permitted at the work site. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HT should be stored in containers made of glass for Research Development Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

OTHER PRECAUTIONS: See AMC-R 385-131, "Safety Regulations for Chemical Agents H, HD, and HT, GB and VX," 9 Oct 1987 and USAEHA Technical Guide No. 173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT," for additional information.

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## SECTION X - TRANSPORTATION DATA

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PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

DOT HAZARD CLASSIFICATION: Poison A

DOT LABEL: Poison Gas

DOT MARKING: Poisonous liquid, n.o.s. (Bis-(2-chloroethyl) sulfide, and Bis-[2-(2-chloroethylthio)-ethyl] ether) NA 1955

DOT PLACARD: POISON GAS

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See sections IV, VII, and VIII.

While the Chemical Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.



DATE: 3 Dec 1990

U.S. ARMY CHEMICAL RESEARCH, DEVELOPMENT AND ENGINEERING CENTER  
MATERIAL SAFETY DATA SHEET

Emergency Telephone #s:  
CRDEC Safety Office  
301-671-4411 0700-1700  
EST After normal duty  
hours: 301-278-5201  
Ask for CRDEC Staff  
Duty Officer

LETHAL NERVE AGENTS  
GD AND THICKENED GD (See Addendum C)

SECTION I - GENERAL INFORMATION

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND  
CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING CENTER  
ATTN: SMCCR-CMS-E  
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: 96-64-0 or 50642-24-5

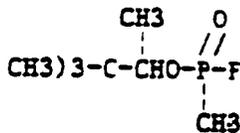
CHEMICAL NAME: Phosphonofluoridic acid, methyl-,1,2,2-trimethylpropyl ester

Alternate chemical names: Pinacolyl methylphosphonofluoridate  
1,2,2-Trimethylpropyl methylphosphonofluoridate  
Methylpinacolyl oxyfluorophosphine oxide  
Pinacolyl oxymethylphosphonyl fluoride  
Pinacolyl methanefluorophosphonate  
Methylfluoropinacolylphosphonate  
Fluoromethylpinacolyl oxyphosphine oxide  
Methylpinacolyl oxyphosphonyl fluoride  
Pinacolyl methylfluorophosphonate  
1,2,2-Trimethylpropoxyfluoromethylphosphine oxide

TRADE NAME AND SYNONYMS: GD, EA 1210, Soman, Zoman, PFMP

CHEMICAL FAMILY: Fluorinated organophosphorus compound

FORMULA/CHEMICAL STRUCTURE: Empirical:



C7H16FO2P

NFPA 704 SIGNAL: Health - 4  
Flammability - 1  
Reactivity - 1



SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT
GD	C7 H16 FOP	100	0.00003 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): (198 DEG C) 388 DEG F

VAPOR PRESSURE: 0.40 mm Hg @ 25 DEG C

VAPOR DENSITY (AIR=1): 6.3

SOLUBILITY IN WATER: Moderate

SPECIFIC GRAVITY (H2O=1): 1.022 @ 25 DEG C

VOLATILITY: 3900 mg/m3 @ 25 DEG C

MELTING POINT: -42 DEG C

APPEARANCE AND ODOR: When pure, colorless liquid with fruity odor. With impurities, amber or dark brown, with oil of camphor odor

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#### SECTION IV - FIRE AND EXPLOSION DATA

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FLASHPOINT: 121 DEG C (Open cup)

FLAMMABILITY LIMITS: Unknown

LOWER EXPLOSIVE LIMIT: Not applicable

UPPER EXPLOSIVE LIMIT: Not applicable

EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid using extinguishing methods that will cause splashing or spreading of the GD.

SPECIAL FIRE FIGHTING PROCEDURES: Fires involving GD should be contained to prevent contamination of uncontrolled areas. All persons not engaged in extinguishing the fire should be evacuated immediately. Contact with GD or its vapors can be fatal. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighter are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

UNUSUAL FIRE AND EXPLOSION HAZARDS: Hydrogen produced by the corrosive vapors reacting with metals, concrete, etc., may be present.

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#### SECTION V - HEALTH HAZARD DATA

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AIRBORNE EXPOSURE LIMIT (AEL): The suggested permissible airborne exposure concentration of GD for an 8-hour workday or a 40 hour work week is an 8-hour time weighted average (TWA) of 0.00003 mg/m3 (2 x 10<sup>-5</sup> ppm). This value is based on the TWA of GB as proposed in the USAEHA Technical Guide No. 169, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX". To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated permissible exposure concentration for GD.

EFFECTS OF OVEREXPOSURE: GD is a lethal anticholinesterase agent with the median lethal dose in man being: LCt50 (inhalation) = 70 mg min/m3 (t = 10 min); LD50 (PC, bare skin) = 0.35 g/man (70 kg).

1. One to several minutes after overexposure to airborne GD, the following acute symptoms appear:

a. LOCAL EFFECTS (lasting 1 - 15 days, increase with dose):

(1) On eyes: Miosis (constriction of pupils); redness, pressure sensation on eyes.

(2) By inhalation: Rhinorrhea (runny nose), nasal congestion, tightness in chest, wheezing, salivation, nausea, vomiting.

b. SYSTEMIC EFFECTS (increases with dose): When inhaled, GD will cause excessive secretion causing coughing/breathing difficulty; salivation and sweating; vomiting, diarrhea; stomach cramps; involuntary urination/defecation; generalized muscle twitching/muscle cramps; CNS depression including anxiety, restlessness, giddiness, insomnia, excessive dreaming and nightmares. With more severe exposure, also headache, tremor, drowsiness, concentration difficulty, memory impairment, confusion, unsteadiness on standing or walking, and progressing to death.

2. After exposure to liquid GD, the following acute symptoms appear:

a. LOCAL EFFECTS:

(1) On eyes: Miosis (constriction of pupils); redness, pressure sensation on eyes.

(2) By ingestion: Salivation, anorexia, nausea, vomiting, abdominal cramps, diarrhea, involuntary defecation, heartburn.

(3) On skin: Sweating, muscle twitching.

b. Chronic exposure to GD causes forgetfulness, thinking difficulty, vision disturbances, muscular aches/pains. Although certain organophosphate pesticides have been shown to be teratogenic in animals, these effects have not been documented in carefully controlled toxicological evaluations for GD.

GD presently is not listed by the International Agency for Research on Cancer (IARC), National Toxicology Program (NTP), Occupational Safety and Health Administration (OSHA), or American Conference of Governmental Industrial Hygienists (ACGIH) as a carcinogen.

\*\* See addendum A for detailed information. \*\*

EMERGENCY AND FIRST AID PROCEDURES:

**INHALATION:** Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

**EYE CONTACT:** IMMEDIATELY flush eyes with water for 10-15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to the medical treatment facility for observation.

**SKIN CONTACT:** Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminant. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal. IMMEDIATELY administer Nerve Agent Antidote Kit, MARK I. Seek medical attention immediately.

\* See Addendum B for detailed instructions. \*\*

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#### SECTION VI - REACTIVITY DATA

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STABILITY: Stable after storage in steel for 3 months at 65 Deg C. GD corrodes steel at the rate of  $1 \times 10^{-5}$  inch/month.

GD will hydrolyze to form HF and  $(\text{CH}_3)_3\text{C}-\text{C}(\text{H})_2-\text{O}-\text{P}(\text{OH})(\text{CH}_3)_2$

HAZARDOUS POLYMERIZATION: Will not occur.

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#### SECTION VII - SPILL, LEAK AND DISPOSAL PROCEDURES

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STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leak or spills occur, only personnel in full protective clothing (see Section 8) will remain in area. In case of personnel contamination, see Section V "Emergency and First Aid Procedures".

RECOMMENDED FIELD PROCEDURES: Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous Sodium Hydroxide solution (a minimum of 10 percent). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of material used to decontaminate exterior of drum IAW Federal, state and local regulations. Contaminated clothing will be placed in a fully removable head drum with a high density polyethylene liner and the contents shall be covered with decontaminating solution as above before affixing the drum head. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the exposure limits (see Section 8).

If 10 wt percent aqueous Sodium Hydroxide solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Solution No. 2 (DS2), Sodium Carbonate, and Supertropical Tropical Bleach Slurry (STB).

RECOMMENDED LABORATORY PROCEDURES: A minimum of 55 grams of decon solution is required per gram of GD. Decontaminant/agent solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour provided a single phase is obtained. At the end of the first hour the pH should be checked and adjusted up to 11.5 with additional NaOH as required.

An alternate solution for the decontamination of GD is 10 percent Sodium Carbonate in place of the 10 percent Sodium Hydroxide solution above. Continue with 55 grams of decon per gram of GD. Agitate for one hour and allow to react for 3 hours. At the end of the third hour adjust the pH to above 10. It is also permitted to substitute 5.25 % Sodium Hypochlorite for the 10% Sodium Hydroxide solution above. Continue with 55 grams of decon per gram of GD. Agitate for one hour and allow to react for 3 hours then adjust the pH to above 10.

Scoop up all material and place in a fully removable head and a high den-

sity polyethylene liner. Cover the contents with additional decontaminating solution before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All contaminated clothing will be placed in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the exposure limits (see Section 8).

**WASTE DISPOSAL METHOD:** Open pit burning or burying of GD or items containing or contaminated with GD in any quantity is prohibited. The detoxified GD (using procedures above) can be thermally destroyed by incineration in an EPA approved incinerator in accordance with appropriate provisions of Federal, state and local RCRA regulations.

**NOTE:** Some states define decontaminated surety material as a RCRA Hazardous Waste.

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### SECTION VIII - SPECIAL PROTECTION INFORMATION

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#### RESPIRATORY PROTECTION:

##### GD Concentration

##### Respiratory Protective Equipment

Less than  
0.00003 mg/m<sup>3</sup>

M9, M17, or M40 series mask shall be available for escape as necessary.

0.00003 mg/m<sup>3</sup>  
to 0.06 mg/m<sup>3</sup>

M9, or M40 series mask with Level A or Level B ensemble (see AMCR 385-131 for determination of appropriate level).

Demilitarization Protective Ensemble (DPE), or Toxicological Agent Protective Ensemble Self-Contained (TAPES), used with prior approval from AMC Field Safety Activity.

Greater than  
0.06 mg/m<sup>3</sup> or  
unknown

DPE or TAPES used with prior approval from AMC Field Safety Activity.

**NOTE:** When DPE or TAPES is not available the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

**Local Exhaust:** Mandatory. Must be filtered or scrubbed to limit exit conc. to < .00001 mg/m<sup>3</sup> (averaged over 8 hr/day, indefinitely).

**Special:** Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (1fpm) + 10 percent with the velocity at any point not deviating from the average face velocity by more than 20 percent. Laboratory hoods shall be located such that cross-drafts do not exceed 20 percent of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent GD.

Emergency back-up power necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be per-

formed 20 cm inside hood face.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted.

PROTECTIVE GLOVES: Butyl Glove M3 and M4  
Norton, Chemical Protective Glove Set

EYE PROTECTION: Chemical Goggles. For splash hazards use goggles and face-shield.

OTHER PROTECTIVE EQUIPMENT: Full protective clothing will consist of M9 mask and hood, butyl rubber suit (M3), M2A1 butyl boots, M3 or M4 gloves, unimpregnated underwear, or demilitarization protective ensemble (DPE). For laboratory operations, wear lab coats and have a protective mask readily available.

MONITORING: Available monitoring equipment for agent GD is the Automatic Chemical Agent Detector Alarm (ACADA), bubblers (GC method), and Chemical Agent Monitor (CAM).

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#### SECTION IX - SPECIAL PRECAUTIONS

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PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: In handling GD, the buddy system will be incorporated. No smoking, eating or drinking is permitted in areas containing agent GD. Containers should be periodically inspected for leaks (either visually or by a detector kit) and prior to transferring the containers from storage to work areas. Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities shall be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday.

OTHER PRECAUTIONS: Agent must be double-contained in liquid and vapor-tight containers when in storage or when outside of the ventilation hood.

For additional information, see AMC-R 385-131, "Safety Regulations for Chemical Agents H, HD, HT, GB, and VX" and USAEHA Technical Guide No. 169, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX".

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#### SECTION X - TRANSPORTATION DATA

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PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

DOT HAZARD CLASSIFICATION: Poison A

DOT LABEL: Poison gas

DOT MARKING: Poisonous liquid, n.o.s. (Pinacolyl methylphosphonofluoridate)  
NA 1955

DOT PLACARD: POISON GA

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Section IV, VII and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency.

AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Chemical Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

#### ADDENDUM A

#### 1. Acute Physiological Effects:

Site of Action	Signs and Symptom Following Local Exposure
<b>Muscarine-like-</b>	
Pupils	Miosis, marked, usually maximal (pinpoint), sometimes unequal.
Ciliary body	Frontal headache, eye pain on focusing, slight dimness of vision, occasional nausea and vomiting.
Conjunctivae	Hyperemia.
Nasal mucous membranes	Rhinorrhea, hyperemia.
Bronchial tree	Tightness in chest, sometimes with prolonged wheezing expiration suggestive of broncho-constriction or increased secretion, cough.
<b>Following Systemic Absorption</b>	
Bronchial tree	Tightness in chest, with prolonged wheezing, expiration suggestive of broncho-constriction or increased secretion, dyspnea, slight pain in chest, increased bronchial secretion, cough, pulmonary edema, cyanosis.
Gastrointestinal	Anorexia, nausea, vomiting, abdominal cramps, epigastric and substernal tightness (cardiospasm) with "heart-burn" and eructation, diarrhea, tenesmus, involuntary defecation.
Sweat glands	Increased sweating.
Salivary glands	Increased salivation.
Lacrimal glands	Increased lacrimation.
Heart	Slight bradycardia.
Pupils	Slight miosis, occasionally unequal, later maximal miosis (pinpoint).

Ciliary body	Blurring of vision.
Bladder	Frequent, involuntary micturition
Nicotine-like-	
Striated muscle	Easy fatigue, mild weakness, muscular twitching, fasciculations, cramps, generalized weakness, including muscles of respiration, with dyspnea and cyanosis.
Sympathetic ganglia	Pallor, occasional elevation of blood pressure.
Central nervous system	Giddiness, tension, anxiety, jitteriness, restlessness, emotional lability, excessive dreaming, insomnia, nightmares, headaches, tremor, withdrawal and depression, bursts of slow waves of elevated voltage in EEG, especially on over-ventilation, drowsiness, difficult concentration, slowness on recall, confusion, slurred speech, ataxia, generalized weakness, coma, with absence of reflexes, Cheyne-Stokes respirations, convulsions, depression of respiratory and circulatory centers, with dyspnea, cyanosis, and fall in blood pressure.

## 2. Chronic Physiological Effects:

### a. Acute Exposure.

If recovery from nerve agent poisoning occurs, it will be complete unless anoxia or convulsions have gone unchecked so long that irreversible central nervous system changes due to anoxemia have occurred.

### b. Chronic Exposure.

The inhibition of cholinesterase enzymes throughout the body by nerve agents is more or less irreversible so that their effects are prolonged. Until the tissue cholinesterase enzymes are restored to normal activity, probably by very slow regeneration over a period of weeks or 2 to 3 months if damage is severe there is a period of increased susceptibility to the effects of another exposure to any nerve agent. During this period the effects of repeated exposures are cumulative; after a single exposure, daily exposure to concentrations of a nerve agent insufficient to produce symptoms may result in the onset of symptoms after several days. Continued daily exposure may be followed by increasingly severe effects. After symptoms subside, increased susceptibility persists for one to several days. The degree of exposure required to produce recurrence of symptoms, and the severity of these symptoms, depend on duration of exposure and time intervals between exposures. Increased susceptibility is not limited to the particular nerve agent initially absorbed.

Estimates have been made for the times as which 50% of exposed subjects would be affected (Et50's) at median incapacitating doses. These are presented below.

Et50	Degree of Effectiveness	ICt50	Exposure Time
min		mg min/m <sup>3</sup>	min

1.5	Moderate	27	0.5
3.0	Incap.	27	2.0
6.0		40	10.0
1.0	Severe	37	0.5
3.8	Incap.	37	2.0
7.8		56	10.0
2.0	Very	47	0.5
4.5	Severe	47	2.0
9.5	Incap.	72	10.0
6.5	Death	70	0.5
9.0		70	2.0
13.5		103	10.0

Exposure to high concentrations of nerve agent may bring on incoordination, mental confusion and collapse so rapidly that the casualty cannot perform self-aid. If this happens, the man nearest to him will give first aid.

#### Onset Time of Symptoms.

Types of Effects	Route of Absorption	Description of Effects	When Effects Appear After Exposure
Vapor Local	Lungs	Rhinorrhea, nasal hyperemia tightness in chest, wheezing	One to several minutes
Vapor Local	Eyes	Miosis, Conjunctival hyperemia eye pain, frontal headache.	One to several minutes
Vapor Systemic	Lungs or eyes	Muscarine-like, nicotine-like and central nervous system effects. (See 2a above)	Less than 1 min to a few min after moderate or marked exposure: about 30 min after mild exposure.
Liquid Local	Eyes	Same as vapor effects.	Instantly
Liquid Local	Ingestion	Gastrointestinal. (See 2a above).	About 30 min. after ingestion.
Liquid Local	Skin	Local sweating and muscular twitching.	3 min to 2 hours
Liquid Systemic	Lungs	See 2a above.	Several minutes
Liquid Systemic	Eyes	Same as for vapor	Several minutes
Liquid Systemic	Skin	Generalized sweating.	15 minutes to 2 hours
Liquid Systemic	Ingestion	Gastrointestinal (See 2a above).	15 minutes to 2 hours

Duration of Effects After

Types of Effects	Route of Absorption	Mild Exposure	Severe Exposure
Vapor Local	Lungs	A few hours	1 to 2 days
Vapor Local	Eyes	Miosis - 24 hours	3 to 14 days 2 to 5 days
Vapor Systemic	Lungs or eyes	Several hours	8 days
Liquid Local	Eyes	Similar to effects of vapor	
Liquid Local	Ingestion	3 days	5 days
Liquid Local	Skin	3 days	5 days
Liquid Systemic	Lungs		1 to 5 days
Liquid Systemic	Eyes		2 to 4 days
Liquid Systemic	Skin		2 to 5 days
Liquid Systemic	Ingestion		3 to 5 days

#### ADDENDUM B

##### First aid procedures.

a. Exposed personnel will be removed immediately to an uncontaminated atmosphere. Personnel handling casualty cases will give consideration to their own safety and will take precautions and employ the prerequisite protective equipment to avoid becoming exposed themselves.

**CAUTION:** Due to the rapid effects of nerve agents, it is extremely important that decontamination of personnel not be delayed by attempting to blot off excessive agent prior to decontamination with sodium hypochlorite.

b. The casualty will then be decontaminated by washing the contaminated areas with commercial liquid household bleach (nominal 5% solution hypochlorite or 10 percent sodium carbonate solution) and flushing with clean water. Mask will be left on the victim until decontamination has been completed unless it has been determined that areas of the face were contaminated and the mask must be removed to facilitate decontamination. After decontamination, the contaminated clothing will be removed and skin contamination washed away. If possible, decontamination will be completed before the casualty is taken to the aid station or medical facility.

**CAUTION:** Care must be taken when decontaminating facial areas to avoid getting the hypochlorite into the eye or mouth. Only clean water shall be used when flushing the eyes or mouth. Skin surfaces decontaminated with bleach should be thoroughly flushed with water to prevent skin irritation from the bleach.

c. If there is no apparent breathing, artificial resuscitation will be started immediately (mouth-to-mouth, or with mechanical resuscitator). The situation will dictate method of choice, e.g., contaminated face. Do not

use mouth-to-mouth resuscitation when facial contamination exists. When appropriate and trained personnel are available, cardiopulmonary resuscitation (CPR) may be necessary.

d. An individual who has received a known agent exposure or who exhibits definite signs or symptoms of agent exposure shall be given an intramuscular injection immediately with the MARK I kit auto-injectors.

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

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

(3) Although myosis (pin-pointing of the pupils) may be an early sign of agent exposure, an injection shall not be administered when myosis is the only sign present. Instead, the individual shall be taken immediately to the medical facility for observation.

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

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

e. If indicated, CPR should be started immediately. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists.

**CAUTION:** Atropine does not act as a prophylactic and shall not be administered until an agent exposure has been ascertained.

#### ADDENDUM C ADDITIONAL INFORMATION FOR THICKENED GD

**TRADE NAME AND SYNONYMS:** Thickened GD, TGD.

**HAZARDOUS INGREDIENTS:**

K125 (acryloid copolymer, 5%) is used to thicken the GD. K125 is not known to be a hazardous material except in a finely-divided, powder form.

**PHYSICAL DATA:**

Essential the same as GD except for viscosity. The viscosity of TGD is approximately 1180 centistokes.

**FIRE AND EXPLOSION DATA:** Same as GD.

**HEALTH HAZARD DATA:**

Same as GD except for skin contact. For skin contact, don respiratory protective mask and remove contaminated clothing. Immediately scrape the TGD from the skin surface, then wash the contaminated surface with acetone. Administer Nerve Agent Antidote Kit, MARK I, only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

**SPILL, LEAK AND DISPOSAL PROCEDURES:**

If spills or leaks of TGD occur, follow the same procedure as those for GD,

but add the following step: Since TGD is not water soluble, dissolve the TGD in acetone prior to introducing any decontaminating solution. Containment of TGD is generally not necessary. Spilled TGD can be carefully scraped off the contaminated surface and placed in a drum with a fully removable head and a high density, polyethylene lining. The TGD can then be decontaminated after it has been dissolved in acetone, using the same procedures as for GD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as for GD.

SPECIAL PROTECTION INFORMATION: Same as GD.

SPECIAL PRECAUTIONS:

Same as GD with the following addition: Handling the TGD requires careful observation of the "stringers" (elastic, thread-like attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a working surface will result.

TRANSPORTATION DATA: Same as GD.

Date: 3 Dec 1990

U.S. ARMY CHEMICAL  
RESEARCH, DEVELOPMENT  
AND ENGINEERING CENTER

Emergency Telephone #s:  
CRDEC Safety Office  
301-671-4411 0700-1700  
EST After normal duty  
hours: 301-278-5201  
Ask for CRDEC Staff  
Duty Officer



MATERIAL SAFETY DATA SHEET

LETHAL NERVE AGENT (GA)

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND  
CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING  
CENTER  
ATTN: SMCCR-CMS-E  
ABERDEEN PROVING GROUND, MD 21010-5423

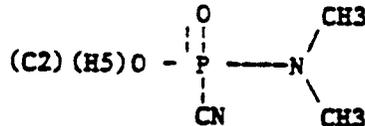
CAS REGISTRY NUMBER: None

CHEMICAL NAME: Ethyl N,N-dimethylphosphoramidocyanidate

TRADE NAME AND SYNONYMS: Ethyl dimethylphosphoramidocyanidate  
Dimethylaminoethoxy-cyanophosphine oxide  
Dimethylamidoethoxyphosphoryl cyanide  
Ethyl dimethylaminocyanophosphonate  
Ethyl ester of dimethylphosphoroamidocyanidic acid  
Ethylphosphorodimethylamidocyanidate  
GA  
EA1205  
Tabun

CHEMICAL FAMILY: Organophosphorus compound

FORMULA/CHEMICAL STRUCTURE: C5 H11 N2 O2 P



NFPA 704 SIGNAL: Health - 4  
Flammability - 2  
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
GA	C5 H11 N2 O2 P	100	0.0001 mg/m3

### SECTION III - PHYSICAL DATA

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BOILING POINT DEG F (DEG C): 247.5 DEG C

VAPOR PRESSURE (mm Hg): 0.07 @ 24 DEG C

VAPOR DENSITY (AIR=1): 5.6

SOLUBILITY IN WATER (g/100 g): 9.8 @ 25 DEG C  
7.2 @ 20 DEG C

SPECIFIC GRAVITY (H2O=1): Not available

FREEZING (MELTING) POINT: -50 DEG C

AUTOIGNITION TEMPERATURE DEG F (DEG C): Not available

VISCOSITY (CENTISTOKES): 2.18 @ 25 DEG C

PERCENTAGE VOLATILE BY VOLUME: 610 mg/m<sup>3</sup> @ 25 DEG C

EVAPORATION RATE: Not available

APPEARANCE & ODOR: Colorless to brown liquid. Faintly fruity; none when pure.

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### SECTION IV - FIRE AND EXPLOSION DATA

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FLASHPOINT: 78 DEG C

FLAMMABILITY LIMITS (% by volume): Not available

EXTINGUISHING MEDIA: Water, fog, foam, CO<sub>2</sub> - Avoid using extinguishing methods that will cause splashing or spreading of the GA.

UNUSUAL FIRE & EXPLOSION HAZARDS: Fires involving this chemical may result in the formation of hydrogen cyanide.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving GA should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

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### SECTION V - HEALTH HAZARD DATA

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AIRBORNE EXPOSURE LIMIT (AEL): The suggested permissible airborne exposure concentration for GA for an 8-hour workday or a 40 hour work week is an 8-hour time weight average (TWA) of 0.0001 mg/m<sup>3</sup> (2 X 10<sup>-5</sup> ppm). This value is based on the TWA of GA as proposed in the USAEHA Technical Guide 169, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX". To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for GA.

EFFECTS OF OVEREXPOSURE: GA is an anticholinesterase agent similar in action to GB. Although only about half as toxic as GB by inhalation, GA in

low concentrations is more irritating to the eyes than GB.

The number and severity of symptoms which appear are dependent on the quantity and rate of entry of the nerve agent which is introduced into the body. (Very small skin dosages sometimes cause local sweating and tremors with few other effects.)

Individuals poisoned by GA display approximately the same sequence of symptoms regardless of the route by which the poison enters the body (whether by inhalation, absorption, or ingestion). These symptoms, in normal order of appearance, are: runny nose; tightness of chest; dimness of vision and pin pointing of the eye pupils; difficulty in breathing; drooling and excessive sweating; nausea; vomiting, cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These symptoms are followed by cessation of breathing and death.

**Onset Time of Symptoms:** Symptoms appear much more slowly from skin dosage than from respiratory dosage. Although skin absorption great enough to cause death may occur in 1 to 2 minutes, death may be delayed for 1 to 2 hours. Respiratory lethal dosages kill in 1 to 10 minutes, and liquid in the eye kills almost as rapidly.

**Median Lethal Dosage, Animals:**

LD50 (monkey, percutaneous) = 9.3 mg/kg (shaved skin)  
LCt50 (monkey, inhalation) = 187 mg-min/m<sup>3</sup> (t = 10)

**Median Lethal Dosage, Man:**

LCt50 (man, inhalation) = 135 mg-min/m<sup>3</sup> (t = 0.5-2 min) at RMV\* of 15 l/min;  
200 mg-min/m<sup>3</sup> at RMV\* of 10 l/min

**\*Respiratory Minute Volume**

GA is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

**EMERGENCY AND FIRST AID PROCEDURES:**

**INHALATION:** Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

**EYE CONTACT:** IMMEDIATELY flush eyes with water for 10 -15 minutes then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to the medical treatment facility for observation.

**SKIN CONTACT:** Don respiratory protection mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminate. Administer an intramuscular injection with the MARK I kit injectors only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

**INGESTION:** Do not induce vomiting. First symptoms are likely to be gastrointestinal. IMMEDIATELY administer 2 mg intramuscular injection of

the MARK I kit auto-injectors. Seek medical attention IMMEDIATELY.

\*\* See Addendum B for further First Aid Procedures \*\*

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#### SECTION VI - REACTIVITY DATA

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STABILITY: Stable

INCOMPATIBILITY: Not available

HAZARDOUS DECOMPOSITION: Decomposes within 6 months at 60 DEG C. Complete decomposition in 3-1/4 hours at 150 DEG C. May produce HCN. Oxides of nitrogen, oxides of phosphorus, carbon monoxide, and hydrogen cyanide.

HAZARDOUS POLYMERIZATION: Not available

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#### SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

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STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leaks or spills occur, only personnel in full protective clothing (see section 8) will remain in area. In case of personnel contamination see section V "Emergency and First Aid Instructions."

##### RECOMMENDED FIELD PROCEDURES:

Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous Sodium Hydroxide solution (a minimum 10 wt percent). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. The decontamination solution must be treated with excess bleach to destroy the CN formed during hydrolysis. Cover the contents with additional bleach before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

If 10 wt percent Sodium Hydroxide is not available then the following decontaminants may be used instead and are listed in order of preference: Decontamination Solution No. 2 (DS2), Sodium Carbonate and Supertropical Bleach Slurry (STB).

##### RECOMMENDED LABORATORY PROCEDURES:

A minimum of 56 grams of decon solution is required for each gram of GA. The decontamination solution is agitated while GA is added and the agitation is maintained for at least one hour. The resulting solution is allowed to react for 24 hours. At the end of 24 hours, the solution must be titrated to a pH between 10 and 12. After completion of the 24 hour period, the decontamination solution must be treated with excess bleach (2.5 mole OCl<sup>-</sup>/mole GA) to destroy the CN formed during hydrolysis. Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents with additional bleach before affixing the drum head. All contaminated clothing will be placed in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW state, EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW State, EPA and DOT regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

WASTE DISPOSAL METHOD: Open pit burning or burying of GA or items contain-

ing or contaminated with GA in any quantity is prohibited. The detoxified GA (using procedures above) can be thermally destroyed by incineration in an EPA approved incinerator in accordance with appropriate provisions of Federal, State and/or local RCRA regulations.

NOTE: Some states define decontaminated surety material as a RCRA Hazardous Waste.

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### SECTION VIII - SPECIAL PROTECTION INFORMATION

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#### RESPIRATORY PROTECTION:

Exposure Potential  
mg/m<sup>3</sup> (8-hour TWA)

Respiratory Protection/Ensemble Required

Less than 0.0001

M9, M17, or M40 series mask shall be available for escape as necessary.

0.0001 to 0.2

M9, or M40 series mask with Level A or Level B protective ensemble (see AMCR 385-131 for determination of appropriate level).

Demilitarization Protective Ensemble (DPE), or Toxicological Agent Protective Ensemble Self-Contained (TAPES), used with prior approval from AMC Field Safety Activity.

Greater than 0.2  
or unknown

Demilitarization Protective Ensemble (DPE), or Toxicological Agent Protective Ensemble Self-Contained (TAPES), used with prior approval from AMC Field Safety Activity.

Note: When DPE or TAPES is not available the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots to reduce aspiration.

VENTILATION: Local Exhaust: Mandatory must be filtered or scrubbed.

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute + or - 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in the assessment of the enclosure's ability to contain agent GA. Emergency backup power necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hood face.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system.

PROTECTIVE GLOVES: Butyl Glove M3 and M4  
Norton, Chemical Protective Glove Set

EYE PROTECTION: Chemical goggles. When there is potential for severe exposure (e.g. sampling pressurized systems, loading & unloading operations) chemical goggles and face shield are recommended.

OTHER PROTECTIVE EQUIPMENT: Full protective clothing will consist of the

M3 Butyl rubber suit with hood, M2A1 boots, M3 gloves, coveralls, fatigues, or similar (with drawers and undershirt) and socks, M9 mask or the Demilitarization Protective Ensemble (DPE). For general lab work, gloves and lab coat shall be worn with M9 or M17 mask readily available.

MONITORING: Available monitoring equipment for agent GA is the Automatic Chemical Agent Detector Alarm (ACADA), bubblers (GC method), Miniature Chemical Agent Monitor (MINICAM) and Chemical Agent Monitor (CAM).

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#### SECTION IX - SPECIAL PRECAUTIONS

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PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: In handling, the buddy system will be incorporated. No smoking, eating and drinking in areas containing agent is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equip shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eye-wash stations, and personal cleanliness facilities be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday.

OTHER PRECAUTIONS: Agents must be double contained in liquid and vapor tight containers when in storage or when outside of ventilation hood.

For additional information see "USAEHA Technical Guide No. 169, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX".

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#### SECTION X - TRANSPORTATION DATA

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PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

DOT HAZARD CLASSIFICATION: Poison A

DOT LABEL: Poison gas

DOT MARKING: Poisonous liquid, n.o.s. (Ethyl dimethylphosphoramidocyanide) NA1955

DOT PLACARD: POISON GAS

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted IAW AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See sections IV, VII, and VIII.

While the Chemical Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

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ADDENDUM B

First aid procedures.

a. Exposed personnel will be removed immediately to an uncontaminated atmosphere. Personnel handling casualty cases will give consideration to their own safety and will take precautions and employ the prerequisite protective equipment to avoid becoming exposed themselves.

CAUTION: Due to the rapid effects of nerve agents, it is extremely important that decontamination of personnel not be delayed by attempting to blot off excessive agent prior to decontamination with sodium hypochlorite.

b. The casualty will then be decontaminated by washing the contaminated areas with 10 % sodium carbonate solution or 5% household bleach and then flushing well with water to remove excess bleach followed by copious soap and water wash. Mask will be left on the victim until contamination has been completed unless it has been determined that areas of the face were contaminated and the mask must be removed to facilitate decontamination. After decontamination, the contaminated clothing will be removed and skin contamination washed away. If possible, decontamination will be completed before the casualty is taken to the aid station or medical facility.

CAUTION: Care must be taken when decontaminating facial areas to avoid getting the hypochlorite into the eye or mouth. Only clean water shall be used when flushing the eyes or mouth. Skin surfaces decontaminated with bleach should to be thoroughly flushed with water to prevent skin irritation from the bleach.

c. If there is no apparent breathing, artificial resuscitation will be started immediately (mouth-to-mouth, or with mechanical resuscitator). The situation will dictate method of choice, e.g., contaminated face. Do not use mouth-to-mouth resuscitation when facial contamination exists. When appropriate and when trained personnel are available, cardiopulmonary resuscitation (CPR) may be necessary.

d. An individual who has received a known agent exposure or who exhibits definite signs or symptoms of agent exposure shall be given an intramuscular injection immediately with MARK I kit auto-injectors.

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

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

(3) Although myosis (pin-pointing of the pupils) may be an early sign of agent exposure, an injection shall not be administered when myosis is the only sign present. Instead, the individual shall be taken immediately to the medical facility for observation.

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

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

CAUTION: Atropine does not act as a prophylactic and shall not be administered until an agent exposure has been ascertained.

e. If indicated, CPR should be started immediately. Mouth-to-mouth re-

ation should be used when approved mask-bag or oxygen delivery systems  
t available. Do not use mouth-to-mouth resuscitation when facial con-  
tion exists.

# Occupational Health Guideline for Tetrachloroethylene\*

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## SUBSTANCE IDENTIFICATION

- Formula:  $\text{CCl}_2 = \text{CCl}_2$
- Synonyms: Perchloroethylene; perchlorethylene; tetrachlorethylene; perk
- Appearance and odor: Colorless liquid with an odor like chloroform or ether.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for tetrachloroethylene is 100 parts of tetrachloroethylene per million parts of air (ppm) averaged over an eight-hour work shift, with a ceiling level of 200 ppm and a maximum acceptable peak of 300 ppm for 5 minutes in any three-hour period. NIOSH has recommended that the permissible exposure limit be reduced to 50 ppm (339 mg/m<sup>3</sup>) averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 100 ppm (678 mg/m<sup>3</sup>) averaged over a 15-minute period. The NIOSH Criteria Document for Tetrachloroethylene should be consulted for more detailed information.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Tetrachloroethylene can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

### • Effects of overexposure

**1. Short-term Exposure:** Tetrachloroethylene may cause headache, nausea, drowsiness, dizziness, incoordination, and unconsciousness. It may also cause irritation of

the eyes, nose, and throat and flushing of the face and neck. In addition, it might cause liver damage with such findings as yellow jaundice and dark urine. The liver damage may become evident several weeks after the exposure.

**2. Long-term Exposure:** Prolonged or repeated overexposure to liquid tetrachloroethylene may cause irritation of the skin. It might also cause damage to the liver and kidneys.

**3. Reporting Signs and Symptoms:** A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to tetrachloroethylene.

### • Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to tetrachloroethylene at potentially hazardous levels:

#### **1. Initial Medical Examination:**

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the liver and the cardiovascular and neurological systems should be stressed. The skin should be examined for evidence of chronic disorders.

—Liver function tests: Tetrachloroethylene may cause liver damage. A profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

—Urinalysis: Since kidney damage has also been observed from exposure, a urinalysis should be obtained to include at minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

**2. Periodic Medical Examination:** The aforementioned medical examinations should be repeated on an annual basis.

### • Summary of toxicology

Tetrachloroethylene vapor is a narcotic. Rats did not survive when exposed for longer than 12-18 minutes to 12,000 ppm; when exposed repeatedly to 470 ppm they showed liver and kidney injury. Cardiac arrhythmias

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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attributed to sensitization of the myocardium to epinephrine have been observed with certain other chlorinated hydrocarbons, but exposure of dogs to concentrations of 5000 and 10,000 ppm tetrachloroethylene did not produce this phenomenon. Four human subjects were unable to tolerate 5000 ppm in a chamber for 6 minutes. They experienced vertigo, nausea, and mental confusion during the 10 minutes following cessation of exposure. In an industrial exposure to an average concentration of 275 ppm for 3 hours, followed by 1100 ppm for 30 minutes, a worker lost consciousness; there was apparent clinical recovery 1 hour after exposure but the monitored concentration of tetrachloroethylene in the patient's expired air diminished slowly over a 2-week period. Long-term industrial exposures have been reported to cause various neuropathies, such as numbness, trembling, neuritis, and defects of memory. During the second and third post-exposure weeks, the results of liver function tests became abnormal, suggesting that acute exposure had had a significant effect upon the liver. Other instances of liver injury following industrial exposure have been reported. Other effects on humans of inhalation of various concentrations are as follows: 2000 ppm, mild narcosis within 5 minutes; 600 ppm, sensation of numbness around the mouth, dizziness, and some incoordination after 10 minutes. In human experiments, 7-hour exposures at 100 ppm resulted in mild irritation of the eyes, nose, and throat; flushing of the face and neck; headache; somnolence; and slurred speech. Exposure of the skin to the liquid for 40 minutes resulted in a progressively severe burning sensation beginning within 5 to 10 minutes; the result was marked erythema, which subsided after 1 to 2 hours. The liquid sprayed into rabbits' eyes produced immediate pain and blepharospasm; patches of epithelium were lost, but the eyes recovered completely within 2 days.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 165.85
2. Boiling point (760 mm Hg): 121.2 C (250 F)
3. Specific gravity (water = 1): 1.62
4. Vapor density (air = 1 at boiling point of tetrachloroethylene): 5.83
5. Melting point: -22.4 C (-8 F)
6. Vapor pressure at 20 C (68 F): 14 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.015

8. Evaporation rate (butyl acetate = 1): 2.8

### • Reactivity

1. Conditions contributing to instability: Heat.
2. Incompatibilities: Tetrachloroethylene reacts with strong oxidizers and chemically active metals such as barium, lithium, and beryllium.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released when tetrachloroethylene decomposes.

4. Special precautions: Liquid tetrachloroethylene will attack some forms of plastics, rubber, and coatings.

### • Flammability

1. Not combustible

### • Warning properties

1. Odor Threshold: Both May and Stern state that 50 ppm is the odor threshold for tetrachloroethylene.

2. Eye Irritation Level: Grant reports that "exposure to high concentrations of (tetrachloroethylene) vapor causes mild sensation of irritation to the eyes, but serious injury is not likely." The exact concentrations producing irritation are not mentioned by Grant.

Spector, however, reports that after a 20- to 30-minute exposure to 206 to 235 ppm, eye irritation occurs in humans.

Patty reports "very slight irritation of the eyes" among humans at 106 ppm.

3. Other Information: Spector reports that a 10-minute exposure to 513 to 690 ppm produces nose and throat irritation.

4. Evaluation of Warning Properties: Since the odor threshold of tetrachloroethylene is below the permissible exposure limit, and since eye irritation occurs at a concentration only twice the permissible exposure limit, its warning properties are considered to be adequate.

## MONITORING AND MEASUREMENT PROCEDURES

### • Eight-Hour Exposure Evaluation

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

### • Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of tetrachloroethylene. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

### • Peak Above Ceiling Evaluation

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of tetrachloroethylene. Each measurement should consist of a 30-minute sample or a series of consecutive samples totalling 30 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of

three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure tetrachloroethylene may be used. An analytical method for tetrachloroethylene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

## RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid tetrachloroethylene.
- Non-impervious clothing which becomes contaminated with liquid tetrachloroethylene should be removed promptly and not reworn until the tetrachloroethylene is removed from the clothing.
- Clothing wet with liquid tetrachloroethylene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of tetrachloroethylene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the tetrachloroethylene, the person performing the operation should be informed of tetrachloroethylene's hazardous properties.

- Employees should be provided with and required to use splash-proof safety goggles where liquid tetrachloroethylene may contact the eyes.

## SANITATION

- Skin that becomes contaminated with liquid tetrachloroethylene should be promptly washed or showered with soap or mild detergent and water to remove any tetrachloroethylene.
- Employees who handle liquid tetrachloroethylene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to tetrachloroethylene may occur and control methods which may be effective in each case:

Operation	Controls
Use as dry cleaning solvent; as degreasing and metal cleaning agent; in vapor degreasing of metal parts	Local exhaust ventilation; general dilution; personal protective equipment
Use as chemical intermediate in production of fluorocarbons, pesticides, and trichloroacetic acid	Process enclosure; local exhaust ventilation; general dilution ventilation
Use as scouring, sizing, desizing, solvent and greaser remover in processing and finishing of textiles	Local exhaust ventilation; general dilution; personal protective equipment
Use as general industrial solvent in rubber, textile, printing, soap, and paint remover industries	Local exhaust ventilation; general dilution; personal protective equipment
Use as extraction agent for vegetable and mineral oils and in pharmaceutical industry; as vermifuge; as laundry treatment for presoaking and as drying medium in metal and wood industries	Local exhaust ventilation; general dilution ventilation; personal protective equipment

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

### • Eye Exposure

If tetrachloroethylene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

### • Skin Exposure

If tetrachloroethylene gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If tetrachloroethylene soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

### • Breathing

If a person breathes in large amounts of tetrachloroethylene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

### • Swallowing

When tetrachloroethylene has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

### • Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If tetrachloroethylene is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Tetrachloroethylene may be disposed of by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

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#### \* SPECIAL NOTE

Tetrachloroethylene appears on the OSHA "Candidate List" of chemicals being considered for further scientific review regarding its carcinogenicity (*Federal Register*, Vol. 45, No. 157, pp. 5372-5379, 12 August 1980). The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 20, 1979.

### RESPIRATORY PROTECTION FOR TETRACHLOROETHYLENE

Condition	Minimum Respiratory Protection* Required Above 100 ppm
Vapor Concentration 500 ppm or less	<p>Any chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).</p> <p>A gas mask with a chin-style or a front- or back-mounted organic vapor canister.</p> <p>Any supplied-air respirator with a full facepiece, helmet, or hood.</p> <p>Any self-contained breathing apparatus with a full facepiece.</p>
Greater than 500 ppm or entry and escape from unknown concentrations	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</p> <p>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</p>
Fire Fighting	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</p>
Escape	<p>Any gas mask providing protection against organic vapors.</p> <p>Any escape self-contained breathing apparatus.</p>

\*Only NIOSH-approved or MSHA-approved equipment should be used.

# Occupational Health Guideline for Methylene Chloride

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## SUBSTANCE IDENTIFICATION

- Formula:  $\text{CH}_2\text{Cl}_2$
- Synonyms: Dichloromethane; methylene dichloride
- Appearance and odor: Colorless liquid with an odor like chloroform.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for methylene chloride is 500 parts of methylene chloride per million parts of air (ppm) averaged over an eight-hour work shift, with an acceptable ceiling level of 1000 ppm and a maximum peak concentration of 2000 ppm for 5 minutes in any two-hour period. NIOSH has recommended that the permissible exposure limit be reduced to 75 ppm averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 500 ppm averaged over a 15-minute period. NIOSH further recommends that permissible levels of methylene chloride be reduced where carbon monoxide is present. The NIOSH Criteria Document for Methylene Chloride should be consulted for more detailed information.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Methylene chloride can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

### • Effects of overexposure

**1. Short-term Exposure:** Methylene chloride is an anesthetic. Inhaling the vapor may cause mental confusion,

light-headedness, nausea, vomiting, and headache. Continued exposure may cause increased light-headedness, staggering, unconsciousness, and death. High vapor concentrations may also cause irritation of the eyes and respiratory tract. Exposure to this chemical may make the symptoms of angina worse. Skin exposure to the liquid may cause irritation. If the liquid is held in contact with the skin, it may cause skin burns. Splashes of the liquid into the eyes may cause irritation.

**2. Long-term Exposure:** Prolonged or repeated exposure to methylene chloride may cause irritation of the skin.

**3. Reporting Signs and Symptoms:** A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to methylene chloride.

### • Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to methylene chloride at potentially hazardous levels:

#### 1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the employee at increased risk, and to establish a baseline for future health monitoring. Examination of the skin, liver, kidneys, cardiovascular system, and blood should be stressed. Clinical impressions of the autonomic nervous system and pulmonary function should be made, with additional tests conducted where indicated.

—Skin disease: Methylene chloride can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Liver function test: Methylene chloride causes liver damage in animals and this justifies consideration before exposing persons with impaired liver function. A profile of liver function should be obtained by utilizing a medically acceptable array of biochemical tests.

—Kidney disease: Methylene chloride causes kidney damage in animals and this justifies special considera-

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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tion before exposing persons with impaired renal function.

—Cardiovascular disease: Because of reports of excessive carbon monoxide levels following exposure to methylene chloride, persons with cardiac disease may be at increased risk.

—A complete blood count: A complete blood count should be performed, including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit. Carboxyhemoglobin values should also be determined periodically, and any level above 5% should prompt an investigation of the worker and his workplace.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis.

• **Summary of toxicology**

Methylene chloride vapor is a mild narcotic. Exposure of animals to 15,000 ppm for 7 hours was fatal. Animal experiments have shown that continuous exposure to 1,000 ppm can be lethal in 5 to 7 weeks for dogs and that fatty livers, icterus, pneumonia, and splenic atrophy developed in dogs. Cardiac arrhythmias attributed to sensitization of the myocardium have been observed following exposure to high concentrations of some chlorinated hydrocarbons, but dogs exposed to 10,000 and 20,000 ppm of methylene chloride did not show this phenomenon. In human experiments, inhalation of 500 to 1000 ppm for 1 to 2 hours resulted in lightheadedness; there was sustained elevation of carboxyhemoglobin level. High exposures have resulted in deaths in industrial situations. Lower but unknown concentrations have caused such symptoms as lightheadedness, weakness, nausea, and "drunken behavior," resulting in mistakes and accidental falls. Phosgene poisoning has been reported to occur in several cases where methylene chloride was used in the presence of an open fire. Liquid methylene chloride is irritating to the skin on repeated contact. Splashed in the eye, it is painfully irritating, but is not likely to cause serious injury.

## CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

1. Molecular weight: 84.9
2. Boiling point (760 mm Hg): 39.8 C (104 F)
3. Specific gravity (water = 1): 1.3
4. Vapor density (air = 1 at boiling point of methylene chloride): 2.9
5. Melting point: -97 C (-142 F)
6. Vapor pressure at 20 C (68 F): 350 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 1.32
8. Evaporation rate (butyl acetate = 1): 27.5

• **Reactivity**

1. Conditions contributing to instability: Heat and moisture
2. Incompatibilities: Contact with strong oxidizers, strong caustics, and chemically active metals such as

aluminum or magnesium powder, sodium and potassium may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released in a fire involving methylene chloride.

4. Special precautions: Liquid methylene chloride will attack some forms of plastics, rubber, and coatings.

• **Flammability**

1. Flash point: None with normal test method
2. Autoignition temperature: 556 C (1033 F)
3. Flammable limits in air, % by volume: (at elevated temperatures) Lower: 12; Upper: 19
4. Extinguishant: Dry chemical, carbon dioxide, foam

• **Warning properties**

1. Odor Threshold: Different authors have reported varying odor thresholds for methylene chloride. Summer and May both report 150 ppm; Kirk-Othmer and Sax both report 25 to 50 ppm; Spector reports 320 ppm. Ratty, however, states that since one can become adapted to the odor, it cannot be considered an adequate warning property.

2. Eye Irritation Level: Grant reports that methylene chloride "presents no particular hazard to the eyes." Kirk-Othmer, however, reports that "methylene chloride vapor is seriously damaging to the eyes." Sax agrees with Kirk-Othmer's statement.

The *Documentation of TLV's* states that irritation of the eyes has been observed in workers who had been exposed to concentrations up to 5000 ppm, but that neurasthenic disorders were found in 50% and digestive disturbances in 30% of the persons exposed.

3. Other Information: Gleason reports that methylene chloride may be "irritating to the respiratory tract and may produce pulmonary edema" but gives no quantitative information. The *Documentation of TLV's* reports that in one investigation, irritation of the respiratory passages was observed in workers who had been exposed to concentrations up to 5000 ppm.

4. Evaluation of Warning Properties: Since no detailed information is available relating the irritant effects of methylene chloride to air concentrations and since adaptation to the odor occurs, methylene chloride is treated as a material with poor warning properties.

## MONITORING AND MEASUREMENT PROCEDURES

• **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

#### • Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of methylene chloride. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

#### • Peak Above Ceiling Evaluation

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of methylene chloride. Each measurement should consist of a 30-minute sample or a series of consecutive samples totalling 30 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

#### • Method

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure methylene chloride may be used. An analytical method for methylene chloride is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

### RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

### PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid methylene chloride.

• Non-impervious clothing which becomes wet with liquid methylene chloride should be removed promptly and not reworn until the methylene chloride is removed from the clothing.

• Employees should be provided with and required to use splash-proof safety goggles where liquid methylene chloride may contact the eyes.

### SANITATION

• Skin that becomes wet with liquid methylene chloride should be promptly washed or showered with soap or mild detergent and water to remove any methylene chloride.

### COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to methylene chloride may occur and control methods which may be effective in each case:

Operation	Controls
Use as a solvent in paint and varnish removers; manufacture of aerosols; cold cleaning and ultrasonic cleaning; and as an extraction solvent for foods and furniture processing	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use as a cooling solvent in manufacture of cellulose acetate; in organic synthesis; and in plastics processing	Process enclosure; local exhaust ventilation
Use as a solvent in vapor degreasing of thermal switches and thermometers	Process enclosure; local exhaust ventilation
Use as a secondary refrigerant in air conditioning and scientific testing	General dilution ventilation; local exhaust ventilation; personal protective equipment

## Operation

Use as an extraction solvent for edible fats, coca, butter, beer flavoring in hops, decaffeinated coffee, oleoresin manufacture, oils, waxes, perfumes, flavorings, and drugs

Use as a solvent for paints, lacquers, varnishes, enamels, adhesives, rubber cements, manufacture of printed circuit boards, as a carrier for pharmaceutical tablet coatings, shrink-fitting of synthetic rubber covers, and dyeing of synthetic fibers

## Controls

General dilution ventilation; local exhaust ventilation; personal protective equipment

General dilution ventilation; local exhaust ventilation; personal protective equipment

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

### • Eye Exposure

If methylene chloride gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

### • Skin Exposure

If methylene chloride gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water if the methylene chloride has not already evaporated. If methylene chloride soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

### • Breathing

If a person breathes in large amounts of methylene chloride, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

### • Swallowing

When methylene chloride has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

### • Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL AND LEAK PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If methylene chloride is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.

## REFERENCES

- American Conference of Governmental Industrial Hygienists: "Methylene Chloride," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
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### RESPIRATORY PROTECTION FOR METHYLENE CHLORIDE

Condition	Minimum Respiratory Protection* Required Above 500 ppm
Vapor Concentration  5000 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood.  Any self-contained breathing apparatus with a full facepiece.
Greater than 5000 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.  A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors.  Any escape self-contained breathing apparatus.

\*Only NIOSH-approved or MSHA-approved equipment should be used.

VCI **VINYLDENE CHLORIDE, INHIBITED**

<p><b>Common Synonyms:</b> 1,1-Dichloroethylene vinyl-Dichloroethylene</p> <p><b>Wettable liquid</b>      <b>Colorless</b>      <b>Sweet odor</b></p> <p>Sinks in water. Flammable, irritating vapor is produced. Boiling point is 89°F.</p>	
<p>Avoid contact with liquid and vapor. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Shut off ignition sources and call for department. Stop discharge if possible. Stay upwind and use water spray to "knock down" vapor. Evacuate area in case of large discharge. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>	
<b>Fire</b>	<p><b>FLAMMABLE. POISONOUS GAS IS PRODUCED IN FIRE.</b> Containers may explode in fire. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear self-contained breathing apparatus. Combat fires from safe distance or protected location. Extinguish with dry chemical, foam, or carbon dioxide. Cool exposed container with water.</p>
<b>Exposure</b>	<p><b>CALL FOR MEDICAL AID</b></p> <p><b>VAPOR:</b> Irritating to eyes, nose, and throat. If inhaled, will cause dizziness or difficult breathing. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p><b>LIQUID:</b> Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. <b>IF IN EYES:</b> hold eyelids open and flush with plenty of water. <b>IF SWALLOWED</b> and victim is <b>CONSCIOUS</b>, have victim drink water or milk.</p>
<b>Water Pollution</b>	<p>Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Harmful to local health and wildlife officials. Notify operators of nearby water intakes.</p>
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Manual, CG 448-4) Insect warning — high flammability Evacuate area.</p>	<p><b>2. LABEL</b></p> 
<p><b>3. CHEMICAL DESIGNATIONS</b></p> <p>3.1 Synonyms: 1,1-Dichloroethylene vinyl-Dichloroethylene</p> <p>3.2 Coast Guard Compatibility Classification: Vinyl halides</p> <p>3.3 Chemical Formula: CH<sub>2</sub>=CCl<sub>2</sub></p> <p>3.4 NRCO/United Nations Hazardous Designation: 3.1/1303</p>	<p><b>4. OBSERVABLE CHARACTERISTICS</b></p> <p>4.1 Physical State (as shipped): Liquid</p> <p>4.2 Color: Colorless</p> <p>4.3 Odor: Sweet; like carbon tetrachloride or chloroform</p>
<p><b>5. HEALTH HAZARDS</b></p> <p>5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; rubber gloves and boots.</p> <p>5.2 Symptoms Following Exposure: Vapor can cause dizziness and drunkenness; high levels cause anesthesia. Liquid irritates eyes and skin.</p> <p>5.3 Treatment for Exposure: <b>INHALATION:</b> If any illness develops, remove person to fresh air promptly, keep warm and quiet, and get medical attention; if breathing stops, start artificial respiration. <b>INGESTION:</b> not likely a problem; no known antidote; treat symptomatically. <b>EYES OR SKIN:</b> flush with plenty of water for at least 15 min; get medical attention for eyes; remove contaminated clothing and wash before reuse.</p> <p>5.4 Toxicity by Inhalation (Threshold Limit Value): 25 ppm (suggested)</p> <p>5.5 Short-Term Inhalation Limits: Data not available</p> <p>5.6 Toxicity by Ingestion: Grade 3; Oral LD<sub>50</sub> 24 hr = 84 mg/kg (adrenal-accumulated rat)</p> <p>5.7 Late Toxicity: Data not available</p> <p>5.8 Vapor (Gas) Irritant Characteristics: Vapor causes moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.</p> <p>5.9 Liquid or Solid Irritant Characteristics: Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.</p> <p>5.10 Odor Threshold: Data not available</p>	

<p><b>6. FIRE HAZARDS</b></p> <p>6.1 Flash Point: 0°F O.C.</p> <p>6.2 Flammable Limits in Air: 7.3%—16.0%</p> <p>6.3 Fire Extinguishing Agents: Foam, carbon dioxide, dry chemical</p> <p>6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.</p> <p>6.5 Special Hazards of Combustion Products: Toxic hydrogen chloride and phosgene are generated in fire.</p> <p>6.6 Behavior in Fire: May explode in fire due to polymerization. Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.</p> <p>6.7 Ignition Temperature: 955—1031°F</p> <p>6.8 Electrical Hazard: Not pertinent</p> <p>6.9 Burning Rate: 2.7 mm/min.</p>	<p><b>8. WATER POLLUTION</b></p> <p>8.1 Aquatic Toxicity: Data not available</p> <p>8.2 Waterway Toxicity: Data not available</p> <p>8.3 Biological Oxygen Demand (BOD): Data not available</p> <p>8.4 Food Chain Concentration Potential: None</p>																																				
<p><b>7. CHEMICAL REACTIVITY</b></p> <p>7.1 Reactivity with Water: No reaction</p> <p>7.2 Reactivity with Common Materials: Copper and aluminum can cause polymerization.</p> <p>7.3 Stability During Transport: Stable</p> <p>7.4 Neutralizing Agents for Acids and Caustics: Not pertinent</p> <p>7.5 Polymerization: Can occur if exposed to sunlight, air, copper, aluminum, heat.</p> <p>7.6 Inhibitor of Polymerization: 200 ppm methyl ether of hydroquinone, 0.5—0.8% phenol</p>	<p><b>9. SELECTED MANUFACTURERS</b></p> <ol style="list-style-type: none"> <li>Dow Chemical Co Midland, Mich. 48640</li> <li>P P G Industries, Inc. Industrial Chemicals Division 1 Gateway Center Pittsburgh, Pa. 15222</li> <li>Valcan Materials Co. Chemicals Division Wichita, Kans. 67201</li> </ol>																																				
<p><b>11. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Manual, CG 448-3) A-X-Y-Z</p>	<p><b>10. SHIPPING INFORMATION</b></p> <p>10.1 Grade or Purity: 99%</p> <p>10.2 Storage Temperature: Ambient</p> <p>10.3 Inert Atmosphere: Padded</p> <p>10.4 Venting: Pressure-vacuum</p>																																				
<p><b>12. HAZARD CLASSIFICATIONS</b></p> <p>12.1 Code of Federal Regulations: Flammable liquid</p> <p>12.2 NAB Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>3</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>2</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>2</td> </tr> <tr> <td>Poisons</td> <td>3</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>0</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>2</td> </tr> <tr> <td>Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemical</td> <td>2</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self-Reaction</td> <td>3</td> </tr> </tbody> </table> <p>12.3 NFPA Hazard Classifications:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>4</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>2</td> </tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	2	Liquid or Solid Irritant	2	Poisons	3	Water Pollution		Human Toxicity	0	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity		Other Chemical	2	Water	0	Self-Reaction	3	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	4	Reactivity (Yellow)	2	<p><b>13. PHYSICAL AND CHEMICAL PROPERTIES</b></p> <p>13.1 Physical State at 15°C and 1 atm: Liquid</p> <p>13.2 Molecular Weight: 96.95</p> <p>13.3 Boiling Point at 1 atm: 85.9°F = 31.6°C = 304.8°K</p> <p>13.4 Freezing Point: -187.6°F = -122.0°C = 151.2°K</p> <p>13.5 Critical Temperature: Not pertinent</p> <p>13.6 Critical Pressure: Not pertinent</p> <p>13.7 Specific Gravity: 1.21 at 20°C (liquid)</p> <p>13.8 Liquid Surface Tension: 24 dynes/cm = 0.024 N/m at 15°C</p> <p>13.9 Liquid-Water Interfacial Tension: 37 dynes/cm = 0.037 N/m at 22.7°C</p> <p>13.10 Vapor (Gas) Specific Gravity: 3.3</p> <p>13.11 Ratio of Specific Heats of Vapor (Gas): Data not available</p> <p>13.12 Latent Heat of Vaporization: 130 Btu/lb = 72 cal/g = 3.0 × 10<sup>4</sup> J/kg</p> <p>13.13 Heat of Combustion: -4860 Btu/lb = -2700 cal/g = -113.0 × 10<sup>3</sup> J/kg</p> <p>13.14 Heat of Decomposition: Not pertinent</p> <p>13.15 Heat of Solution: Not pertinent</p> <p>13.16 Heat of Polymerization: -333 Btu/lb = -185 cal/g = -7.75 × 10<sup>3</sup> J/kg</p>
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<p><b>NOTES</b></p> <p>(Continued on pages 3 and 6)</p>																																					

# OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR BENZENE POTENTIAL HUMAN CARCINOGEN

## INTRODUCTION

This guideline summarizes pertinent information about benzene for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

## SUBSTANCE IDENTIFICATION

- **Formula:** C<sub>6</sub>H<sub>6</sub>
- **Structure:**



- **Synonyms:** Benzol, benzole, benzolene, bicarburet of hydrogen, carbon oil, coal naphtha
- **Identifiers:** CAS 71-43-2; RTECS CY1400000; DOT 1114, label required: "Flammable Liquid"
- **Appearance and odor:** Colorless liquid with an aromatic odor

## CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
  1. Molecular weight: 78.12
  2. Boiling point (at 760 mmHg): 80.1°C (176°F)
  3. Specific gravity (water = 1): 0.88
  4. Vapor density (air = 1 at boiling point of benzene): 2.7
  5. Melting point: 5.5°C (42°F)
  6. Vapor pressure at 20°C (68°F): 75 mmHg
  7. Solubility in water, g/100 g water at 20°C (68°F): 0.06
  8. Evaporation rate (butyl acetate = 1): 5.1
  9. Saturation concentration in air (approximate) at 25°C (77°F): 12.5% (125,000 ppm)
  10. Ionization potential: 9.25 eV
- **Reactivity**

Incompatibilities: Benzene reacts with strong oxidizers including chlorine, oxygen, and bromine with iron.

2. Hazardous decomposition products: Toxic vapors and gases (e.g., carbon monoxide) may be released in a fire involving benzene.

3. Caution: Benzene will attack some forms of plastics, coatings, and rubber.

### • Flammability

1. Flash point: -11.1°C (12°F) (closed cup)
2. Autoignition temperature: 498°C (928°F)
3. Flammable limits in air, % by volume: Lower, 1.4; upper, 7.1
4. Extinguishant: Alcohol foam, carbon dioxide, and dry chemical extinguishants are effective. Water may be an ineffective extinguishant but may be used to cool fire-exposed containers.
5. Class IB Flammable Liquid (29 CFR 1910.106), Flammability Rating 3 (NFPA)
6. Unusual fire and explosion hazards: Benzene liquid is flammable, and its vapors can easily form explosive mixtures. Flashbacks may occur along a vapor trail.

### • Warning properties

1. Odor threshold: 12 ppm
2. Eye irritation levels: 3,000 ppm for 0.5-1 hour
3. Other information: 3,000 ppm may irritate nose and respiratory tract.
4. Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

## EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for benzene is 1 part of benzene per million parts of air (PPM) as a time-weighted average (TWA) concentration over an 8-hour workshift; the short-term exposure limit is 5 ppm in any 15-minute sampling period. The National Institute for Occupational Safety and Health (NIOSH) recommends that benzene be controlled and handled as a potential human carcinogen in the workplace and that exposure be reduced to the lowest feasible limit. The NIOSH recommended exposure limit (REL) is 0.1 ppm [0.32 milligrams of benzene per cubic meter of air (mg/m<sup>3</sup>)] as an 8-hour TWA and 1 ppm (3.2 mg/m<sup>3</sup>) as a ceiling in any 15-minute sampling period. The NIOSH REL is the lowest con-

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Public Health Service Centers for Disease Control  
National Institute for Occupational Safety and Health  
Division of Standards Development and Technology Transfer

centration detectable by current NIOSH-validated sampling and analytical methods. The American Conference of Governmental Industrial Hygienists (ACGIH) has designated benzene as an A2 substance (suspected human carcinogen) having an assigned threshold limit value (TLV<sup>®</sup>) of 10 ppm (30 mg/m<sup>3</sup>) as a TWA for a normal 8-hour workday and a 40-hour workweek.

**Table 1.—Occupational exposure limits for benzene**

	Exposure limits	
	ppm	mg/m <sup>3</sup>
OSHA PEL TWA	1	—
Short-term exposure limit (15 min)	5	—
NIOSH REL (Ca)* TWA	0.1	0.32
Ceiling (15 min)	1	3.2
ACGIH TLV <sup>®</sup> TWA (A2)†	10	30

\* (Ca): NIOSH recommends treating as a potential human carcinogen.

†(A2): Suspected human carcinogen.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Benzene may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

### • Summary of toxicology

1. *Effects on animals:* Acute inhalation of benzene by rats, mice, or rabbits caused narcosis, spontaneous heart contractions (ventricular fibrillation), and death due to respiratory paralysis. Subchronic inhalation of benzene by rats produced decreased white blood cell counts, decreased bone marrow cell activity, increased red blood cell activity, and cataracts. In rats, chronic inhalation or oral administration of benzene produced cancers of the liver, mouth, and Zymbal gland. Inhalation of benzene by pregnant rats caused retardation of fetal development and increased fetal mortality.

2. *Effects on humans:* Acute inhalation exposure of benzene has caused nerve inflammation (polyneuritis), central nervous system depression, and cardiac sensitization. Chronic exposure to benzene has produced anorexia and irreversible injury to the blood-forming organs; effects include aplastic anemia and leukemia.

### • Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to benzene can cause dizziness, euphoria, giddiness, headache, nausea, staggering gait, weakness, drowsiness, respiratory irritation, pulmonary edema and pneumonia, gastrointestinal irritation, convulsions, and paralysis. Benzene can also cause irritation to the skin, eyes, and mucous membranes.

2. *Long-term (chronic):* Exposure to benzene can cause fatigue, nervousness, irritability, blurred vision, and labored breath-

ing. Repeated skin contact can cause redness, blistering, and dry, scaly dermatitis.

## RECOMMENDED MEDICAL PRACTICES

### • Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

### • Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to benzene, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, and respiratory, nervous, and hematopoietic (blood-cell-forming) systems. The physician should obtain baseline values for the complete blood count and a stained differential count of all blood cell types. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to benzene at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindi-

cations to job placement, include a history of chronic skin disease, concurrent dermatitis, or mild non-hemolytic anemia (e.g., mild iron-deficiency anemia).

• **Periodic medical screening and/or biologic monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker report symptoms that may be attributed to exposure to benzene. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the integrity and physiologic function of the skin, liver, and respiratory, nervous, and hematopoietic (blood-cell-forming) systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and the ATS: standardized questionnaires and tests of lung function.

• **Medical practices recommended at the time of job transfer or termination.**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to benzene may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• **Sentinel health events**

1. Acute SHE's include: Acute myeloid leukemia and contact and/or allergic dermatitis.
2. Delayed-onset SHE's include: Decrease in the number (neutropenia) or absence (agranulocytosis) of certain white blood cells in the peripheral circulation and/or in the bone marrow (aplastic anemia) and cancer of the red blood cells (erythro-leukemia).

## MONITORING AND MEASUREMENT PROCEDURES

• **TWA exposure evaluation**

Measurements to determine worker exposure to benzene should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• **Ceiling concentration evaluation**

Measurements to determine worker exposure should be taken during periods of maximum expected airborne concentrations of benzene. Each measurement to determine the NIOSH REL (ceiling exposure) in the worker's breathing zone (air that most nearly represents that inhaled by the worker) should consist of a 15-minute sample. A minimum of three measurements

should be taken during one workshift, and the highest of all measurements taken is an estimate of the worker's exposure. If the periods of maximum exposure are not clearly defined, a statistical procedure which can be used as a peak exposure detection strategy is given in the *Occupational Exposure Sampling Strategy Manual*.

• **Method**

Sampling and analysis may be performed by collecting benzene vapors with charcoal tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Direct-reading devices calibrated to measure benzene may also be used if available. A detailed sampling and analytical method for benzene may be found in the *NIOSH Manual of Analytical Methods* (method number 1500).

## PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with benzene.

## SANITATION

Clothing which is contaminated with benzene should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of benzene from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of benzene's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

A change room with showers, washing facilities, and lockers that permit separation of street and work clothes should be provided.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with benzene should be promptly washed with soap and water.

Workers who handle benzene should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or use of smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

## COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to benzene may occur and control methods which may be effective in each case are listed in Table 2.

**Table 2.—Operations and methods of control for benzene**

Operations	Controls
During the manufacture and processing of benzene; during use as a raw material in the production of aromatic compounds and derivatives	Process enclosure, local exhaust ventilation, personal protective equipment
During the use of chemicals in which benzene may be an impurity (e.g., naphthas, toluene, xylene)	Process enclosure, local exhaust ventilation, personal protective equipment
During the manufacture and use of motor fuel blends in which benzene is used as an ingredient; during use as an extracting solvent	Process enclosure (when possible), local exhaust ventilation, personal protective equipment, material substitution
During the preparation and use of paint and varnish removers, rubber cements, and lacquers	Process enclosure (when possible), local exhaust ventilation, personal protective equipment, material substitution

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

### • Eye exposure

Where there is any possibility of a worker's eyes being exposed to benzene, an eye-wash fountain should be provided within the immediate work area for emergency use.

If benzene gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

### • Skin exposure

Where there is any possibility of a worker's body being exposed to benzene, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If benzene gets on the skin, wash it immediately with soap and water. If benzene penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

### • Rescue

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If benzene is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities of liquids containing benzene, absorb on paper towels and place in an appropriate container.
4. Large quantities of liquids containing benzene may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.
5. Liquids containing benzene may be collected by vacuuming with an appropriate system. If a vacuum system is used, there should be no sources of ignition in the vicinity of the spill, and flashback prevention devices should be provided.

## WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

## RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

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**Table 3.—Respiratory protection for benzene**

Condition	Minimum respiratory protection*
Any detectable concentration	<p>Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode</p> <p>Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode</p>
Planned or emergency entry into environments containing unknown or any detectable concentration	<p>Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode</p> <p>Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode</p>
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	<p>Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic canister</p> <p>Any appropriate escape-type self-contained breathing apparatus</p>

\* Only NIOSH/MSHA-approved equipment should be used.

BNZ

## BENZENE

<p><b>Common Synonyms:</b> Benzene Benzol</p> <p><b>Physical State:</b> Volatile liquid</p> <p><b>Color:</b> Colorless</p> <p><b>Odor:</b> Gasoline-like odor</p> <p>Flashes on water. Flammable. Irritating vapor is produced. Freezing point is 42° F.</p>	
<p>Avoid contact with liquid and vapor. Keep people away. Wear goggles and self-contained breathing apparatus. Shut off ignition sources and call fire department. Stop discharge if possible. Stay upwind and use water spray to "soak down" vapor. Soak and remove discolored material. Notify local health and pollution control agencies.</p>	
<b>Fire</b>	<p><b>FLAMMABLE.</b> Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>
<b>Exposure</b>	<p><b>CALL FOR MEDICAL AID.</b></p> <p><b>VAPOR:</b> Irritating to eyes, nose and throat. If inhaled, will cause headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p><b>LIQUID:</b> Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. <b>IF IN EYES:</b> hold eyelids open and flush with plenty of water. <b>IF SWALLOWED</b> and victim is <b>CONSCIOUS</b>, have victim drink water or milk.</p>
<b>Water Pollution</b>	<p><b>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.</b> May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook, CG 448-4) Issue warning—high flammability Restrict access</p>	<p><b>2. LABEL</b></p> 
<p><b>3. CHEMICAL DESIGNATIONS</b></p> <p>3.1 Synonyms: Benzol Benzole</p> <p>3.2 Coast Guard Compatibility Classification: Aromatic hydrocarbon</p> <p>3.3 Chemical Formula: C<sub>6</sub>H<sub>6</sub></p> <p>3.4 IBCO/United Nations Numerical Designation: 3.2/1114</p>	<p><b>4. OBSERVABLE CHARACTERISTICS</b></p> <p>4.1 Physical State (as shipped): Liquid</p> <p>4.2 Color: Colorless</p> <p>4.3 Odor: Aromatic; rather pleasant aromatic odor; characteristic odor</p>
<p><b>5. HEALTH HAZARDS</b></p> <p>5.1 Personal Protective Equipment: Hydrocarbon vapor canister, wrapped air or a hose mask; hydrocarbon-insoluble rubber or plastic gloves; chemical goggles or face splash shield; hydrocarbon-soluble apron such as neoprene.</p> <p>5.2 Symptoms Following Exposure: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death.</p> <p>5.3 Treatment for Exposure: SKIN: flush with water followed by soap and water; remove contaminated clothing and wash skin. EYES: flush with plenty of water until irritation subsides. INHALATION: remove from exposure immediately. Call a physician. If breathing is irregular or stopped, start resuscitation, administer oxygen.</p> <p>5.4 Toxicity by Inhalation (Threshold Limit Value): 25 ppm</p> <p>5.5 Short-Term Inhalation Limit: 75 ppm for 30 min.</p> <p>5.6 Toxicity by Ingestion: Grade 3; LD<sub>50</sub> 50 to 500 mg/kg</p> <p>5.7 Late Toxicity: Leukemia</p> <p>5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary.</p> <p>5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause staining and reddening of the skin.</p> <p>5.10 Odor Threshold: 4.66 ppm</p>	

<p><b>6. FIRE HAZARDS</b></p> <p>6.1 Flash Point: 12°F.C.C.</p> <p>6.2 Flammable Limits in Air: 1.3%—7.9%</p> <p>6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide</p> <p>6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective</p> <p>6.5 Special Hazards of Combustion Products: Not pertinent</p> <p>6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back</p> <p>6.7 Ignition Temperature: 1097°F</p> <p>6.8 Electrical Hazard: Class I, Group D</p> <p>6.9 Burning Rate: 6.0 mm/min</p>	<p><b>8. WATER POLLUTION</b></p> <p>8.1 Aquatic Toxicity: 5 ppm/6 hr/minnow/lethal/distilled water 20 ppm/24 hr/sunfish/TLm/iso water</p> <p>8.2 Waterfowl Toxicity: Data not available</p> <p>8.3 Biological Oxygen Demand (BOD): 1.2 lb/lb, 10 days</p> <p>8.4 Feed Chain Concentration Potential: None</p>																																				
<p><b>7. CHEMICAL REACTIVITY</b></p> <p>7.1 Reactivity with Water: No reaction</p> <p>7.2 Reactivity with Common Materials: No reaction</p> <p>7.3 Stability During Transport: Stable</p> <p>7.4 Neutralizing Agents for Acids and Bases: Not pertinent</p> <p>7.5 Polymerization: Not pertinent</p> <p>7.6 Inhibitor of Polymerization: Not pertinent</p>	<p><b>9. SELECTED MANUFACTURERS</b></p> <p>1. Commonwealth Oil Refining Co., Inc. Commonwealth Petrochemical Co. Penuelas, Puerto Rico 00724</p> <p>2. Phillips Petroleum Co. Phillips Puerto Rico Corp. Inc. Banco Popular Center Hato Rey, P. R. 00936</p> <p>3. Shell Chemical Co. Petrochemicals Div. P. O. Box 2463 Houston, Texas 77001</p>																																				
<p><b>11. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook, CG 448-3) A-T-U-V-W</p>	<p><b>10. SHIPPING INFORMATION</b></p> <p>10.1 Grades or Purity: Industrial pure ..... 99+% Thiophene-free ..... 99+% Nitration ..... 85+% Industrial 90% ..... 99+% Reagent ..... 99+%</p> <p>10.2 Storage Temperature: Ambient</p> <p>10.3 Inert Atmosphere: No requirement</p> <p>10.4 Venting: Pressure-vacuum</p>																																				
<p><b>12. HAZARD CLASSIFICATIONS</b></p> <p>12.1 Code of Federal Regulations: Flammable liquid</p> <p>12.2 NFPA Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>3</td> </tr> <tr> <td>Health</td> <td>1</td> </tr> <tr> <td>Vapor Irritant</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>Poison</td> <td>3</td> </tr> <tr> <td>Water Pollution</td> <td>1</td> </tr> <tr> <td>Herman Toxicity</td> <td>3</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>2</td> </tr> <tr> <td>Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td>1</td> </tr> <tr> <td>Other Chemicals</td> <td>0</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self-Reaction</td> <td>0</td> </tr> </tbody> </table> <p>12.3 NFPA Hazard Classifications:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>	Category	Rating	Fire	3	Health	1	Vapor Irritant	1	Liquid or Solid Irritant	1	Poison	3	Water Pollution	1	Herman Toxicity	3	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity	1	Other Chemicals	0	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	3	Reactivity (Yellow)	0	<p><b>13. PHYSICAL AND CHEMICAL PROPERTIES</b></p> <p>13.1 Physical State at 18°C and 1 atm: Liquid</p> <p>13.2 Molecular Weight: 78.11</p> <p>13.3 Boiling Point at 1 atm: 176°F = 80.1°C = 353.3°K</p> <p>13.4 Freezing Point: 42.0°F = 5.5°C = 278.7°K</p> <p>13.5 Critical Temperature: 552.0°F = 288.9°C = 562.1°K</p> <p>13.6 Critical Pressure: 710 psia = 48.3 atm = 4.89 MN/m<sup>2</sup></p> <p>13.7 Specific Gravity: 0.879 at 20°C (liquid)</p> <p>13.8 Liquid Surface Tension: 28.9 dynes/cm = 0.0289 N/m at 20°C</p> <p>13.9 Liquid-Water Interfacial Tension: 35.0 dynes/cm = 0.035 N/m at 20°C</p> <p>13.10 Vapor (Gas) Specific Gravity: 2.7</p> <p>13.11 Ratio of Specific Heats of Vapor (Gas): 1.061</p> <p>13.12 Latent Heat of Vaporization: 169 Btu/lb = 94.1 cal/g = 3.94 × 10<sup>5</sup> J/kg</p> <p>13.13 Heat of Combustion: -17,460 Btu/lb = -9698 cal/g = -406.0 × 10<sup>3</sup> J/kg</p> <p>13.14 Heat of Decomposition: Not pertinent</p> <p>13.15 Heat of Solution: Not pertinent</p> <p>13.16 Heat of Polymerization: Not pertinent</p>
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Fire	3																																				
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<p><b>NOTES</b></p> <p>(Continued on pages 3 and 4)</p>																																					

DOP

## DIOCTYL PHTHALATE

<p>Common Synonyms: Phthalic acid, bis(2-octylthexyl ester) DOP Di(2-octylthexyl) phthalate Di(2-octylthexyl) phthalate Octol</p>		<p>Oilily liquid</p>	<p>Colorless</p>	<p>Slight odor</p>
<p>Stop discharge if possible. Call fire department. Isolate discharge if possible. Notify local health and pollution control agencies.</p>				
<p><b>Fire</b></p>		<p>Combustible. Extinguish with dry chemical, foam, or carbon dioxide.</p>		
<p><b>Exposure</b></p>		<p>Not harmful.</p>		
<p><b>Water Pollution</b></p>		<p>Effect of low concentrations on aquatic life is unknown. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>		
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Worksheet, CG 446-4) Mechanical containment Chemical and physical treatment</p>		<p><b>2. LABELS</b> No hazard label required by Code of Federal Regulations.</p>		
<p><b>3. CHEMICAL DESIGNATIONS</b></p> <p>3.1 Synonyms: Bis(2-octylthexyl) phthalate Di(2-octylthexyl) phthalate DOP Octol Phthalic acid, bis(2-octylthexyl) ester</p> <p>3.2 Comd Guard Compatibility Classification: E412</p> <p>(Continued on page 4)</p>		<p><b>4. OBSERVABLE CHARACTERISTICS</b></p> <p>4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Very slight, characteristic</p>		
<p><b>5. HEALTH HAZARDS</b></p> <p>5.1 Personal Protective Equipment: Not required 5.2 Symptoms Following Exposure: Produces no ill effects at normal temperatures but may give off irritating vapor at high temperature. 5.3 Treatment for Exposure: Leave contaminated area; wash skin with soap and water; flush eyes with water. 5.4 Toxicity by Inhalation (Threshold Limit Value): Not pertinent 5.5 Short-Term Inhalation Limits: Not pertinent 5.6 Toxicity by Ingestion: Grade 0; LD<sub>50</sub> above 15 g/kg (rat) 5.7 Late Toxicity: Not established 5.8 Vapor (Gas) Irritant Characterization: Nonirritating to the eyes and throat. 5.9 Liquid or Solid Irritant Characterization: No appreciable hazard. Practically harmless to the skin. 5.10 Odor Threshold: Not pertinent</p>				
<p><b>6. FIRE HAZARDS</b></p> <p>6.1 Flash Point: 425°F O.C. 6.2 Flammable Limits in Air: Not pertinent 6.3 Fire Extinguishing Agents: Dry powder, carbon dioxide, foam 6.4 Fire Extinguishing Agents Not to be Used: Water or foam may cause frothing 6.5 Special Hazards of Combustion Products: None 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: Data not available 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Data not available</p>				
<p><b>7. CHEMICAL REACTIVITY</b></p> <p>7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent</p>				
<p><b>8. WATER POLLUTION</b></p> <p>8.1 Aquatic Toxicity: Data not available 8.2 Waterway Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None</p>				
<p><b>9. SELECTED MANUFACTURERS</b></p> <p>1. Allied Chemical Corp. Plastics Division Morristown, N. J. 07960 2. W. R. Grace &amp; Co. Haco Chemical Division Fords, N. J. 08033 3. Monsanto Corp. Monsanto Industrial Chemicals Co. 800 N. Lindbergh Blvd. St. Louis, Mo. 63166</p>				
<p><b>10. SHIPPING INFORMATION</b></p> <p>10.1 Grades or Purity: Data not available 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open flame arresters</p>				
<p><b>11. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Worksheet, CG 446-3) A-T-U-X-Y</p>		<p><b>13. PHYSICAL AND CHEMICAL PROPERTIES</b></p> <p>13.1 Physical State at 18°C and 1 atm: Liquid 13.2 Molecular Weight: 380.6 13.3 Boiling Point at 1 atm: 727°F = 386°C = 654°K 13.4 Freezing Point: Not pertinent 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 0.980 at 25°C (liquid) 13.8 Liquid Surface Tension: (25°C) 15 dynes/cm = 0.015 N/m at 20°C 13.9 Liquid-Water Interfacial Tension: (25°C) 30 dynes/cm = 0.03 N/m at 20°C 13.10 Vapor (Gas) Specific Gravity: Not pertinent 13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 13.12 Latent Heat of Vaporization: Not pertinent 13.13 Heat of Combustion: -15,130 Btu/lb = -4410 cal/g = -352 x 10<sup>3</sup> J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent</p> <p>(Continued on pages 5 and 6)</p>		
<p><b>3. CHEMICAL DESIGNATIONS (Cont'd.)</b></p> <p>3.3 Chemical Formula: C<sub>24</sub>H<sub>40</sub>O<sub>4</sub> (COO C<sub>8</sub>H<sub>17</sub>CH<sub>2</sub>CH<sub>2</sub>)<sub>2</sub></p> <p>3.4 IMCO/United Nations Hazardous Designation: Not listed</p>				

REVISED 1978

**APPENDIX B**

**SAIC CERTIFICATION HEALTH AND SAFETY CERTIFICATION DOCUMENTS**



Science Applications International Corporation

# CERTIFICATE OF COMPLETION

Presented to:

**WAYNE STONER**

OSHA 8-HOUR REFRESHER TRAINING  
SITE HEALTH AND SAFETY

(MANDATED BY 29 CFR 1910.120)

August 6, 1993

Completion Date

*Robert Reindorf*  
Course Director



# CERTIFICATE OF COMPLETION

Presented to:

**CHRISTOPHER MANIKAS**

OSHA 8-HOUR REFRESHER TRAINING  
SITE HEALTH AND SAFETY

(MANDATED BY 29 CFR 1910.120)

August 6, 1993

Completion Date

*Robert Rivarolo*

Course Director



Science Applications International Corporation

# CERTIFICATE OF COMPLETION

Presented to:

**CHRISTOPHER MANIKAS**

OSHA 8-HOUR REFRESHER TRAINING  
SITE HEALTH AND SAFETY

(MANDATED BY 29 CFR 1910.120)

August 6, 1993

Completion Date

*Robert Rueloff*

Course Director



# CERTIFICATE OF COMPLETION

This is to certify that  
**THOMAS J. VIETS**  
has successfully completed

OSHA HAZ-MAT SITE WORKER (Annual Recertification)

at

HAZMAT T.I.S.I; COLUMBIA, MARYLAND

A stylized signature in black ink, appearing to read "D. E. H.", written over a horizontal line.

Chief Operating Officer

A stylized signature in black ink, appearing to read "Eth Conway", written over a horizontal line.

Chief Executive Officer

April 28, 1993  
REF-9304B



# CERTIFICATE OF COMPLETION

This is to certify that  
**PAIGE A. DILLON**  
has successfully completed  
OSHA HAZ-MAT SITE WORKER (Annual Recertification)  
at

HAZMAT T.I.S.I; COLUMBIA, MARYLAND

*DOE*

Chief Operating Officer

*E. Conway*

Chief Executive Officer

April 28, 1993  
REF-9304B