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FINAL
RI/FS
HEALTH AND SAFETY PLAN

SITES 69, 74, and 41

MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0106

Prepared For:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

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A Baker Environmental, Inc. Safety Standard Operating Procedures
B Material Safety Data Sheets
C Chemical Agent Identification Sets Information
D Technical Escort Unit SOPs*
E Emergency Procedures for Exposure to Hazardous Materials/Waste

* This appendix will be available and included with the Health and Safety Plan at the time of the site mobilization, scheduled for January 3, 1994.

EXECUTIVE SUMMARY

Subcontractors will be on site to assist with detecting UXO, Hydropunching™, and drilling. The U.S. Army Technical Escort Unit (TEU) will be on site to assist the screening of samples for chemical agents, chemical agent monitoring and identification, and emergency decontamination. Section 2.0 describes the subcontractor's responsibilities.

Several potential chemical and physical hazards are associated with the tasks of this project at Sites 69, 74, and 41. The chemical hazards include the potential for exposure to various chemicals, including volatile organic compounds (VOCs), pesticides, polychlorinated biphenyls (PCBs), and mustard agents. The physical hazards of this project are from the use of heavy equipment (drill rig and back hoe), potential unexploded ordnances (UXO), temperature stress, and the limitations using personnel protective equipment. The environmental hazards include the various degrees of hazardous flora and fauna. Section 3.0 describes these hazards.

Environmental monitoring requirements consists of using an oxygen/combustible gas meter, an HNu with an 11.7 electron volt (eV) bulb, and chemical agent monitoring equipment (Minicam). Section 5.0 describes air monitoring requirements including frequency, action levels, operation, and documentation.

Various levels will be required for the different site tasks. The protection levels will range between Level D, Modified Level D (D+), Level C, and Level B. Each of these protection levels is discussed in Section 6.0.

1.0 INTRODUCTION

1.1 Policy

It is the policy of Baker Environmental, Inc. (Baker) that all on-site hazardous waste management activities be performed in conformance with a Site-Specific Health and Safety Plan (HASP). The HASP is written based on the anticipated hazards and expected work conditions and applies to activities performed by both Baker and subcontractor personnel. The HASP may be modified/updated with the approval of the Project Health and Safety Officer (PHSO) and Project Manager. Proper notification will be given to the Navy Technical Representative (NTR) when significant changes to the plan are implemented.

Baker's HASPs are based on an outline developed by the U.S. Coast Guard for responding to hazardous chemical releases (U.S.C.G. Pollution Response COMDTINST-M16465.30) and by National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Coast Guard (USCG), and U.S. Environmental Protection Agency's (USEPA) recommended health and safety procedures (Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities). This plan, at a minimum, meets the requirements under OSHA Standard 29 CFR 1910.120 (Hazardous Waste Operations and Emergency Response). This Site-Specific HASP has been designed for field investigation and sampling activities at Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina, Sites 69, 74, and 41.

1.2 References

The following publications have been referenced in the development and implementation of this HASP.

- American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices for 1993-1994.

- NIOSH/OSHA/USCG/USEPA. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. October 1985.

- USCG. Policy for Response to Hazardous Chemical Releases. USCG Pollution Response COMDTINST-M16465.30.

- U.S. Department of the Army. The Army Toxic Chemical Agent Safety Program, Army Regulation 385-61.

- U.S. Department of the Army. Safety Regulations for Chemical Agents H, HD, HT, GB and VX, AMC Regulation 385-131.

- U.S. Department of Health and Human Services, June 1990, Public Health Service, Centers for Disease Control, NIOSH. NIOSH Pocket Guide to Chemical Hazards.

- USEPA, Office of Emergency and Remedial Response, Emergency Response Division. Standard Operating Safety Guides. June 1992.

- Water and Air Research, Inc. Initial Assessment Study of Marine Corps Base Camp Lejeune, North Carolina, Prepared for Naval Energy and Environmental Support Activity (NEESA). April 1983.

1.3 Pre-Entry Requirements

During the initiation of site activities (site mobilization) and prior to the investigation, the SHSO will perform a reconnaissance of the anticipated work areas as identified in the Work Plan, establish or confirm emergency points of contact and procedures, and review any other issues deemed necessary to address site safety and health. The SHSO will then call a meeting with site personnel (as identified in Section 2.0) to discuss data obtained from the previous site reconnaissance, provisions outlined in this HASP, and appropriate safety and health related procedures/protocols.

2.0 PROJECT PERSONNEL AND RESPONSIBILITIES

The following personnel are designated to carry out the stated job functions for both on- and off-site activities. (Note: One person may carry out more than one job function, and personnel identified are subject to change.). The responsibilities that correspond with each job function are outlined below.

PROJECT MANAGER: Mr. Raymond Wattras

The project manager is responsible for assuring that all activities are conducted in accordance with the HASP. The Project Manager has the authority to suspend field activities if employees are in danger of injury or exposure to harmful agents. In addition, the Project Manager is responsible for:

- Assisting the Project Health and Safety Officer in Site-Specific HASP development for all phases of the project.
- Designating a Site Health and Safety Officer and other site personnel who will assure compliance with the HASP.
- Reviewing and approving the information presented in this HASP.

PROJECT HEALTH AND SAFETY OFFICER (PHSO): Mr. Ronald Krivan, CSP

The Project Health and Safety Officer is responsible for development and monitoring of compliance with the HASP. The PHSO will be the primary contact for inquiries as to the contents of the HASP. The PHSO will approve changes to the HASP. The PHSO's responsibilities include:

- Coordinating the review, evaluation, and approval of the HASP.
- Developing amendments to the HASP when applicable.
- Resolving issues that arise in the field with respect to interpretation or implementation of the HASP.

- Monitoring the field program through a regular review of field health and safety records, on-site activity audits, or a combination of both.

- Determining if on-site personnel have received the required training and medical surveillance prior to entry onto the site.

SITE MANAGER: Mr. Pete Monday

The Site Manager is responsible for assuring that site activities are conducted in accordance with the HASP. The Site Manager has the immediate authority to suspend field activities if employees are subjected to a situation that can be immediately dangerous to life or health. The Site Manager's responsibilities include:

- Assuring that the appropriate health and safety equipment and PPE is available and that it is properly maintained.

- Coordinating overall site access and security measures.

- Controlling site access, including documenting all personnel arriving/departing the site (by name, company, and time).

- Coordinating site safety and health issues with the SHSO.

- Assisting the SHSO in coordinating emergency procedures with the Naval Activity, emergency medical responders, etc., during site mobilization activities.

SITE HEALTH AND SAFETY OFFICER: Mr. Ronald Krivan, CSP

The SHSO is responsible for the implementation of the HASP. These responsibilities include:

- Coordinating and documenting the pre-entry HASP briefing and periodic (weekly) briefings.

- Assuring that monitoring equipment is properly calibrated, used, and maintained.

- Managing health and safety equipment, including instruments, respirators, PPE, etc., that are used in field activities.

- Arranging emergency response provisions in cooperation with Naval Activity Requirements, emergency medical care, etc., during site mobilization activities.

- Monitoring field activities for compliance with the HASP. Evaluate the need for work procedure or PPE changes and notifying the PHSO and Project Manager of any changes.

- Documenting relevant health and safety events; site monitoring information; accident investigation and reporting; safety inspections; and site conditions.

- Overseeing the decontamination of personnel and equipment.

- Determining safe boundary locations and procedures for activities requiring Level C or higher protection.

- Implementing the Baker Hazard Communication Program on site.

- Suspending field activities if the health and safety of personnel are endangered.

- Auditing the subcontractor training and medical surveillance records to verify compliance.

- Acting as the Emergency Coordinator and assuring the availability of a communication network and deployment of the HASP and emergency equipment to field teams.

- Assuring compliance with the Standard Operating Procedures (SOPs) in Appendix A.

FIELD TEAM LEADER: _____ (To be named prior to on-site activities) _____

The Field Team Leader is responsible for:

- Implementing safety procedures relevant to the tasks under his/her direction.
- Determining safe boundary for activities requiring Level D or D+ protection levels.
- Assuring that PPE is properly maintained.
- Complying with the conditions as outlined under Field Team Members.

FIELD TEAM MEMBERS: (To be named prior to site activities)

_____	_____	_____
_____	_____	_____
_____	_____	_____

The Field Team Members are responsible for:

- Becoming familiar with the HASP.
- Attending training sessions to review the HASP and additional safety and health information.
- Being alert to identified and unidentified hazards.
- Reporting unidentified hazards to the SHSO and Site Manager.
- Offering suggestions, ideas, or recommendations that may improve site safety.
- Complying with the contents of the HASP.
- Conducting site activities in a cautious, safe, and professional manner.
- Reporting accidents/injuries, however minor, to the SHSO as soon as possible.

Subcontractor personnel are responsible for:

- Complying with the conditions as outlined under Field Team Members.
- Obtaining the appropriate training, fit testing, and medical surveillance requirements under 29 CFR 1910.120 and 1910.134 and providing this documentation to the Site Manager.
- Complying with the training and medical surveillance requirements as outlined in Sections 9.0 and 10.0, respectively, and providing his/her own PPE that meets or exceeds the level of protection as outlined in this HASP.

SUBCONTRACTOR COMPANIES:

Drilling Operations:	Harden Huber, Inc.
Survey Operations:	(To Be Determined per Baker's Basic Ordering Agreements)
Geophysical Operations:	Geo-Center
UXO Identification:	Geo-Center
Hydropunch™ Operations:	(To Be Determined per Baker's Basic Ordering Agreements)

NAVFACENGCOM REPRESENTATIVE:

Ms. Linda Berry, P.E., (NTR) (804) 322-4793

ACTIVITY/BASE REPRESENTATIVES:

Mr. Neal Paul (CLEJ EMD) (910) 451-5063

FEDERAL/STATE/LOCAL REPRESENTATIVES:

Ms. Gena Townsend (USEPA, Region IV) (404) 347-3016

Mr. Patrick Watters (N.C. DEHNR) (919) 733-2801

INDEPENDENT REPRESENTATIVE:

U.S. Army Technical Escort Unit (TEU)

3.0 SITE CHARACTERIZATION

3.1 Site Background

The information contained in this section has been obtained from an April 1983 NEESA document titled Initial Assessment Study of Marine Corps Base Camp Lejeune, North Carolina. This site information is for Sites 69, 74, and 41. A site location map for all three sites is presented in Figure 3-1.

3.1.1 Site 69 - Rifle Range Chemical Landfill

The Rifle Range Chemical Landfill is located approximately 9,000 feet east of the intersection of Range Road and Sneads Ferry Road, north of Everett Creek. The site is an estimated 6 acres in size, containing approximately 93,000 cubic yards of material. Available records indicate the site was active from the early 1950s until 1976. It is reported that the site was utilized as a disposal area for all chemical wastes generated on the base. The list of materials disposed at the site include the following: pentachlorophenol, DDT, trichloroethylene, malathion, diazinon, lindane, gas cylinders, HTH, polychlorinated biphenyls (PCBs), drums that appeared to contain a training agent consisting of chloroacetophenone (CN) gas, all other hazardous materials generated or used on the base, and chemical agent test kits for chemical warfare, which contain no agent substances. The chemical agent test kits were a type called "Kit, Chemical Agent Detector, M255" for detecting mustards, nitrogen mustards, arsenicals and phosgene. This kit was located on the surface of the site. No background information exists that indicate that these kits were buried in this area.

Material was disposed in trenches or pits that were between 6 to 20 feet deep. At least 12 different disposal events have been documented. Some PCBs, sealed in cement septic tanks, are reported to be buried here.

Two reports of atmospheric emissions were noted. One incident occurred possibly as a result of meteorological conditions; the second incident was caused by accidental disturbance of the ground at the site by grading/disking machinery.

Both fired and unfired blank rifle cartridges were found on the ground within the boundaries of this site. The presence of these cartridges indicate that troop training exercises may have extended into this area, possibly at night when warning signs might not have been seen.

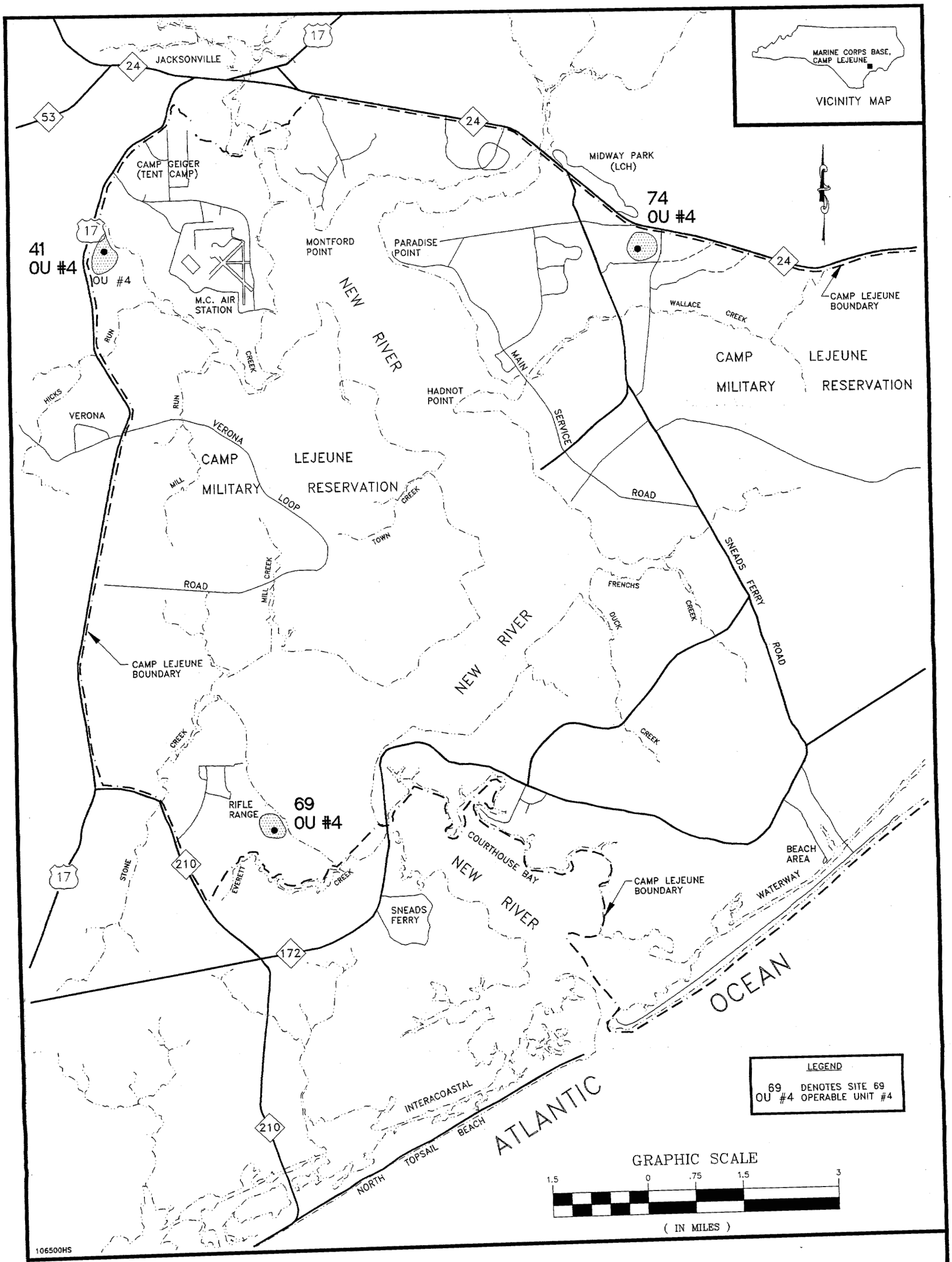


FIGURE 3-1
SITE LOCATIONS AT
MARINE CORPS BASE CAMP LEJEUNE

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02318T01Z

One disposal incident occurred in 1953 or 1954. About 50 drums of what is believed to be training agent were delivered on rubber padded trucks and were buried in two trenches. The drums were described as being "not nearly as heavy as if filled with oil". These drums were placed in the pit one at a time and laid side by side. These two pits were up to 20 feet deep and the drums were stacked so that the top layer was five or six feet below ground level when the drums were covered. Gas masks with some type of adsorption canister and other protective clothing were worn by those people present. The heavy equipment operator reported that he itched after working at this site. The drums were light blue or bluish-green and unmarked.

In 1970, another burial incident took place during which 5-gallon cans and 55-gallon drums of DDT, trichloroethylene (TCE), and calcium hypochlorite were placed together in a common pit. When earth was being placed over the containers, an explosion and fire occurred which caused a forest fire and blew drums from the pit into the forest about 40 yards from the pit. A fire truck and base safety personnel were present. Some of those present possessed gas masks.

3.1.2 Site 74 - Mess Hall Grease Pit Disposal Area

The Mess Hall Grease Pit Disposal Area is located in a wooded area approximately 1/2 mile east of Holcomb Boulevard in the northeast portion of Camp Lejeune. The Pest Control Area is located approximately 20 to 50 yards south of the grease pit and 75 yards east of Supply Well 654. The disposal area north of the dirt access road is approximately 3 acres in size. The grease pit measured 135 feet long, 30 feet wide, and 12 feet deep. The total size of the Pest Control Area has been estimated at 100 feet by 100 feet.

Available information indicates the site was active from the early 1950s until 1960. Three separate activities occurred in this area:

- Grease from mess halls was deposited in a large pit;
- Burials of 55-gallon drums, possibly containing PCB transformer oil and pesticides occurred near the grease pit; and
- Burlap bags of sawdust were soaked in a DDT solution and then later deposited in wetland areas for mosquito control.

Disposal activities at the site included the placement of mess hall grease and some waste food into a pit. Records indicate that there was at least one unsuccessful attempt to burn the grease

using a more volatile substance. The material was washed out of the pit in 1954, when Hurricane Hazel passed through the area. Use of the pit was discontinued at this time. No estimates regarding the quantity of grease disposed of at the site have been made.

Drums and pesticide-soaked bags were dumped near the grease pit. Detailed information regarding the contents of the drums is not available. Personnel involved with disposal of the drums were not informed of the drum's contents or origin. It is speculated that the drums may have contained pesticides and/or transformer oil containing PCBs. Best estimates indicate that approximately 500 gallons of pesticides were released from the deposition of the bags. Approximately 2,200 gallons of pesticides, contained in drums, were deposited at the site. It is estimated that 1,100 gallons of PCB-containing oil were buried at the site. Some drums may have been left over from a burial/disposal incident at the Rifle Range Chemical Landfill (Site No. 69).

3.1.3 Site 41 - Camp Geiger Landfill

Site 41 (Camp Geiger Landfill) is located south of the terminus of Robert L. Wilson Boulevard and the abandoned trailer park. The site lies between an unnamed creek and Tank Creek, east of U.S. Highway 17.

Site 41 was used as an open burn dump from 1946 to 1970. It received a mixture of industrial waste, commercial waste, and construction debris including waste oils, solvents, garbage, trash, asphalt, concrete, batteries, Mirex®, and ordnance.

It is estimated, based on interviews with MCAS New River and Camp Lejeune personnel, that 10,000 to 15,000 gallons of waste oils and solvents were disposed at Site 41. Most of the waste solvents and oils were burned after disposal. The number of batteries containing lead that were disposed at the site is assumed to be relatively small. Tons of Mirex® in bags were disposed in 1964. The disposed quantity of ordnance is estimated to include thousands of mortar shells, at least one case of grenades and a 105mm cannon shell.

In the mid-1960s, at least two waste disposal incidents occurred, during which two truckloads of drummed wastes were unloaded. These wastes were described as being similar to those disposed at the Rifle Range Chemical Landfill, Site 69 (see Section 3.1.2).

3.2 Site Work Plans

The Work Plan (detailing the tasks to be performed at each site), the Sampling and Analysis Plan (SAP), and Quality Assurance Project Plan (QAPP) are bound as separate documents. Site work tasks included for Sites 69, 74, and 41 are:

- Sediment/Surface Water Sampling
- Surface Soil Sampling
- Monitoring Well Installation
- Groundwater Sampling

In addition, a geophysical survey will be performed at Site 41 and Hydropunching™ will be performed at Sites 41 and 69.

3.3 Hazard Evaluation

The following subsections will identify the potential task-specific, chemical, physical, and environmental hazards associated with these work tasks to be performed under this HASP.

3.3.1 Task-Specific Hazards

Hazards at each of the sites may be associated with the job tasks as detailed in the Work Plan; listed below are summaries for the potential hazards associated with each task where specified. An UXO clearance contractor will provide expertise in the location of sampling points (i.e., monitoring well installation locations and soil sampling locations) before activities commence at the sites.

Geophysical Investigation - Site 41

Chemical

- Skin contact with potentially contaminated soils.
- Ingestion of contaminated material from hand to mouth contact.

Physical/Environmental

- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Interaction with native and potentially hostile animal life.

Sediment/Surface Water Sampling - Sites 69, 74, and 41

Chemical

- Potential for contaminated material to be splashed onto body or in eyes.
- Ingestion of contaminated material from hand to mouth contact.
- Inhalation of volatile constituents within the sediments or surface water.
- Absorption of constituents through the skin.

Physical/Environmental

- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Interaction with native and potentially hostile animal life.

Surface Soil Sampling - Sites 69, 74, and 41

Chemical

- Skin contact with potentially contaminated soils.
- Ingestion of hazardous materials from hand to mouth contact.
- Inhalation of volatile contaminants within the surface soil.

Physical/Environmental

- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Interaction with native and potentially hostile animal life.
- Muscle strain from boring with hand auger.
- Contact with UXO.

Monitoring Well Installation - Sites 69, 74, and 41

Chemical

- Potentially-contaminated mud, etc. in eyes and on skin.
- Contact with potentially contaminated material.
- Ingestion of hazardous materials from hand to mouth contact.
- Inhalation of volatile contaminants.

Physical/Environmental

- Heavy equipment operation hazards.
- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Overhead hazards from drill rig operations.
- Interaction with native and potentially hostile animal life.
- Contact with underground utility lines.
- Lifting hazards (muscle strain).
- Explosion from contact with explosive/ignitable material (contact with UXO)

Groundwater Sampling - Sites 69, 74, and 41

Chemical

- Skin contact with potentially contaminated water.
- Eye contact from splashing water.
- Ingestion of hazardous materials from hand to mouth contact.
- Inhalation of volatiles emitting from the well opening.

Physical/Environmental

- Skin irritation from contact with insects and vegetation.
- Lifting hazards (muscle strain, etc.) while bailing well.
- Cuts from using knives to cut bailer rope.
- Slips/trips/falls - sloped, uneven terrain.
- Interaction with native and potentially hostile animal life.

Hydropunching - Sites 41 and 69

Chemical

- Potentially-contaminated mud, etc., in eyes or on skin.
- Skin contact potentially with contaminated soil.
- Ingestion of contaminated soils from hand to mouth contact.
- Inhalation of volatile contaminants.

Physical/Environmental

- Heavy equipment operation hazards.
- Lifting hazards (muscle strain).
- Skin irritation from contact with insects and vegetation.
- Contact with underground utilities.
- Interaction with native and potentially hostile animal life.
- Heavy objects landing on foot/toe or head.
- Strips/trips/falls from sloped, uneven terrain.
- Contact with UXO.

3.3.2 Chemical Hazards

Exposure to hazardous chemicals can occur through various pathways into the body. These pathways include:

- Inhalation of vapors and/or particulates.
- Ingestion of contaminated particulates from hand-to-mouth contact.
- Dermal and eye contact from direct, unprotected contact.
- Absorption through the eye from exposure to concentrations in the air.

The chemical exposure potential for personnel working at Sites 69, 74, and 41 is expected to relate directly to the chemicals detected during previous sampling investigations and reported potential disposal practices. Therefore, Table 3-1 identifies the toxicological properties for the chemicals detected during preliminary sampling investigations that present the greatest hazard. Note that a Material Safety Data Sheet (MSDS) was not available for Mirex at the time of the HASP development. However, Mirex is a chlorinated hydrogen with similar characteristics as lindane [isomer of benzene hexachloride (BHC)], therefore, the BHC information in Appendix B can be referred to as a substitute for Mirex™.

The following information pertains to blister agents and tear agent. Additional information regarding other chemicals listed on Table 3-1 can be reviewed on the MSDSs in Appendix B. A summary of information regarding chemical agent identification sets (CAIS) is contained in Appendix C along with accompanying MSDSs.

Blister Agents

All of the Blister Agents are persistent. Blister agents damage any tissue that they contact. They affect the eyes and lungs and blister the skin. They damage the respiratory tract when inhaled and cause vomiting and diarrhea when absorbed.

Mustard - H, HS or HD (Sulfur Mustards)

Levinstein mustard (H) -H is the original mustard (gas) of WWI vintage. During WWII, HS, signifying Sulfur Mustard, was also used as opposed to HN or Nitrogen Mustard which had been stockpiled by Germany. H contains about 30% sulfur impurities, which give it a pronounced odor similar to garlic or horseradish. The impurities lessen the effectiveness of H and lower its freezing point 2-5°F. Other properties of H are essentially the same as those for distilled mustard, which is discussed next.

Distilled Mustard (HD) - HD is a purified form of H and is a colorless to amber colored liquid with a garlic-like odor. The effects of HD are usually delayed 4-6 hours, but 24-hour latency periods have been observed. The higher the concentration, the shorter the interval of time from exposure to the first symptoms (i.e., latency period) Mustard acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. Early symptoms include inflammation of the eyes; inflammation of the nose, throat, trachea, bronchi, and lung tissue;

TABLE 3-1

TOXICOLOGICAL PROPERTIES OF CHEMICALS

CHEMICAL COMPOUND(1)	HAZARD RATING(2) H F R	Volatility(3)	Skin Absorption(4)	Carcinogen(5)	TWA(6)	STEL(7)	Ceiling(8)	IDLH(9)	IP(10)
VOLATILES:									
Acetone	1 3 0	180	No	No	750 ppm	1,000 ppm	-	20,000 ppm	9.69
Benzene	2 3 0	75	No	Yes	1 ppm	5 ppm	-	3,000 ppm	9.25
Carbon Disulfide	2 4 0	300	Yes	No	4 ppm	12 ppm	-	500 ppm	10.08
Chlorobenzene	2 3 0	8.8	No	No	75 ppm	-	-	2,400 ppm	9.07
Chloroform	2 0 0	160	No	Yes	2 ppm	-	-	1,000 ppm	11.42
Chloromethane (Methyl Chloride)	2 4 0	5 atm.	Yes	Yes	50 ppm	-	-	10,000 ppm	11.32
2-Chloroacetophenone	2 1 0	0.01	No	No	0.3 mg/m^3	-	-	100 mg/m^3	9.44
1,2-Dibromoethane	3 0 0	12	Yes	Yes	20 ppm	-	30 ppm	400 ppm	9.45
1,2-Dichloroethane	2 3 0	64	No	Yes	1 ppm	2 ppm	-	1,000 ppm	11.05
1,1-Dichloroethylene (Vinylidene Chloride)	2 4 2	591 mm @ 25° C	No	No	1 ppm	-	-	-	-
1,2-Dichloroethene	2 3 2	180	No	No	200 ppm	-	-	-	9.65
Methylene Chloride	2 1 0	350	No	Yes	500 ppm	-	1,000 ppm	5,000 ppm	11.32
Phosgene	4 0 0	>1 atm.	No	Yes	0.1 ppm	-	-	200 ppm	9.96
1,1,2,2-Tetrachloroethane	2 0 0	9 mm @ 86°F	Yes	Yes	1 ppm	-	-	150 ppm	11.10
Tetrachloroethene	2 0 0	14	No	Yes	25 ppm	-	-	500 ppm	9.32
Toluene	2 3 0	22	No	No	100 ppm	150 ppm	-	2,000 ppm	8.82
Trichloroethene	2 2 0	58	Yes	Yes	50 ppm	200 ppm	-	1,000 ppm	9.45
Vinyl Chloride	2 4 2	2530	No	Yes	1 ppm	5 ppm		-	9.99

TABLE 3-1 (Continued)

TOXICOLOGICAL PROPERTIES OF CHEMICALS

CHEMICAL COMPOUND(1)	HAZARD RATING(2) H F R	Volatility(3)	Skin Absorption(4)	Carcinogen(5)	TWA(6)	STEL(7)	Ceiling(8)	IDLH(9)	IP(10)
SEMIVOLATILES:									
Phenol	3 2 0	0.35	Yes	No	5 ppm	-	-	250 ppm	8.5
Polychlorinated Biphenyls (PCBs)	2 1 0	0.005 mm @ 100° C	No	Yes	0.5 mg/m^3	-	-	-	-
PESTICIDES:									
DDT	-	-	Yes	Yes	1 mg/m^3	-	-	-	-
Diazinon	-	-	Yes	No	0.1 mg/m^3	-	-	-	-
Lindane (gamma-BHC)	-	0.00001	Yes	Yes	0.5 mg/m^3	1.0 mg/m^3	-	1000 mg/m^3	-
Malathion	-	0.00004	Yes	Yes	10 mg/m^3	-	-	5000 mg/m^3	-
Pentachlorophenol	3 0 0	0.0001	Yes	No	0.5 mg/m^3	-	-	150 mg/m^3	-
MUSTARD GAS:									
Cyanogen Chloride	4 4 2	1000	No	No	-	-	0.3 ppm	-	12.4
H	4 1 1	0.072	Yes	Yes	0.003 mg/m^3	-	-	-	-
HD	4 1 1	0.072	Yes	Yes	0.003 mg/m^3	-	-	-	-
HS	4 1 1	0.072	Yes	Yes	0.003 mg/m^3	-	-	-	-

Notes:
(1) Chemical compound of potential concern obtained from previous investigation.
(2) Hazard Rating - based upon Health (H), Fire (F), or Reactivity (R) hazard from NFPA 704 Standard Rating System (0 = no hazard, 4 = high hazard)
(3) Volatility - based upon vapor pressure in mm Hg at 68° F, 20° C
(4) Skin Absorption - "Yes" indicates potential exposure through skin and mucous membranes, either by airborne or, more particularly, by direct contact - ACGIH 1993-1994
(5) Carcinogen - "Yes" indicates a compound is a confirmed or suspect human carcinogen by the IARC, NIOSH, NTP, EPA or ACGIH
(6) TWA - Time Weighted Average from the 1993-1994 TLV - Threshold Limit Value of the ACGIH or OSHA Permissible Exposure Limits (PEL), whichever is lower
(7) Short Term Exposure Limit - "STEL" denotes a 15 minute time weighted average which may not be exceeded - ACGIH 1993-1994
(8) Ceiling Limit - denotes the ceiling concentration that cannot be exceeded at any time -ACGIH 1993-1994
(9) IDLH - Immediately Dangerous to Life and Health
(10) Ionization Potential - expressed in electron volts (eV) from the NIOSH Pocket Guide To Chemical Hazards

and redness of the skin; blistering or ulceration may follow. Effects may include a more "at ease" attitude, vomiting, and fever, beginning about the same time as skin reddening.

Nitrogen Mustard - HN-1 or HN-3

HN-1 is an oily, colorless to pale yellow with a fishy or musty odor. HN-3 is an oily liquid with no odor. HN-1/HN-3 irritate the eyes in dosages which do not significantly damage the skin or respiratory tract, insofar as single exposures are concerned. Eye irritation appears in a shorter time than that from HD. Mild vapor exposure may result in no skin lesions. After severe vapor or liquid exposure irritation, itching and reddening of the skin may occur. Later blisters may form on the affected areas. Effects on the respiratory tract include irritation of the nose and throat, hoarseness progressing to loss of voice, and persistent cough. Fever, labored respiration, and rales (abnormal sounds) may develop. Bronchial pneumonia may appear after the first 24 hours. Following ingestion or systemic absorption, the agent causes inhibition of cell division, resulting in depression of the blood-forming mechanism and injury to other tissues. Severe diarrhea, which may be accompanied by bleeding, occurs.

Lewisite - L (Arsenical)

The arsenical vesicants are a group of blister agents in which arsenic is the central atom.

Lewisite is a liquid with an odor similar to geraniums and very little odor when pure. L warns of its presence by irritating the eyes and skin and has a rapid rate of action. Liquid L causes immediate burning sensation in the eyes and permanent loss of sight if not decontaminated within one minute with large amounts of water. It has about the same blistering action on the skin as does the Mustard (HD), even though the lethal dosage for L is much higher. Skin exposure to L produces an immediate and strong stinging sensation; reddening of the skin starts within 30 minutes. Blistering does not appear until after about 13 hours.

Tear Agent

Tear compounds cause a flow of tears and irritation of the skin. Because tear compounds produce only transient effects, they are widely used for training and riot control.

Chloroacetophenone - CN

The physical state of CN is a solid powder. CN is described as having an odor similar to apple blossoms.

CN identifies the riot control agent popularly known as tear gas or mace. CN quickly irritates the eyes and upper respiratory passages. In higher concentrations it causes copious tearing; a tingling sensation, irritation, burning and pain of the nose and throat; and burning and itching on tender areas of the skin, especially areas wet by perspiration. High concentrations can cause blisters. The effects are similar to those of a sunburn and disappear in a few hours.

3.3.3 Physical Hazards

3.3.3.1 Underground/Overhead Utilities

An underground utility clearance must be obtained before any intrusive activities are performed at Sites 69, 74, and 41. This clearance must come from the base representative for this project. If underground utilities are identified in these areas the ground above the utility lines are to be physically marked, such as, with spray paint or flags. Baker personnel are to notify the base representative at least three days prior to soil intrusive activities to acquire a utility clearance. A minimum of a 24 inch tolerance zone must be used for underground utilities.

The generally accepted uniform color code for underground utilities is as follows:

- Red - Electric power lines, cables, conduit and lighting cables
- Yellow - Gas, oil, steam, petroleum, or gaseous materials
- Orange - Communication, alarm or signal lines, cables or conduit
- Blue - Water, irrigation, and slurry lines
- Green - Sewers and drain lines
- White - Proposed excavation

Energized overhead electric lines may present a risk of electrocution. OSHA standards require that equipment maintain certain distances from power lines. For lines 0 to 50 kilovolts (kV), the minimum distance is 10 feet. Lines carrying over 50 kV require that equipment maintain 10 feet, plus an additional 0.4 inch for each 1 kV over 50.

3.3.3.2 Heavy Equipment

One of the primary physical hazards on the site is associated with the use of heavy equipment. The heavy equipment includes the use of a drill rig and a backhoe.

General hazards associated with the drill rig include moving parts, such as, the auger and cathead. Personnel must remain clear of moving parts and must avoid loose fitting clothing that can become entangled in the moving parts. Personnel working near a drill rig must be aware of the location and operation of the emergency shut off devices. Personnel are to stand clear of the drill rig immediately prior to starting the engine.

During backhoe operations, a "spotter" will be in place to direct the backhoe operator. Other personnel in the area, such as those conducting sampling, are to remain close together and in the line of sight of the operator. The backhoe may be used to clear paths for the drill rigs. Caution must be exercised in these work areas to avoid slips, trips, and falls.

Noise from the operation of the heavy equipment will limit verbal warning abilities. Hand signals will be prearranged between operators and personnel working in and around heavy equipment. Backup alarms and lights must operate properly on the heavy equipment. Only operators trained, qualified, and authorized will be permitted to operate the heavy equipment.

The subcontracting drilling and trenching companies' representatives are to provide any other cautions that need to be observed when working around this equipment during the HASP briefing.

3.3.3.3 Unexploded Ordnances

Fired and unfired ordnance have been reported at Sites 69 and 41. All identification and management of unexploded ordnance (UXO) will be controlled by the UXO subcontractor. The UXO subcontractor will be with the work crews during work activities at these sites. Removal of live UXO will be handled by military personnel at Camp Lejeune. The UXO subcontractor will present all applicable standard operating procedures and safety guidelines during the initial HASP training.

3.3.3.4 Thermal Stress

Provisions for monitoring of heat stress and/or cold stress are outlined in Appendix A - Baker Safety SOPs.

3.3.3.5 Explosion and Fire

In general, the following items present potential physical hazards and will be monitored closely:

- Explosion and fire resulting from:
  - UXO detonation
  - Heavy equipment malfunction
  - Penetration into underground utility/service lines (gas, electric, fuel)
  - Ignition of trapped flammable vapors
  - Vehicular accidents
  - Puncturing of drums or containers during test pitting

Provisions for monitoring for potential fire/explosive conditions will include the use of an oxygen/combustible gas meter (as indicated in Section 5.2) and the performance of utility checks prior to conducting intrusive activities. An ABC rated, minimum 20 lb. fire extinguisher will be maintained in the area. As additional concerns are identified, provisions for making changes to the HASP will be presented by the SHSO, as needed.

3.3.3.6 Noise

Elevated noise levels can be produced during drilling and other heavy equipment operations; therefore, hearing protection devices will be available.

3.3.3.7 Confined Space Entry

Confined space entry is not anticipated for this project. If this should change the PHSO must be contacted prior to entry.

3.3.4 Radiation Hazards

Although the potential for exposure to radiological wastes or radioisotopes at Sites 69, 74, and 41 are not anticipated, a radiation survey meter will be available for use during site activities (Section 5.2 identifies the monitoring criteria).

3.3.5 Environmental Hazards

The hazardous flora and fauna are not expected to present much of a concern because the project is scheduled for the winter months.

Hazardous Flora

Incidence of contact by individuals to poisonous/thorny plants exists; therefore, bare skin should be covered (i.e., long pants and shirt, steel toe boots, leather or cotton gloves, safety glasses, and head protection) as much as practical when working in forested areas. Personnel should avoid entering an area in the direct path of known poisonous flora (i.e., poison ivy/oak), a secondary route should be selected. Care should also be taken when walking in such areas as uneven terrain or vines may present a tripping hazard.

While attempting to cut into dense underbrush, hazards exist from the sharp machete, gas-powered weed cutter, etc. (Note: Hearing protection, steel toe boots, gloves, and safety glasses are required when using weed cutters). Care should be taken when using such devices. All rashes and other injuries will be reported to the SHSO as soon as they are known.

Hazardous Fauna

All animal life must be treated with respect. Without proper training, personnel may not be able to differentiate between dangerous and nondangerous varieties. Working in wet or swampy areas unprotected is not permitted. Contact with surface water will be kept to a minimum.

Mosquitoes and gnats pose a nuisance and physical hazard to field personnel; as a nuisance, they distract workers, leading to accidents. Perfumes and scented deodorants should be avoided. Donning light colored clothing is preferable, as mosquitoes are not attracted to lighter colors. The use of Avon's "Skin So Soft" is encouraged as an insect repellent.

There is a potential to come in contact with other dangerous insects. These include fire ants, chiggers, bees, wasps, hornets, mites, fleas, spiders, and ticks.* All personnel should perform "checks" on each other periodically and at the end of the work shift. All insect bites must be reported to the SHSO.

Poisonous snakes such as the rattlesnake, copperhead, and cottonmouth (water moccasin), all known as pit vipers, are common to the United States. Snakes, as a general rule, typically do not attack people but will bite when provoked, angered, or accidentally injured (as when stepped on). When encountering a snake(s), avoid quick/jerky motions, loud noises, and retreat slowly; do not provoke the snake(s). If bitten, follow procedures outlined in Section 8.6, Emergency Medical Treatment.

Prior to initiating site activities, each individual shall be questioned as to any known sensitivities to the previously mentioned organisms or agents.

* *Site personnel have been provided with a copy of Baker's policy (per our medical consultant) regarding the signs and symptoms of exposure for Lyme Disease.*

4.0 SITE CONTROL

The following section defines measures and procedures for maintaining site control. Site control is an essential component in the implementation of the site health and safety program.

4.1 Site Access

- The Site Manager is designated to coordinate overall access and security on site. Perimeters for activities to be conducted at Sites 69, 74, and 41 will be established according to the site boundary procedures identified in Section 4.3, local conditions, and Navy Activity requirements.

- Personnel will not be permitted within the Work Zone (Exclusion Zone) or Contamination Reduction Zone without proper authorization from the SHSO.

- All personnel arriving or departing the site will be documented in the field log.

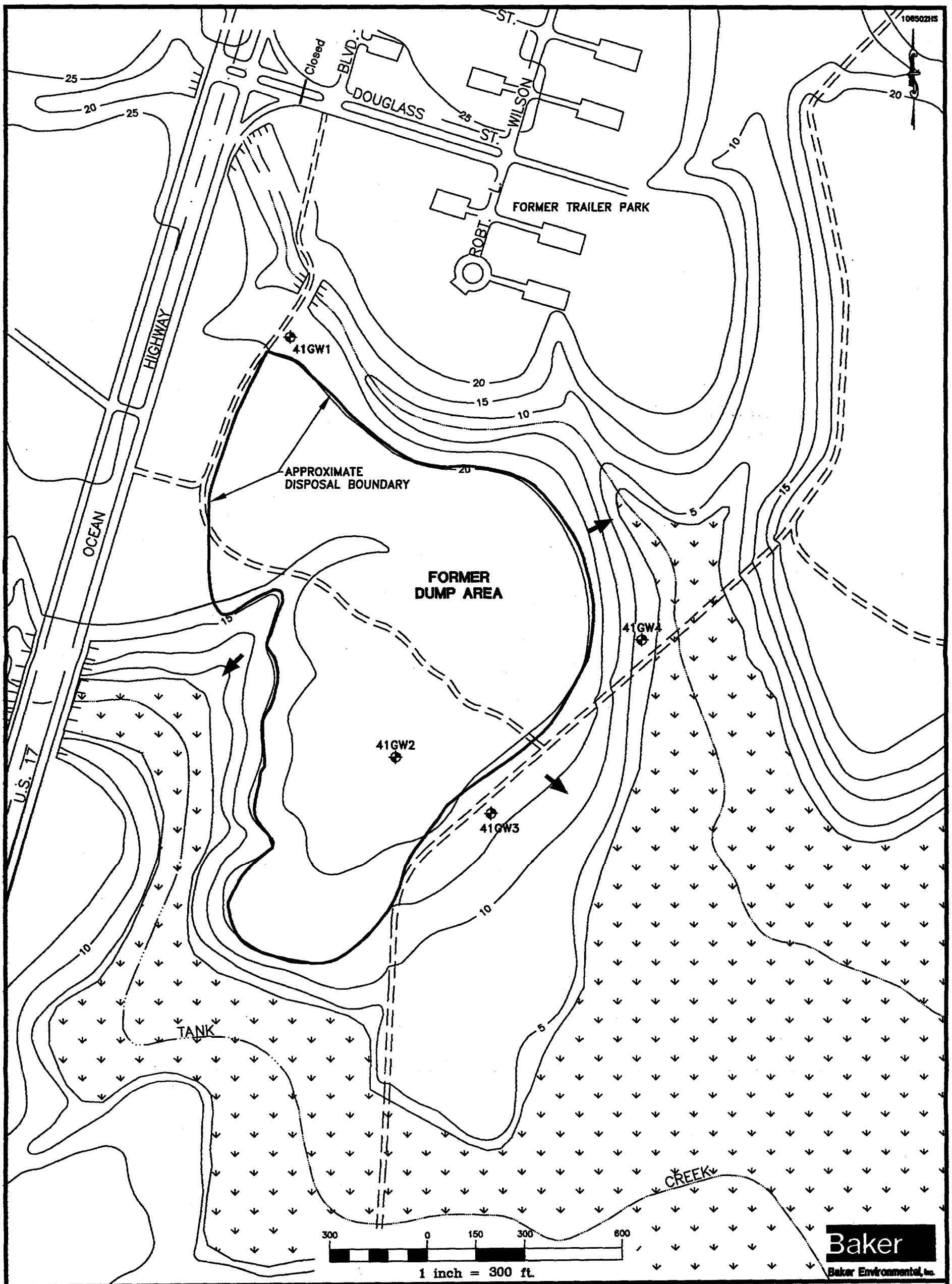
- All activities on site must be cleared through the Site Manager and documented in the Field Log.

- Figures 4-1, 4-2, and 4-3 identifies the location of the sites under investigation.

4.2 Site Conditions

- The prevailing wind conditions are to be determined daily. This will be accomplished with the use of a wind direction device, such as a wind sock. The wind direction indicators are to be provided in areas readily visible to personnel in the areas.

- An on-site Command Post will be established at each site. This location will be in the Support Zone and oriented upwind from the Work Zone.



LEGEND

41GW1 – EXISTING GROUNDWATER MONITORING WELL

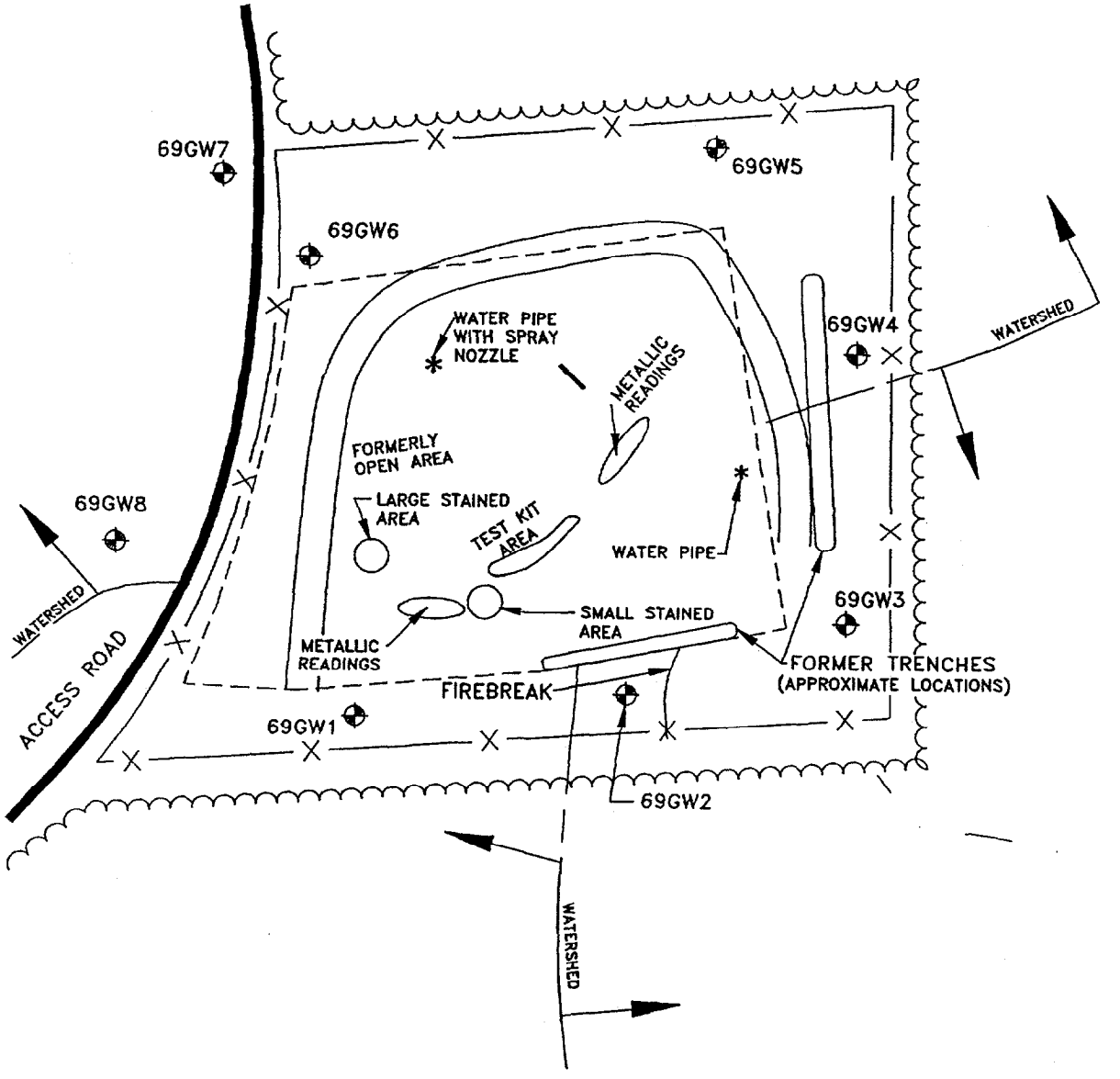
→ – DIRECTION OF GROUNDWATER FLOW

SOURCE: LANTDIV, OCT. 1991

FIGURE 4-1
SITE 41
CAMP GEIGER LANDFILL

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02318T02Z



N.T.S.

Baker
Baker Environmental, Inc.

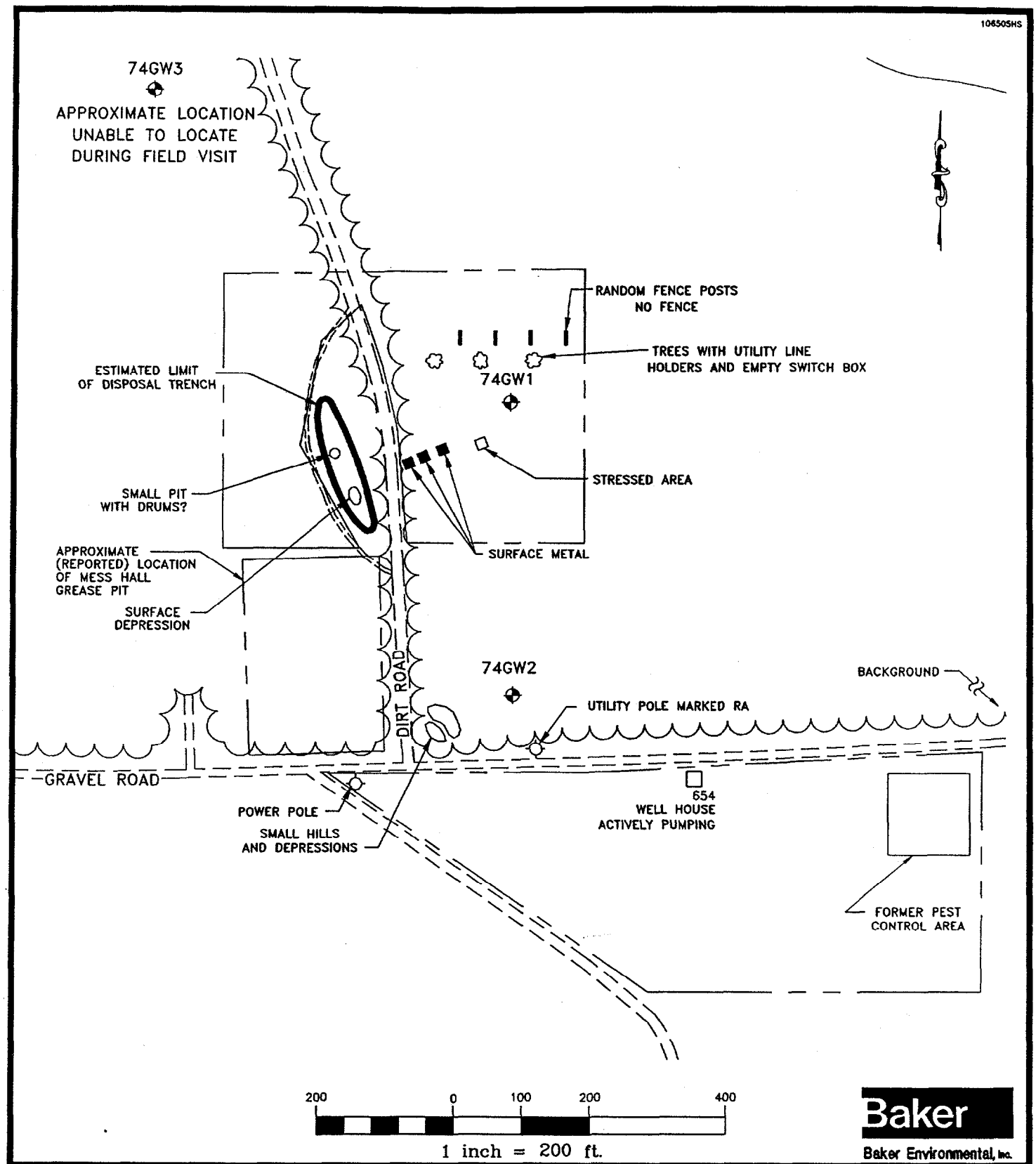
LEGEND

⊕ - EXISTING WELLS

SOURCE: ESE, 1991

FIGURE 4-2
SITE 69
RIFLE RANGE CHEMICAL LANDFILL

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

74GW2 ◆ – EXISTING SHALLOW WELL

SOURCE: REVISED FROM LANTDIV. OCT. 1991

FIGURE 4-3
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

4.3 Work Zones

Level C and B Activities

Boundaries will be established at each of the three sites for Work Zones with Level C or higher protection levels. These boundaries will identify the Work Zone, the Contamination Reduction Zone (CRZ), and the Support Zone (Clean Zone). The boundaries are defined as follows:

- Work Zone - A radius of at least 50 meters (barring obstruction) from site investigative activities, providing agreement with the UXO subcontractor.

- Hotline - The boundary between the Work Zone and CRZ.

- CRZ - The area between the Work Zone and the Support Zone (located upwind of the site investigative activities).

- Contamination Control Line - The boundary between the CRZ and the Support Zone.

- Support Zone - The outermost area next to the CRZ and upwind of the site investigative activities.

These boundaries will be demarcated using:

- Colored boundary tape, cones, or equivalent for the Hotline.

- Colored boundary tape, cones, or equivalent for the Decontamination Corridor of the CRZ.

- Colored boundary tape and barriers for the Contamination Control Line including posted signs and/or barricades indicating "Work Area"/"Authorized Personnel Only", or equivalent.

Refer to Figure 4-4 for a description of how the zones will be arranged at each site. Exact location of the demarcated zones will be field determined during site mobilization.

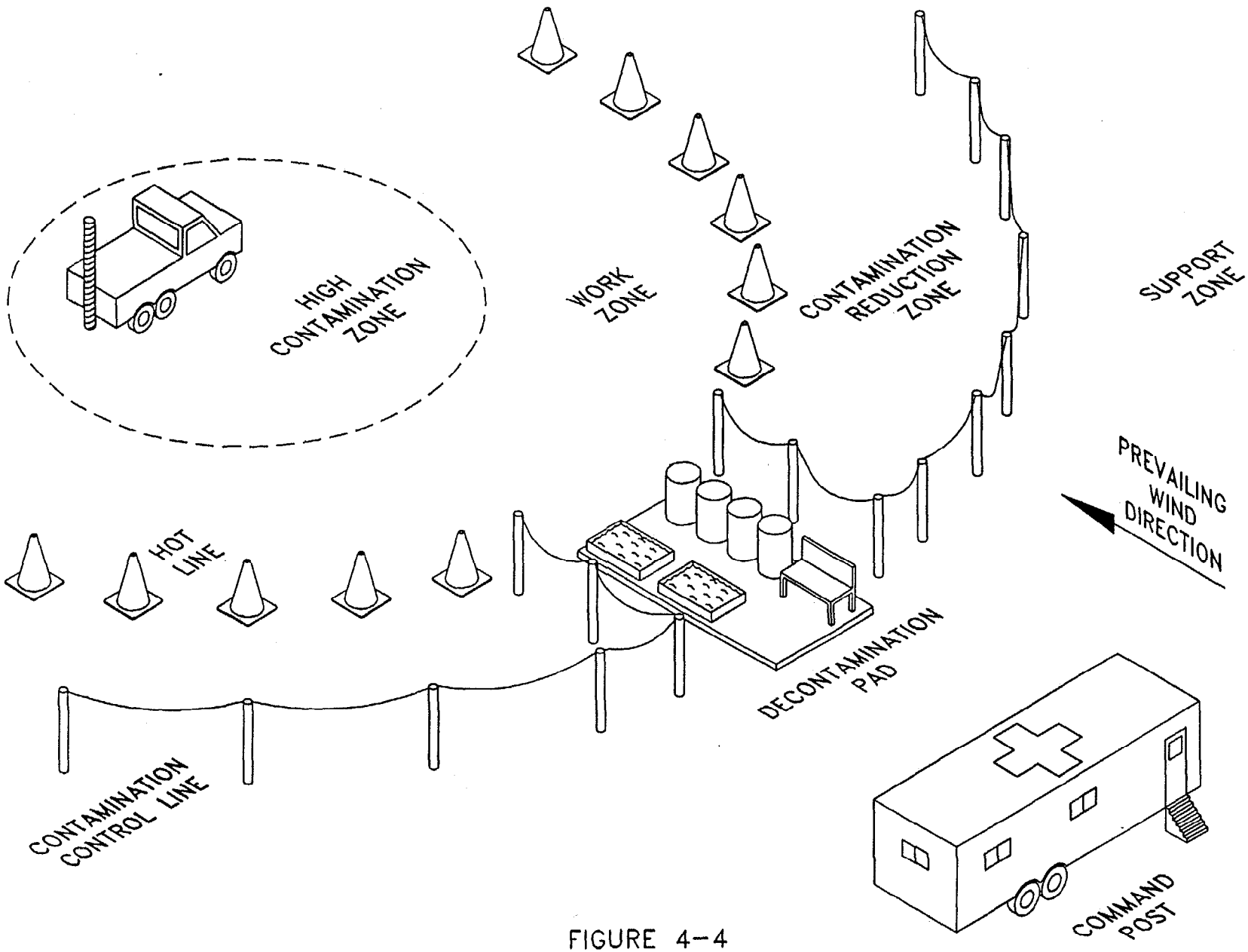


FIGURE 4-4
SCHEMATIC DIAGRAM
GENERAL CONTAMINATION
REDUCTION ZONE LAYOUT

Baker
Baker Environmental, Inc.

CONZONE2

Level D and D+ Activities

Work Zones for activities conducted under Level D or D+ protection levels shall be established in such a manner as to preclude unauthorized personnel from entering the investigative area. A boundary will be established around the Work Zone to separate it from the Clean Zone using available materials. Such materials may include the Baker Field Vehicle, natural boundaries (buildings, structures, fences), or signs/placards, boundary tape, cones, barricades, etc.

4.4 "Buddy System"

All site activities that involve hazards and/or the potential for contact with hazardous materials will be performed by a work team of no fewer than two people (Buddy System). For potential "high-hazard" activities, a third person located in the Support Zone will serve as an observer or rescue person.

4.5 Safe Work Practices

Routine safe work practices may consist of:

- Setting up barriers to exclude unauthorized personnel from contaminated areas.
- Minimizing the number of personnel and equipment at the site (s).
- Establishing work zones within the site.
- Establishing control points with regular access to and egress from work zones.
- Conducting operations in a manner to reduce exposure of personnel and equipment.
- Implementing appropriate decontamination procedures.
- Conducting sampling activities from an upwind location.

4.5.1 Heavy Equipment

The following safe work practices will be adhered to during heavy equipment operations.

- Hard hats will be worn when working in a work zone with heavy equipment.

- Heavy equipment requiring an operator will not be permitted to run unattended.

- Heavy equipment will not be operated in a manner that will endanger persons or property nor will the safe operating speeds or loads be exceeded.

- Heavy equipment will be shut down and positive means taken to prevent its operation while repairs or fueling are being performed.

- Personnel, other than the operator, shall not ride on equipment.

- A "spotter" will be used to help direct the heavy equipment operator.

- Personnel are to remain in the field of vision of the operator and remain clear of moving parts.

- Hand signals will be prearranged between operator and personnel working around the heavy equipment.

- Backup alarms must operate properly on the heavy equipment.

4.5.2 Drilling Operations

The following safe work practices will be adhered to during drilling operations.

- Hand signals will be prearranged between operator and personnel working around the drill rig.

- Personnel are to remain in the field of vision of the operator and remain clear of moving parts where protective clothing can be entangled, i.e., Tyvek caught in the auger.

- Utility clearances must be secured prior to drilling (see Section 3.3.3.1).

- Personnel working near a drill rig are to be aware of the location and operation of the emergency shut off devices.

- The supervisor for the drilling subcontractor is to provide additional precautions to be observed when working around the drill rig, during the HASP briefing.

4.6 Sanitation/Site Precautions

Provisions for sanitation procedures and site precautions to be followed on site can be found in Appendix A - Baker Safety SOPs.

5.0 ENVIRONMENTAL MONITORING

The environmental monitoring will consist of point source and personal monitoring with the potential for perimeter monitoring. The following presents the methodology for site monitoring procedures.

5.1 Point Source Monitoring

Point source monitoring is defined by this HASP as monitoring performed at the source of the sampling/investigative activity at Sites 69, 74, and 41 (i.e., bore hole, test pits/trenches). Instrumentation to be available for use include an HNu (PID), Dräger Tubes, Oxygen/Combustible Gas Meter, and Radiation Survey Meter.

5.2 Personal Monitoring

Personal monitoring will be accomplished using real time environmental monitoring instrumentation during soil intrusive activities directed at the breathing zone (defined as the area bordered by the outside of the shoulders and from the bid-chest to the top of the head) of work party personnel. Levels of protection outlined in Section 6.0 will not be downgraded because of the potential chemical concerns. The monitoring equipment outlined below will be used to verify that the levels of protection are adequate and to determine if work can continue after a work stoppage.

5.2.1 Minicam (Model FM-3000)

The Minicam is designed to detect chemical warfare agents and simulants. The Minicam will be used to monitor for the potential blistering agents identified in Section 3.0. The TEU will conduct the operation of the Minicam.

- Alarm activation will immediately activate emergency decontamination procedures of site personnel and an emergency procedure evaluation (see Section 8.0) with the TEU, UXO subcontractor, SHSO and Site Manager.

The Minicam is based on the collection of compounds on solid sorbents, separation using temperature-programmed capillary-column gas chromatography, and detection with a flame-photometric detector.

The Minicam has been designed for the reliable detection of chemical agents, simulants, or related compounds over a wide range of concentrations. The Minicam is capable of meeting the following general specifications:

- The detection of CW-agents and simulants at the Surgeon General's 8-hr, time-weighted-average (TWA) concentrations with the following response times: GB (0.0001 mg/m^3) and HD (0.003 mg/m^3) in 5 minutes or less and GD (0.00003 mg/m^3) and VX (0.00001 mg/m^3) in 10 minutes or less without the use of any external accessory.

- The automatic collection and analysis of samples 24 hours per day, 7 days per week, etc. with only periodic challenges of the monitor with dilute standard solutions needed to ensure proper operation and <u>without</u> the generation of liquids or liquid wastes that could be classified as hazardous under the Resource Conservation and Recovery Act (RCRA).

5.2.2 PID

The PID will be used initially and periodically thereafter for soil intrusive activities and well sampling activities; additional use is at the discretion of the SHSO or Site Manager. The PID will consist of an HNu with an 11.7eV ultraviolet lamp, used to detect the volatile and semivolatile organic compounds, with ionization less than 11-7eV, that are identified in Table 3-1. The following lists the action levels that will be followed while using the HNu.

- Background to 1 meter units(mu) above background in the breathing zone, can remain in Level D

- >1 mu to 5 mu above background in the breathing zone for greater than 5 continuous minutes can remain in Level C, plus Dräger Tube Monitoring

- >5 mu for up to 5 continuous minutes = Level B or Stop Work and consult PHSO

5.2.3 Dräger Tubes

The Dräger Tubes will be used to determine if Level C or D+ protection levels are adequate for highly volatile constituents with a TWA* <10 ppm, when a PID response meets the level identified above.

- Below limits of detection (BLD) to less than 25% of the TWA, can remain in Level D
- 25% of the TWA to 5 times the TWA, can remain in Level C
- >5 times the TWA, work must stop and the situation evaluated.

*Refer to Table 3-1 for explanation.

Dräger Tubes on site will include:

- Benzene
- Carbon disulfide
- Cyanogen chloride
- Methylene chloride
- Phosgene
- Vinyl chloride

5.2.4 Oxygen/Combustible Gas Meter*

This meter will be used during soil intrusive activities to determine if a combustible atmosphere becomes a concern.

<u>Combustible Gas Meter</u>

- <10% of the Lower Explosive Limit (LEL) = continue working
- >10% of the LEL* = Stop Work immediately and consult SHSO

<u>Oxygen Meter</u>

- 19.5% to 22% = continue working
- <19.5% or >22% = Stop Work immediately and consult SHSO

*Used to evaluate physical safety.

5.2.5 Radiation Survey Meter - Ludlum Model 3-98 Survey Meter with Model 44-2 Gamma Scintillator Tube

The Scintillator Tube (external probe) will be available and used at the discretion of the SHSO or Site Manager. This probe is used to measure higher energy gamma sources. the following will be the monitoring action levels for this instrument:

- Background (typically 0.02 to 0.04 mR/hr) - Continue work
- 0.5mR/hr to 1mR/hr - Continue work, monitor levels closely
- >1 mR/hr - Leave work area and consult PHSO

The GM Pancake Probe (internal probe) will be available and used at the discretion of the SHSO or Site Manager. This probe is used to measure beta and lower energy gamma sources and registers in counts per minute (cpm). The following will be the monitoring action levels for this instrument:

- Background (typically 50 to 70 cpm) = Continue work
- Background to <2 x background = Continue work, monitor levels closely
- ≥2 x background = Retreat from work area until background levels are reached and consult PHSO

As work progresses, the scope of monitoring may be extended based on monitoring results, odor detection, changing work conditions, and signs or symptoms of exposure. Any or all of these conditions will be immediately investigated and acted upon by the SHSO.

5.3 Perimeter Monitoring

Perimeter monitoring is defined as monitoring performed at borders beyond the Support Zone and often at the "fence line." Releases occurring during these types of investigative activities are expected to be minimal. Therefore, it is anticipated that the type and frequency of monitoring required for each site will be as follows:

- The PID will be used periodically to scan the perimeter as a means of documenting any volatile releases that may extend past the work zone, when volatile concentrations exceed 25 mu for greater than 5 continuous minutes in the breathing zone.

- Dräger Colorimetric Tubes will be used at the discretion of the SHSO to measure any potential releases when concentrations exceeding the TWA are detected at the breathing zone.

- The Radiation Survey Meter will be used to determine a safe distance from the source, if a radiation level exceeding 2 x background or 1 mR/hr is detected.

5.4 Equipment Maintenance and Calibration

Equipment calibration under the direction of the SHSO will be performed according to manufacturer's recommendations. Calibration information will be recorded onto an equipment calibration log sheet. The log sheets will be maintained on site for the duration of the project. Copies will be given to the Equipment Manager and placed into the program and project files once the equipment has been returned to the office. Procedures for equipment maintenance and calibration can be found in the operating manual provided by the manufacturer (included with each piece of equipment), or in Baker's Standard Operating Procedures for Administrative, Field, and Technical Activities Manual.

5.5 Monitoring Documentation

As environmental monitoring is performed, documentation of the results will be entered into the Field Log Book of the SHSO or other personnel performing the monitoring. Documentation is to include the date, time, instrument results, general location, and specific location, such as, point source, breathing zone, or area. At the end of the project, copies of the log book are to be placed in the program and project files.

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 Personal Protective Equipment Selection

The required personal protective equipment available for the various levels of protection, is listed below.

Personal Protective Equipment	Level of Protection			
	B	C	D+	D
Chemical-Resistant Clothing (Saranex)	X	X	X(1)	
Uncoated Tyvek®/Kleenguard® Coveralls			X(1)	
Normal Work Clothes or Coveralls			X	X
Air-Line Respirator (ALR) with 5-minute escape pack or Self-Contained Breathing Apparatus (SCBA)	X			
5-Minute Escape Pack (on standby)			X(2)	
Full-face Cartridge Respirator		X		
Full-face or Half-face Cartridge Respirator (on standby)			X	
Chemical-Resistant Inner Gloves (Nitrile)	X	X	X	
Chemical-Resistant Outer Gloves (Nitrile)	X	X	X(1)	
Work Gloves (outer)			X(1)	X(1)
Chemical-Resistant Overboots	X	X	X(1)	
Steel Toe Boots	X	X	X	X
Safety Glasses/Goggles			X(1)	X(1)
Hard Hat (during heavy equipment operations)	X	X	X	X
Hearing Protection(1)	X(1)	X(1)	X(1)	X(1)

(1) At the discretion of the SHSO.
(2) During soil intrusive activities.

Changes to the type of PPE required under each level of protection may be instituted by the SHSO with the approval of the PHSO.

6.2 Site-Specific Levels of Protection

Based on an evaluation of potential hazards the levels of personal protection have been designated for the following tasks. Upgrading or downgrading the level of protection will be

based on real time monitoring and working conditions. Changes in level of protection will be the responsibility of the SHSO.

Note: No single combination of protective equipment and clothing is capable of protection against all hazards. PPE should be used in conjunction with safe work practices, decontamination, and good personal hygiene.

Site(s)	Job Task	Level of Protection			
		B	C	D+	D
Sites 69, 74 and 41	General Site Activities				X
Sites 69, 74 and 41	Sediment/Surface Water Sampling			X	
Sites 69, 74 and 41	Surface Soil Sampling			X	
Sites 69, 74 and 41	Monitoring Well Installation	X(1)		X	
Sites 69, 74 and 41	Groundwater Sampling			X	
Site 41	Geophysical Investigation				X
Sites 41 and 69	Hydropunching			X	

EXCEPT IN EMERGENCY SITUATIONS, CHANGES TO THE SPECIFIED LEVELS OF PROTECTION SHALL ONLY BE MADE WITH THE APPROVAL OF THE SITE HEALTH AND SAFETY OFFICER AND THE SITE MANAGER, IN CONSULTATION WITH THE PROJECT HEALTH AND SAFETY OFFICER AND PROJECT MANAGER.

(1) The monitoring well being installed inside the fence at Site 69 will be performed in Level B.

6.3 Respiratory Protection

Site-specific respiratory protection requirements as outlined below will comply with the procedures in Appendix A - Baker Safety SOPs. The criteria for using these types of respiratory protection have been determined by qualified Baker personnel in compliance with OSHA Standard 29 CFR 1910.134.

Level B

The "North" NIOSH-certified Air Line Respirator (ALR) system (four-person manifold) with 5-minute escape pack or the "North" SCBA will be used at this level. The line-of-site worker will be equipped with "North" SCBA on standby for emergency rescue purposes. This individual may also be responsible for monitoring a supplied air system.

Level B is expected to be used for the well installation inside the chain link fence that surrounds Site 69.

Level C

The "North" or "MSA" full-face/half-face NIOSH-certified negative pressure Air-Purifying Respirator (APR) with an organic vapor and a HEPA cartridge for use with the detected hazardous materials and the measured contaminant concentrations. Upgrades/downgrades in this level of respiratory protection will be based upon measured "real-time" air contaminant concentrations (see Section 5.2) and the SHSO's observations.

Cartridge changeover will occur when one or more of the following have been observed: exposure duration greater than eight hours for vapor/gas cartridges; breathing resistance; a noticeable odor or taste; eye/throat irritation; and other indicators such as end-of-service life indicators for specialty filter cartridges.

Level D+

A NIOSH-certified negative pressure APR, meeting all the requirements identified under Level C, will remain on standby at this level. During well installation and soil boring operations, personnel will have 5 minute escape packs immediately available for use, as necessary, based on TEU observations and air monitoring results.

6.4 Care and Cleaning of Personnel Protective Equipment

Provisions for the care and cleaning of personal protective equipment used on site can be found in Appendix A - Baker Safety SOPs. Responsibility for compliance with these provisions lies with the Site Manager and/or Field Team Leader.

7.0 DECONTAMINATION PROCEDURES

7.1 Personnel Decontamination

Personnel leaving the Work Zone will be thoroughly decontaminated. The following protocol will be used for the decontamination stations according to levels of protection:

Level D	Level D+	Level C	Level B
1. Equipment drop	1. Equipment drop	1. Equipment drop	1. Equipment drop
2. Boot and glove gross contamination removal*	2. Outer boot and glove wash	2. Outer boot and glove wash	2. Outer boot and glove wash
3. Boot and glove wash*	3. Outer boot and glove rinse	3. Outer boot and glove rinse	3. Outer boot and glove rinse
4. Boot and glove rinse*	4. Tape Removal	4. Tape Removal	4. Tape Removal
5. Tape Removal*	5. Outer boot and glove removal	5. Outer boot and glove removal	5. Outer boot and glove removal
6. Boot removal*	6. Coverall removal/ disposal	6. Coverall removal/ disposal	6. SCBA or escape tank removal
7. Glove removal*	7. Inner glove removal/disposal	7. Respirator removal	7. Coverall removal/ disposal
8. Hand/Face wash	8. Hand/face wash	8. Inner glove removal/disposal	8. SCBA or ALR face shield removal
9. Equipment wipe down	9. Equipment cleaning	9. Hand/face wash	9. Inner glove removal/disposal
		10. Respirator cleaning/ sanitizing	10. Hand/face wash
		11. Equipment cleaning	11. Respiratory cleaning/ sanitizing
			12. Equipment cleaning

*Optional - depends on degree of contamination and type of PPE used.

The following decontamination equipment will be available for Level C and higher protection levels and recommended for Level D+ protection:

- Boot wash tubs
- Scrub brush
- Towels*
- Disposable wipes*
- Pressurized sprayers for rinsing
- Contaminated clothing disposal bag or drum*
- Contaminated liquids disposal drum
- Respirator cleaning solution
- Liquinox and water as the decontamination solution
- 5 percent sodium hypochlorite solution

*Minimum for Level D decontamination.

The decontamination liquids and clothing will be contained and disposed according to policy defined in the Sampling and Analysis Plan (SAP).

7.2 Equipment Decontamination

The portion of the drilling and trenching equipment that will contact intrusive materials (i.e., augers and backhoe bucket) will be decontaminated prior to and upon completion of work in each area. Pressurized steam cleaning will be used to clean the equipment. Field sampling equipment will be cleaned using a 5 percent sodium hypochlorite solution.

Pressure steam cleaning will be conducted by the subcontractor. A portable steam cleaning unit will be used for the cleaning. Decontamination will be conducted at specific locations established at each site.

7.3 Waste Handling Procedures

The protocols outlined in the SAP for the handling, packaging, storing, and disposing of contaminated materials must be followed to: (1) minimize the risk of off-site exposures that could endanger public health; and (2) limit the potential for liabilities associated with handling, containment, storage, and transportation of contaminated materials. These protocols comply with Baker's procedures on the "Handling of Site Investigation Generated Wastes," located in the Standard Operating Procedures for Administrative, Field, and Technical Activities Manual.

7.4 Emergency Decontamination

Emergency decontamination procedures for chemical exposure is described in Section 8.7. The TEU will provide emergency decontamination in the event of chemical agent exposure, these procedures are provided in the TEU Standard Operating Procedure (SOP) in Appendix D.

8.0 EMERGENCY PROCEDURES

8.1 Pre-Emergency Planning

All applicable Navy/local emergency response contacts (On-Scene Coordinator, Fire Department, Security, Ambulance, Hospital, etc.) at MCB Camp Lejeune will be contacted during site mobilization activities. This notification will be performed by the SHSO and/or Site Manager. The information discussed may include:

- A description of site activities.
- Anticipated site hazards.
- Hazardous chemicals to be used on site.
- Expected length of time on site.
- Specific requirements the emergency response facilities may require.
- Confirmation of emergency phone numbers.

Specific points of contact, where applicable, will be established and added to the HASP. If requested, Material Safety Data Sheets will be provided at this time.

8.2 Emergency Coordinator

The SHSO acting as the Emergency Coordinator is responsible for field implementation of the Emergency Plan. As the Emergency Coordinator, specific duties include:

- Familiarizing all on-site personnel with the emergency procedures and the emergency coordinator's authority.

- Identifying the nearest telephone in the event of an emergency.

- Communicating site emergency procedures and requirements to all Baker and subcontractor personnel.

- Specifying a backup/alternate Emergency Coordinator.

- Controlling activities of subcontractors and contacting the Navy On-Scene Coordinator and other response groups.

- Anticipating, identifying, assessing, and controlling fires, explosions, chemical releases, and other emergency situations to the best of his/her abilities.

- Familiarity with site personnel trained in emergency first aid and CPR.

All on-site personnel, whether involved in emergency response or not, will be notified of their responsibilities by the Emergency Coordinator in an emergency. They will be familiar with the emergency procedures and the Emergency Coordinator's authority.

8.3 Communications

Internal communications will rely on direct communication (via verbal or two-way radios) between site personnel. External communications will employ a telephone located in the field trailer and a cellular (portable) telephone in the investigation area. The cellular phone must be placed in the recharger each night after work.

The "Buddy System" will be in effect at all times; any failure of communication requires an evaluation of whether personnel should discontinue activities.

Air horns will be used for communication during emergency evacuation of site personnel. One long (3 second) air horn blast is the emergency signal to indicate that all personnel should evacuate the Work Zone.

Hand signals will be used in case of failure of radio communications or when radio communications are not available:

Hand gripping throat	-	Can't breathe (typically Level C/B activities)
Grip partner's wrist or both hands around waist ...	-	Leave area immediately
Hands on top of head	-	Need assistance
Thumbs up	-	OK, I am all right, I understand
Thumbs down	-	No, I do not understand

Coordination between Baker and subcontractor personnel is the responsibility of the Site Manager. The best means for securing the lines of communication will be determined prior to start-up by on-site project personnel.

Emergency telephone numbers will be posted in each Baker Site Trailer and maintained in each Baker Field Vehicle. The list of emergency phone numbers is presented below.

Agency/Facility	Phone Number	Contact*
Security (Police)	911 or (910) 451-4555	Response Operator
Fire	911	Emergency Services Operator
Ambulance (On-Base)	911	Emergency Services Operator
Ambulance (Off-Base)	(919) 455-9119	Response Operator
Hospital (On-Base)	911 or (910) 451-4840, 4841, 4842	Response Operator
Hospital (Off-Base) (Emergency Room)	(919) 577-2240	Emergency Room Physician
Hospital (Off-Base) (Information)	(919) 577-2345	Onslow County Hospital Information
Hazardous Materials Team	911	Emergency Services Operator
On-Scene Coordinator	911	Fire Chief
Public Works Department (Underground Utilities via EMD Contact)	(910) 451-5874	Neal Paul
Poison Control Center	1-800-672-1697	Response Operator
National Response Center	1-800-424-8802	Response Operator
CHEMTREC	1-800-424-9300	Response Operator
Agency for Toxic Substances and Disease Registry	1-404-639-0615	Response Operator

* Remaining points of contact will be identified prior to the start of activities.

Notes:

1. When using the portable cellular phone in the Jacksonville, North Carolina area, area code (919) or base area code (910) must be dialed first in addition to the local phone number.

2. When calling 911 on a non-base phone, ask emergency services operator to transfer call to Base 911 system and report emergency.

3. When using an on-base phone, first dial extension 99 for local calls or extension 92 for long distance calls.

8.4 Assembly Area

In the event of an emergency personnel will be instructed before the start of operations to meet upwind of the emergency. Where applicable, personnel will exit the work area through the contamination reduction zone. At this location, emergency needs will be provided, such as:

- Assembly for evacuated personnel
- First aid for injured personnel
- Decontamination material
- Communications.

8.5 Emergency Hospital Route

An emergency hospital route map showing the location of the local hospital will be posted at strategic locations throughout the site. Personnel will be informed of the location of the map and the directions to the hospital. Note that the Naval Hospital will be used for potential chemical agent exposure.

The following are directions to the base Naval Hospital (Building NH100) from Sites 41 and 69 (refer to Figure 8-1):

1. Proceed north on Route 17 until intersecting with Route 24 (Lejeune Boulevard).

2. Turn right onto Route 24 (Lejeune Boulevard) and continue following Lejeune Boulevard through the main gate.

3. At first traffic light turn right onto Brewster Boulevard.

4. Continue on Brewster Boulevard until intersecting with driveway to Naval Hospital on right (approximately 0.75 miles).

5. Follow signs for emergency room entrance (bear to right).

Directions to Onslow County Memorial Hospital (317 Western Boulevard) from Sites 41 and 69 (refer to Figure 8-1).

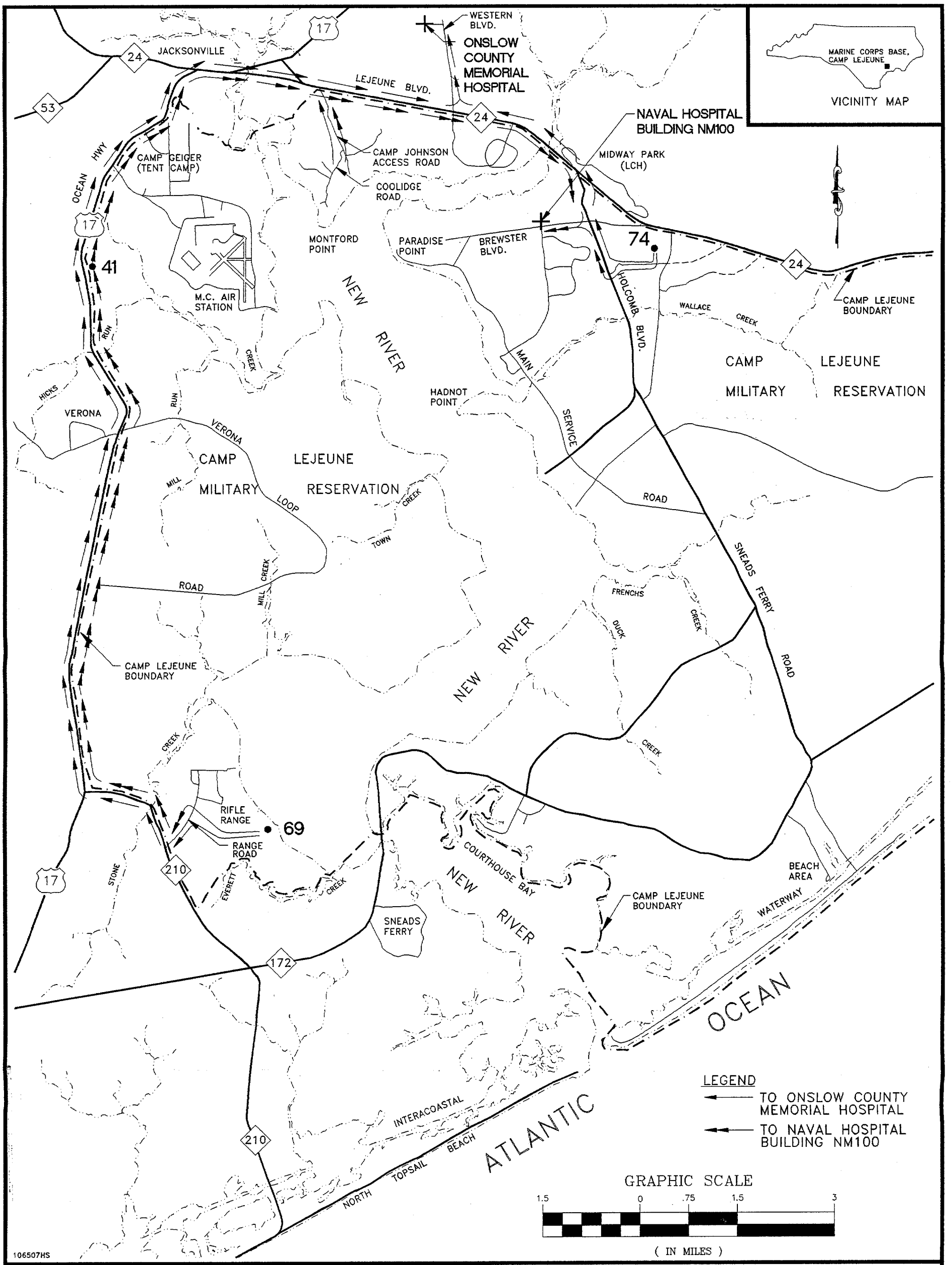


FIGURE 8-1
EMERGENCY HOSPITAL ROUTE
FOR RI/FS ACTIVITIES AT
SITES 41, 69, AND 74
CTO-0106
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02318T03Z

1. Leave Site 41 or Site 69 heading north on Route 17 until intersecting with Route 24 (Lejeune Boulevard).

2. Turn right onto Route 24 (Lejeune Boulevard) until intersecting with Western Boulevard.

3. Turn left onto Western Boulevard.

4. Continue on Western Boulevard to the fifth stop light and the hospital will be on the left hand side.

5. Follow directions to emergency room entrance.

Directions to the Onslow County Memorial Hospital (317 Western Boulevard) from Site 74 (refer to Figure 8-1):

1. Leave Base through Main Gate (via Holcomb Boulevard).

2. Take Highway 24 west to Western Boulevard and turn right (north).

3. Continue on Western Boulevard to the fifth stop light and Hospital will be on the left.

4. Follow directions to emergency room entrance.

Directions to Base Naval Hospital (Building NH100) from Site 74 (Refer to Figure 8-1):

1. Travel north on Holcomb Boulevard until intersecting with Brewster Boulevard.

2. Turn left (west) onto Brewster Boulevard.

3. Continue on Brewster Boulevard until intersecting with driveway to Naval Hospital on right.

4. Follow signs for emergency room entrance (bear to right).

8.6 Emergency Medical Treatment

Emergency Services

The nearest public hospital is Onslow County Memorial Hospital located at 317 Western Boulevard, Jacksonville, NC, Telephone No.: (99) 577-2240 (on base) and (919) 577-2240 or 911 (off base).

Note: In instances of extreme emergency, chemical exposure, or for stable patient transfer to nearby public hospitals, personnel may be transported to Building NH100 (Naval Hospital).

Local ambulance service is available from the Naval Ambulance Service by dialing 911 and the City of Jacksonville by dialing (919) 455-9119. Contact should be made with emergency personnel prior to the start of activities (See Section 8.1).

There will be a minimum of 2 persons on each site that will be trained in emergency first aid and CPR.

Instances requiring treatment beyond "first-aid" will be handled at appropriate facilities and reported to the Project Manager and PHSO within 24 hours.

Physical Injury

If an employee working in a contaminated area is physically injured, first aid procedures are to be followed. Depending on the severity of the injury, emergency medical response from Navy personnel may be sought to stabilize victim for transport to public hospitals. If the employee can be moved, he/she will be taken to the edge of the work area and decontaminated, if necessary (refer to Section 8.7). Then, if circumstances permit, administered emergency first aid, and transported to an awaiting ambulance or to a local emergency medical facility.

Chemical Injury

If the injury to a worker is chemical in nature (e.g., direct contact/exposure), the following first aid procedures are to be instituted:

- Eye Exposure - If contaminated solid or liquid gets into the eyes, wash the eyes immediately at the emergency eyewash station using large amounts of water and lifting the lower and upper lids occasionally. Obtain medical attention immediately. Contact lenses will not be worn when working. The TEU will perform the emergency decontamination for chemical agent exposure as outlined in Appendix D.

- Skin Exposure - If contaminated solid or liquid gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If solids or liquids penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If a blistering agent is suspected, flush skin and clothes with 5 percent solution of sodium hypochlorite or bleach for one minute. Remove contaminated clothing and flush skin again with 5 percent sodium hypochlorite or bleach, then wash with soap and water. Obtain medical attention immediately. The TEU will perform the emergency decontamination for chemical agent exposure as outlined in Appendix D.

- Swallowing - If contaminated solid or liquid has been swallowed immediately contact the Poison Control Center at the Duke University Medical Center, Durham, NC at 1-800-672-1697. Do not make an unconscious person vomit. Obtain medical attention as directed by the Poison Control Center.

- Breathing - If a person has difficulty breathing, move the exposed person to fresh air at once. If breathing has stopped, check pulse and perform the necessary first aid procedure (CPR or rescue breathing). Obtain medical attention immediately. Refer to Appendix E for Baker's emergency procedures for exposure to hazardous materials/waste.

Snakebite Injury

Although snake incidents are not anticipated because of the time of year this project is taking place, the following presents the actions to perform in the event of a snakebite injury.

Look for signs and symptoms such as the characteristic appearance of two small holes, usually about a half inch apart, with surrounding discoloration, swelling, and pain. Systematic signs (which may or may not occur) including weakness, sweating, faintness, and signs of shock.

Provide treatment as follows:

1. Calm the victim and keep affected area still.

2. Contact ambulance if victim needs transportation to the nearest hospital.

3. Wash the wound.

4. Keep the affected area below the level of the heart if bite is on the arm or leg.

5. Treat for shock.

6. Monitor airway, breathing, and circulation.

7. Obtain physical description of snake, if possible.

8. Transport victim to the nearest medical facility.

9. Provide the emergency medical responder (either the ambulance attendant or the emergency room at the hospital) with all pertinent information such as: how long ago the bite occurred, the type of snake (if known), any known allergic conditions (if known), etc.

Inform the SHSO immediately if a snakebite has occurred. The SHSO will in turn, inform the PHSO, as soon as possible.

8.7 Emergency Decontamination Procedures

In the event of a medical emergency, patients are to be adequately decontaminated before transfer, if possible. This is to prevent contamination of the medical transport vehicle and medical facility. Emergency personnel decontamination will include the following, depending on the level of protection.* Emergency shower and eye wash capabilities will be made available at each site in the event of suspect chemical surety agent contact.

Level D	Level D+	Level C	Level B
• Equipment drop • Tape, boot, and glove removal • Coverall removal • The TEU will conduct emergency decontamination if chemical surety agent suspected	• Equipment drop • Tape, outer boot, and glove removal • Coverall removal/ disposal • Inner glove removal/ disposal • The TEU will conduct emergency decontamination if chemical surety agent suspected	• Equipment drop • Tape, outer boot, and glove removal • Coverall removal/ disposal • Respirator removal • Inner glove removal/ disposal • The TEU will conduct emergency decontamination if chemical surety agent suspected	• Equipment drop • Tape, outer boot, and glove removal • SCBA or escape tank removal • Coverall removal/ disposal • SCBA or ALR face shield removal • Inner glove removal/ disposal • The TEU will conduct emergency decontamination if chemical surety agent suspected

* If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination and wrap injured personnel with clean garments/blankets, to avoid contaminating other personnel or transporting equipment.

All emergency personnel are to be immediately informed of the injured person's condition and potential contaminants and provided with all pertinent chemical data.

If necessary, one of the site personnel equipped with appropriate PPE may accompany the injured worker and perform decontamination with supervision of medical personnel.

8.8 Personal Protection and First Aid Equipment

PPE available for emergency response will include the following:

- Chemical resistant overshoe boots
- Saranex® suits
- Tyvek® suits, polyethylene coated and uncoated
- Nitrile gloves (inner and outer)
- Goggles
- SCBA

PPE, first aid equipment and the first aid kits will be available in the support zone (i.e., Baker Field Vehicle or Baker Site Trailer).

Emergency and first aid equipment can be found at the following locations:

Fire Extinguisher: Baker Site Trailer and Contractor Field Vehicle

First aid kit:	Baker Site Trailer and Baker Field Vehicles
Emergency eye wash bottle:	Baker Site Trailer and Baker Field Vehicles
Air Horn:	With Personnel
Portable Emergency Eye Wash Station:	Near Area With Greatest Potential for Chemical Splash/ Exposure

8.9 Notification

If the Emergency Coordinator determines that the site has an uncontrolled situation, such as a spill, fire, or explosion, that could threaten human health or the environment, he/she will report their findings to the Fire Chief (Navy On-Scene Coordinator) and the Base Representative. The notification report will be made from the nearest safe location and will include:

- Description of incident (e.g., release, fire).
- Name and telephone number of individual reporting the emergency.
- Location of incident.
- Name and quantity of material (s) involved.
- The extent of injuries, and number of casualties.
- The possible hazards to human health or the environment and cleanup procedures.
- Assistance that is requested.

8.10 Hazard Assessment

The Emergency Coordinator will assess possible hazards to human health or the environment that may result from an uncontrolled situation, to the best of his/her abilities, incorporating the following steps, as appropriate.

- Assess the immediate need to protect human health and safety.

- Identify the materials involved in the incident including exposure and/or release pathways and the quantity.

- Inform appropriate personnel as identified in Section 8.9, who will determine if release of material(s) meets EPA requirements for reportable quantities for spills under the RCRA or CERCLA.

This assessment may consider both the direct and indirect effects of the chemical release, fire, explosion, or severe weather conditions (e.g., the effects of any toxic, irritating, or asphyxiating gases that are liberated).

8.11 Security

During activation of the Emergency Plan, the Emergency Coordinator or his/her designated representative will control access to the site and maintain an incident log until the Navy On-Scene Coordinator arrives. The incident log will include:

- Time of entry.
- Expected exit time.
- Use of team or "buddy" system.
- Task being performed.
- Location of task.
- Rescue and response equipment used.
- Protective equipment being used.

8.12 Emergency Alerting

Personnel Injury in the Work Zone:

- Initiate a verbal warning or one long airhorn blast and move all site personnel to the decontamination control line (for Level D/D+) or the CRZ (for Level C or higher).

- Send the rescue team into the Work Zone (if required) to remove the injured person to the hotline.

- Have the SHSO and/or Site Manager evaluate the nature of the injury, and assure that the affected person is decontaminated according to Section 8.7.

- If required, contact an ambulance and/or the designated medical facility.

No persons shall reenter the Work Zone until an accident investigation is performed by the SHSO and/or the Site Manager.

Personnel Injury in the Support Zone:

- The Site Manager and SHSO will assess the nature of the injury; if the cause of the injury or loss of the injured person does not affect the performance of other site personnel, operations may continue.

- If the injury increases the risk to others, a verbal warning or one long airhorn blast shall be sounded and all remaining site personnel will move to the support zone for further instructions.

- Activities on site will stop until the added risk is mitigated.

Fire/Explosion:

- Initiate a verbal warning or one long airhorn blast and move all site personnel to the contamination control line (for Level D/D+) or the CRZ (for Level C or higher).

- Alert the fire and security departments and move all personnel to a safe distance from the involved area for further instructions.

- Activities will stop until the added risk is mitigated.

Personal Protective Equipment Failure:

- If any site worker experiences difficulty, failure or alteration of protective equipment that affects the protection factor, that person and his/her buddy shall immediately cease work activities, leave the Work Zone, and repair or replace the defective equipment.

- Reentry will not be permitted until the equipment has been repaired or replaced.

Other Equipment Failure:

- If any other equipment on site fails to operate properly, the Field Team Leader shall notify the Site Manager and SHSO to determine the effect of this failure on continuing operations on site.

- If the failure affects the safety of site personnel, work with the equipment will cease until the situation is evaluated and appropriate actions taken.

In all situations, when an on-site emergency results in evacuation of the Work Zone, personnel shall not reenter until:

1. The conditions resulting in the emergency have been corrected.
2. The hazards have been reassessed.
3. The HASP has been reviewed and, if appropriate, modified.
4. Site personnel have been briefed on any changes in the HASP.

8.13 Training

Site personnel will be informed of the details in the Emergency Plan during initial HASP training. The Emergency Plan will be reviewed/rehearsed by site personnel at least monthly or when elements of the plan change.

8.14 Spill Containment Procedures

In the event that a spill of hazardous substances (gasoline, oil, etc.) occurs during the implementation of field activities, spill containment will be utilized to prevent the additional migration of contaminants through the site area. In the event of a spill, measures will be taken to contain the spill and clean it up. For the purpose of this HASP, a spill is defined as a release of a hazardous substance to soils or surface waters. Any release to soils or surface waters equaling or exceeding the reportable quantities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (40 CFR 304) or the USEPA Clean Water Act (40 CFR 116 and 177) will be reported to the Environmental Management Department who in turn will report it to the appropriate agency within 24 hours.

Specific spill containment procedures will be dependent on the type of materials spilled and the type of environment affected. Potential spill containment procedures may include diking with absorbent material/pads, then removal or containment of the contaminated materials. Spill containment materials will be located within close proximity to the storage area of the hazardous substances in a manner such that the pathway remains accessible and free of obstructions. Spill containment materials available on site will include:

- Sheets of polyethylene
- Shovels
- Minimum of four empty 55 gallon drums
- Packing material

9.0 TRAINING REQUIREMENTS

9.1 General

All Baker employees or other personnel entering the site will need to have received training in compliance with the Occupational Safety and Health Administration (OSHA) Standard 29CFR 1910.120. Baker employees engaged in field activities which potentially expose workers to hazardous substances receive a minimum of 40 hours of instruction off site, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor. Key points of the 40-hour training include field demonstrations, respiratory fit testing and training, risk assessment, toxicology, chemical reactivity, use of monitoring equipment, downrange work procedures, site safety procedures, levels of protection, protective clothing, decontamination, and practical field exercises (which include donning, doffing, and working in personal protective ensembles for personal protection Levels A, B, and C).

In addition to the initial 40-hour training program, Baker requires site employees to receive an annual 8-hour refresher training course on the items specified by the 1910.120 standard. The general purpose of the 8-hour refresher is to ensure that personnel retain the knowledge necessary to be adequately protected, and stay current with proper site health and safety procedures. The SHSO collects training certificates of site personnel and reviews them to assure they are current.

Baker also requires that personnel involved with on-site employee supervision receive (in addition to 40 hours initial training and three days of supervised field experience) at least eight additional hours of specialized training at the time of job assignment. Training topics include, but are not limited to, the employer's safety and health program and the associated employee training program, personal protective equipment program, spill containment program, and health hazard monitoring procedures and techniques. The 8-hour supervisory training is required to ensure that supervisors have the knowledge necessary to understand and use the various Health and Safety Programs and to implement the elements of the HASP.

The TEU will discuss chemical agent concerns, air monitoring procedures with the Minicam, chemical agent first aid procedures, and their role during this project. This will be conducted during the HASP training during project mobilization.

9.2 Site-Specific Training

Site-specific training, as discussed in Section 1.3, will consist of an initial health and safety briefing on the following information:

- Names of individuals responsible for site health and safety and methods of communicating safety and health concerns.
- Site-specific health and safety hazards.
- Use of PPE.
- Work practices by which employees can minimize risk.
- Safe use of equipment on site.
- Recognition of symptoms and signs of exposure to hazardous materials.
- Site control measures.
- Decontamination procedures.
- Emergency response procedures.
- Baker Hazard Communication Program.
- TEU SOPs in Appendix D.

The SHSO will conduct the initial site-specific training prior to the initiation of field activities.

10.0 MEDICAL SURVEILLANCE REQUIREMENTS

This Site-Specific HASP will require that project personnel, who may be exposed to materials having potentially adverse and deleterious health effects, have obtained medical clearance from Baker's Board Certified Occupational Health Physician in accordance with 29 CFR 1910.120(f) prior to entry onto the site. Baker's corporate medical surveillance program establishes a medical baseline and monitors for symptoms of overexposure for individuals who participate in Preliminary Assessments, Site Inspections, Remedial Investigations, Feasibility Studies, and construction-phase services at sites covered by the Department of Labor, Occupational Safety and Health Administration (OSHA), Hazardous Waste Operations and Emergency Response Standard, 29 CFR 1910.120. Additionally, the program is intended to determine the individual's capability for performing on-site work, including wearing respiratory protective equipment.

All Baker employees that will be engaged in site activities covered by the 1910.120 standard receive a Group III physical examination by a licensed physician who is provided information on the individuals site activities, and exposure or anticipated exposure levels. This exam is received initially, then once every 12 months thereafter. More frequent medical examinations, consultations, and/or laboratory testing will be provided if the examining physician determines that an increased frequency of examination is required. A complete Group III medical exam includes parameters such as height, weight, vision, temperature, blood pressure, and a complete review of occupational and medical histories. Other tests in a Group III exam include chest x-rays, electrocardiogram, spirometry, urinalysis, and blood tests. Table 10-1 describes the medical surveillance testing parameters performed annually on Baker employees.

Prior to entry onto the site, all personnel, including subcontractors, will be required to provide medical clearance information from their company physician stating that they are physically capable of performing the activities required. A copy of the Baker Bloodborne Pathogen Program will be available in the field trailer for review by site personnel.

TABLE 10-1

MEDICAL SURVEILLANCE TESTING PARAMETERS*

Group II - Individuals Occasionally in the Field (10-30 days/year)

- Medical History (Physical Exam)
- Eye Exam
- EKG (baseline and for individuals over 40 years of age)
- Chest X-ray (baseline then every 5 years)
- Spirometry
- CBC with differential
- SMA 12 or 26 (liver enzyme scan)

Group III - Individuals Frequently in the Field (>30 days/year)

- Medical History (Physical Exam)
- Eye Exam
- EKG (baseline then annually for individuals over 40 years of age)
- Audiometry
- Chest X-ray (baseline then every 3 years)
- Spirometry
- CBC with differential
- SMA 12 or 26 (liver enzyme scan)
- Urinalysis (glucose scan)
- Specific Blood and Urine Tests (dependent on field exposure)**

Group III with Asbestos - Individuals frequently in the field whom also work with asbestos

- Group III testing with the Asbestos Medical Questionnaire w/Pulmonary Function Test ($FVC_{1.0}$ and $FEV_{1.0}$)

* The attending physician has the right to reduce or expand the medical monitoring on an annual basis as he/she deems necessary.

** To be performed for individuals identified by the attending physician as being chronically exposed to organic compounds.

11.0 HEALTH AND SAFETY PLAN APPROVAL

This HASP has been reviewed by the following personnel for approval of activities at Sites 41, 69, and 74 at MCB Camp Lejeune.

Name (print)	Title	Signature	Date
Ronald Krivan	PHSO	Ronald Krivan	12/20/93
Peter Monday	Site Manager	Peter A. Monday	12/20/93
Raymond Wattras	Project Manager	Raymond Wattras	12/22/93
Barbara J. Cummings	Industrial Hygienist	Barbara J. Cummings	12/20/93

12.0 DECLARATION OF HASP REVIEW

All site personnel indicated below, have reviewed and are familiar with this Health and Safety Plan. Site personnel are to sign and date this sheet after HASP training.

1. _____ _____
(Name-Print) (Company)

_____ _____
(Name-Sign) (Date/Time)

2. _____ _____
(Name-Print) (Company)

_____ _____
(Name-Sign) (Date/Time)

3. _____ _____
(Name-Print) (Company)

_____ _____
(Name-Sign) (Date/Time)

4. _____ _____
(Name-Print) (Company)

_____ _____
(Name-Sign) (Date/Time)

5. _____ _____
(Name-Print) (Company)

_____ _____
(Name-Sign) (Date/Time)

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(Name-Sign) (Date/Time)

Appendix A
Baker Environmental, Inc.
Safety Standard Operating Procedures

APPENDIX A

BAKER ENVIRONMENTAL, INC.
SAFETY STANDARD OPERATING PROCEDURES

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1.0 Confined Space Entry Program*

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* Not Applicable

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2.0 - RESPIRATORY PROTECTION PROGRAM

2.1 INTRODUCTION

In accordance with OSHA requirements (29 CFR 1910.134), this document represents Baker Environmental, Inc.'s (Baker's) program governing the selection and use of respiratory protection for its employees. It is Baker's policy to provide its employees with the proper protective equipment, training, and medical surveillance necessary to protect individuals from any potential hazards which may be present during the tasks performed throughout the course of each individual's employment. This program specifically describes the procedures which have been established and implemented for the use of respiratory protection equipment. The effectiveness of this program shall be reevaluated on an annual basis and appropriate changes shall be made if deemed necessary.

2.2 EMPLOYER RESPONSIBILITY

Baker shall provide its employees the respiratory protection equipment which is appropriate and suitable for the purpose intended, when such equipment is necessary to protect the health of the employee.

2.3 EMPLOYEE RESPONSIBILITY

The employee shall use the respiratory protection provided in accordance with instructions and training received, and shall report any malfunction of the equipment to a responsible person. The employee shall not wear contact lenses in atmospheres where respiratory protection is required. Corrective lens inserts will be provided, at Baker's expense, for employees who require corrective lenses.

2.4 HAZARD ASSESSMENT

The key elements of a respiratory protection program must start with an assessment of the inhalation and ingestion hazards present in the work area. Because Baker's services involve a variety of environmental and industrial hygiene studies, it is not practical to identify all

possible hazards to which all employees could be exposed within the scope of this document. Therefore, it is essential that a task specific assessment be conducted prior to the initiation of any activities on a given project. This task specific assessment may be part of the site-specific Health and Safety Plan.

After a task-specific assessment is completed and it is determined that airborne exposure concentrations exceed or may exceed the recommended limits, engineering and administrative controls should be implemented, whenever feasible.

If the exposure cannot be reduced, or it is not feasible to reduce the airborne exposure below the recommended limits, respirators will be selected by the Site Health and Safety Officer on the basis of:

- Toxicity
- Maximum Expected Concentration
- Oxygen Levels
- Warning properties of the substance(s) involved
- Sorbent Limitations
- Facepiece Fit
- Mobility Requirements
- Type of Use (routine, escape, or emergency entry)
- Possibility of Ingestion of Toxic Materials
- Respirator Attributes

2.5 TRAINING

Each respirator wearer shall be given training, by a qualified individual, which will include explanations and discussions of:

- Opportunity to wear respiratory protection in an uncontaminated environment.
- Respirator Fit Testing (qualitative)
- The respiratory hazard(s) and what may occur if the respirator is not used properly.
- The reasons for selecting a particular type of respirator.
- The function, capabilities, and limitations of the selected respirator.
- The method of donning the respirator and checking its fit and operation.
- The proper wearing of the respirator.

- Respirator maintenance, repair, and cleaning.
- Recognizing and handling emergency situations.

Respirator training will be conducted on an annual basis, at a minimum. Records of the training and fit-testing will be maintained for a minimum of 30 years following termination of employment for each employee.

2.6 TYPES OF RESPIRATORS

Baker provides employees with the North Brand half-face (Model 7700) and full-face (Model 7600) air purifying respirators, positive pressure 30-minute Self-Contained Breathing Apparatus (SCBAs) (Model 800), positive pressure supplied airline respirators, with 5-minute escape air cylinders (Model 85500). Only respiratory equipment certified by the appropriate approval agencies (e.g., NIOSH, MSHA) according to Title 30, Part II of the Code of Federal Regulations, will be distributed to Baker employees. As an alternate air purifying respirator, Baker will also keep, on-hand, the MSA ultra twin full-face respirator. All Baker employees who regularly perform tasks requiring respiratory protection will be issued their own half-face or full-face respirator, provided the employee can achieve a proper fit and is medically capable of wearing the equipment.

Because 30-minute SCBAs, positive pressure supplied airline respirators, and 5-minute escape air cylinders are used less frequently, this equipment will be distributed on an as-needed basis.

2.7 AIR QUALITY

Liquid air used for respiration shall be of high purity. Breathing air shall meet at least the requirements of the specification for Grade D Breathing Air (or higher) as described in Compressed Gas Association Commodity Specification G-7.1-1966. Breathing air may be supplied to respirators from cylinders; oxygen must never be used with air-line respirators.

Air cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178). Air-line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air-line respirators with nonrespirable gases or oxygen.

Breathing gas containers (air cylinders) shall be marked in accordance with American National Standard Method of marking Portable Compressed Gas Containers to Identify the Material Contained, A48.1-1954; Federal Specification BB-A-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG-B00675b, April 27, 1965, Breathing Apparatus, Self-Contained.

Breathing air, as supplied by air compressors, shall be of high purity and meet the requirements of the specification for Grade D Breathing air (or higher) as described in Compressed Gas Association Commodity Specification G-7.1-1966.

The compressor for supplying air shall be equipped with necessary safety and standby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in the event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to insure that it meets the specifications outlined above.

2.8 CLEANING AND MAINTENANCE

Respirator maintenance will be performed by each trained individual on a regular basis. The maintenance shall be carried out in a manner that ensures that each respirator wearer is provided with a respirator that is clean and in good operating condition.

Respiratory equipment that is used on an as-needed basis shall be maintained by qualified personnel. This equipment shall be cleaned/sanitized, then rinsed and air-dried, after each use. Inspections shall be conducted before and after each use.

Respiratory equipment that has been issued to an employee shall be cleaned/sanitized then rinsed and air-dried by the wearer, (specified by OSHA in 29 CFR 1910.134) which ensures that it will be maintained in clean and good operating condition. Inspections shall be conducted on a regular basis during usage and prior to each project requiring the potential usage of the equipment.

All respirators shall be stored in a plastic bag within a cool/dry location, in a manner that will protect them against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. They shall be stored to prevent distortion of rubber or other elastomer parts.

Parts replacement and repairs shall be performed only by appropriate personnel. Equipment requiring repairs shall be reported to appropriate Baker personnel. Examples of inspection forms are included at the end of this text.

2.9 FIT-TESTING

Each respirator wearer shall be provided with a respirator that can properly form a secure face to mask seal. Each wearer shall be fit-tested prior to issuance of the respirator using either an irritant smoke or odorous vapor, or other suitable test agent (see example of form at end of text). Retesting shall be performed, at a minimum, on an annual basis or if a different model respirator, other than the model he/she was previously fit-tested for, is to be used by the wearer. Air purifying respirators fit-tested qualitatively will be assigned a protection factor of 10 (APF = 10).

Facial hair, which interferes with the normally effective face to mask seal, is prohibited. Each respirator wearer shall be required to check the seal of the respirator by negative and positive pressure checks prior to entering a harmful atmosphere.

2.10 MEDICAL SURVEILLANCE

Personnel who are or may be assigned to tasks requiring use of respirators shall participate in a medical surveillance program on an annual basis. The medical surveillance program shall include, but may not be limited to, a physical and a pulmonary function test conducted by the company's physician and at the expense of the company. Test parameters included in Baker's medical surveillance program is included as Appendix A in each site-specific Health and Safety Plan.

2.11 LIMITATIONS

Wearing any respirator, alone or in conjunction with other types of protective equipment, will impose some physiological stress on the wearer. Therefore, selection of respiratory protective

devices will be based on the breathing resistance, weight of the respirator, the type and amount of protection needed as well as the individual's tolerance of the given device. Additional concerns regarding the limitations of different types of PPE and the monitoring requirements for heat stress/strain will be addressed in the "Heat Stress" SOP.

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FULL-FACE AND HALF-FACE RESPIRATOR INSPECTION FORM

Inspection Date	Type	FACE PIECE					HEADSTRAPS OR HEADBANDS		RESPIRATOR INTERIOR		
		Clean and Sanitized	No Cracks, Tears, or Holes	Proper Shape and Flexibility	Air Purifying Element Holders Operate Correctly	Proper Storage Free From Heat, Dirt, Sunlight, etc.	No Signs of Wear or Tears	Buckles Function Properly	No Foreign Material Under Valve Seat	No Cracks or Tears in Valves or Valve Bodies	Valve Covers and Bodies in Good Condition and Installed Correctly

✓ = OK X = Not OK

RESPIRATOR FIT TEST RECORD

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TEST SUBJECT NAME _____
(last) (first) (initial)

DATE _____ DEPARTMENT _____

SEX (M/F) _____ AGE _____ SOCIAL SECURITY NUMBER _____

RESPIRATOR MEDICAL DATE _____ RESPIRATOR TRAINING DATE _____

SPECIAL/UNUSUAL CONDITIONS/CONSIDERATIONS:

___ Claustrophobia
___ Facial hair
___ Eyeglasses
___ Contacts
___ Other: _____

___ Scars
___ Broken or crooked nose
___ Extreme facial dimensions
___ Wrinkles

RESPIRATOR SELECTION

Manufacturer/Model	Size	Style	
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___

Testing Agent	Qualitative Test	Sensitivity Check
Isoamyl Acetate	Yes: ____ No: ____	Yes: ____ No: ____
Irritant Smoke	Yes: ____ No: ____	Yes: ____ No: ____

TEST EXERCISES
(Check all that apply)

Normal Breathing _____
Deep Breathing _____
Head, Side to Side _____
Head, Up and Down _____

Talking _____
Running _____
Bending _____
Rainbow Passage _____

COMMENTS: _____

_____

Signed: _____
(Test Subject)

Signed: _____
(Technician/Instructor)

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SCBA AND SAR (WITH 5-MINUTE ESCAPE TANK) DAILY INSPECTION FORM

Type (SCBA or SAR)	Cylinder Condition (Damaged or Undamaged)	Cylinder (Full or MT)	Facepiece and Hoses (Damaged or Undamaged)	Connections (Damaged or Undamaged)	Apparatus Complete (Yes/No)	Cleaned and Sanitized (Yes/No)	Remarks	Inspected By (Initials)	Date Inspected

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3.0 - CARE AND CLEANING OF PERSONAL PROTECTIVE EQUIPMENT

3.1 INTRODUCTION

The following procedures cover the care and cleaning of Levels D, C, and B personal protective equipment. Note: These are general procedures that apply to most situations and are not all inclusive. Procedures are subject to change at the direction of the Site Health and Safety Officer (SHSO).

3.2 EQUIPMENT CARE

3.2.1 Chemical Resistant Suit (Levels C and B)

- Before donning, inspect suit for holes or tears; check to see that zippers are operable; and look for signs of suit degradation.

- When wearing, avoid contact with contaminated material where possible; be aware of sharp objects that can tear suit; periodically look over suit to check for major rips or tears.

- While decontaminating, remove gross excess of material from suit; remove suit so that material does not contact inner suit; place clothing in properly labeled disposal containers.

3.2.2 Inner/Outer Gloves (Levels D+ through B)

- Look for rips, tears, or degradation of material. Replace as necessary or at the direction of the SHSO.

3.2.3 Chemically Resistant Boots (Levels D+ through B)

- Nondisposable boots are to be examined on a daily basis before and after use. Disposable boots should be examined prior to donning and while in use, and disposed according to site procedures.

3.2.4 Safety Shoes/Boots (Levels D through B)

- Examine daily for gouges, open seams, etc., anything that would lessen the integrity of the boot. Replace as shoe/boot becomes worn.

3.2.5 Hard Hats (Levels D through B)

- Should be visually inspected before donning for fit, cracks, and overall condition.

3.2.6 Safety Glasses/Goggles (Levels D and C)

- Should be visually inspected before donning for cracks, deteriorated parts, and overall condition. Replace as necessary.

3.2.7 Respirators (Levels C and B)

- Procedures for care of respiratory protective equipment are covered in Baker's SOP for Respiratory Protection.

3.2.8 Hearing Protection (Levels D through B)

- Disposable - Replace daily, or as material becomes worn or dirty.
- Reusable - Inspect before use, clean regularly, replace parts as necessary.

3.3 EQUIPMENT CLEANING

General procedures for cleaning of equipment are listed below. Site-specific concerns will be addressed by the SHSO prior to and during site activities. Cleaning of respiratory equipment is covered under the "Respiratory Protection Program" SOP.

3.3.1 Gross Physical Removal

Large amounts of contaminated soil is scraped off with a tongue depressor, or wiped off using a disposable wipe.

3.3.2 Physical/Chemical Removal

The residual contamination will be scrubbed with a soft-bristled, long-handled brush using a nonphosphate detergent solution.

3.3.3 Rinsing/Dilution

The detergent solution and residual contaminants will be rinsed with tap water using a pressurized sprayer.

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4.0 - SANITATION/SITE PRECAUTIONS

4.1 SANITATION

- A supply of clearly marked potable water, tightly closed, and equipped with a tap.
- Single service disposal cups.
- Outlets for non-potable water, clearly marked, for fire fighting, or other purposes. Cross-contamination of the potable supply shall be prevented.
- One toilet facility which is either chemical, recirculating, combustion, or flush, depending on local code requirements.
- A place for food handling meeting all applicable laws, otherwise, suitable alternatives to such facilities will be provided (i.e., nearby restaurants, food wagons, etc.).
- Clean wash water will be available in the decontamination zone and the Baker Site Trailer. Disposable towelettes will be available in each Baker Field Vehicle, for periodic cleanups.

4.2 SITE PRECAUTIONS

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material, is prohibited in any area designated as contaminated. Smoking will also not be allowed in areas where flammable materials are present.
- Hands and face must be thoroughly washed before breaking for meals and upon leaving the site.
- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

- "Contaminated" work garments are not to be worn off site.

- Contact lenses are not permitted to be worn on site.

- No facial hair which interferes with a satisfactory fit of the mask-to-face seal, is allowed on personnel who are or may be required to wear respirators.

- Contact with contaminated or potentially contaminated surfaces should be avoided. Wherever possible, do not walk through puddles, leachate, discolored surfaces, kneel on ground, lean, sit or place equipment on drums/containers.

- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. Prescribed and non-prescription drugs should not be taken by personnel where the potential for absorption, inhalation, or ingestion of toxic substances exist unless specifically approved by a qualified physician. Alcoholic beverage intake should be minimized or avoided during after-hour operations.

- Alcoholic beverages and fire arms are prohibited on site.

- All personnel will observe any posted sign, warning, fence, or barrier posted around contaminated areas.

5.0 HEAT STRESS

Monitoring

Provisions for monitoring for heat stress will be determined by the SHSO and performed as outlined below.

Heat stress monitoring is required for personnel wearing semipermeable or impermeable protective outerwear when there is an ambient air temperature greater than 70°F. One or more of the following procedures will be implemented when this condition exists:

1. Increased awareness of heat stress symptoms and buddy monitoring.
2. Fluid intake discipline.
3. Self monitoring of urine output quantities to prevent dehydration.
4. Work-rest intervals.
5. Calculate the Heat Exposure Threshold Limit Value (TLV) for work-rest intervals using the following steps:
   a. Calculate the WBGT (Wet Bulb Globe Temperature) Index using the Quest® Heat Stress Monitor
   b. Estimate the work load using the following guidelines:
      (1) Light work = sitting or standing to control machines, performing light hand or arm work.
      (2) Moderate work = walking about with moderated lifting and pushing.
      (3) Heavy work = pick and shovel work.
   c. Evaluate the calculations against the following Heat Exposure TLVs in °C or °F.

Work - Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous work	30.0 (86)	26.7 (80)	25.0 (77)
75% work - 25% rest, each hour	30.6 (87)	28.0 (82)	25.9 (78)
50% work - 50% rest, each hour	31.4 (89)	29.4 (85)	27.9 (82)
25% work - 75% rest, each hour	32.2 (90)	31.1 (88)	30.0 (86)

* For unacclimatized workers, the permissible heat exposure TLV should be reduced by 2.5°C.

Special Considerations

- Clothing - Subtract 2 from the TLV to compensate for the use of semipermeable clothing.

- Acclimatization - After approximately a week, workers should have acclimated themselves to their environment.

- Fitness - Physically fit workers will adjust more readily to a change in environment.

- Medication - Some medications can predispose individuals to heat-induced illnesses.

Causes and Symptoms

The following heat stress causes and symptoms are provided for buddy monitoring purposes. Site personnel must realize that monitoring the physical condition of fellow personnel in Level B and C protective ensembles will be difficult.

1. *Heat rash* results from continuous exposure to heat or humid air.

2. *Heat cramps* are caused by heavy sweating and inadequate fluid intake. Symptoms include muscle spasms and pain in the hands, feet, and abdomen.

3. *Heat exhaustion* occurs when body organs attempt to keep the body cool, due to inadequate fluid intake and personnel not acclimated to the environment. Symptoms include pale, cool, moist skin; heavy sweating; and dizziness.

4. *Heat stroke* is the most serious form of heat stress. It is a MEDICAL EMERGENCY. Symptoms are red, hot, dry skin; lack of perspiration; nausea; dizziness and confusion; strong, rapid pulse rate; and coma.

The need to seek medical attention and the urgency in seeking medical attention depends on the symptoms and the severity of the symptoms displayed by the affected individual. If *heat stroke* is noted or suspected, medical attention must be sought IMMEDIATELY. Efforts should be taken to cool the body to prevent serious injury or death. Excessive cooling can cause hypothermia and should be avoided.

Prevention

Fluid intake should be increased during rest schedules to prevent dehydration. Drinking cool water is best; however, diluted electrolyte solutions (i.e., Gatorade or equivalent) can be substituted for water. Each individual should monitor their urine output and adjust their fluid intake to ensure that urine output and urine color are close to normal. Additional means for preventing heat-induced illnesses may include providing shelter or cooling devices, such as vests and showers.

6.0 COLD STRESS

The potential exists for either frostbite or hypothermia to occur when conducting work activities in an environment where air temperatures may fall below freezing or where wind-chill factors lower air temperatures below freezing. A brief description and exposure symptoms for both hypothermia and frostbite are as follows:

1. *Hypothermia* - a condition in which the body loses heat faster than it is produced. At a body temperature of 95°F, an average man is considered to be hypothermic. Vasodilators, which include alcohol and drugs, allow the body to lose heat faster which can accelerate hypothermia. The five stages of hypothermia include: (1) shivering; (2) apathy; (3) unconsciousness; (4) freezing; and (5) death.

2. *Frostbite* - a condition in which there is a freezing or partial freezing of some part of the body. Individuals previously exposed to frostbite are more susceptible to contracting it again. Vasoconstrictors, which include tobacco products, constrict blood vessels, and can accelerate frostbite. The three stages of frostbite include: (1) frostnip - the beginnings of frostbite whereby the skin begins to turn white; (2) superficial - similar to frostnip except the skin begins to turn numb; and (3) deep - the affected area is frozen to the bone, cold, numb, and very hard.

The need to seek medical attention and the urgency in seeking medical attention depends on the symptoms and the severity of the symptoms displayed by the affected individual. If the latent conditions of hypothermia or frostbite are noted or suspected, medical attention must be sought IMMEDIATELY to prevent permanent injury or death.

To prevent conditions from occurring have personnel:

- Dress in a minimum of three layers (a skin layer to absorb moisture and keep skin dry, an insulating layer, and an outer chemical-protective layer).

- Avoid touching cold surfaces (especially metal) with bare skin, minimize exposed skin surfaces.
- Keep active, use shelter areas during rest cycles.
- Maintain body fluids.
- Use wind breaks whenever possible.

Appendix B
Material Safety Data Sheets

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Material Safety Data Sheets Collection:

Sheet No. 366
Chlorobenzene

Issued: 11/82 Revision: B, 11/90

Section 1. Material Identification

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Chlorobenzene (C_6H_5Cl) Description: Produced by chlorinating benzene in the presence of a catalyst. Used in dry cleaning; as a solvent in manufacturing paints, adhesives, polishes, waxes, diisocyanates, natural rubber, and pharmaceuticals; a chemical intermediate for phenol, *o*-, and *p*-chloronitrobenzene, DDT, and aniline; and an intermediate in manufacturing dyestuffs.

Other Designations: CAS No. 0108-90-7, benzene chloride; chlorobenzol; MCB; monochlorobenzene; phenyl chloride.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R	1
I	3
S	2
K	3

NFPA

HMIS
H 2
F 3
R 0
PPG*
* Sec. 8

Cautions: Chlorobenzene is a skin and mucous membrane irritant, a fairly strong narcotic, and a central nervous system (CNS) depressant. Chronic inhalation may cause *lung, liver, and kidney damage*. This material is a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Chlorobenzene, ca 100%

1989 OSHA PEL	1990-91 ACGIH TLV*	1988 NIOSH REL	1985-86 Toxicity Data†
8-hr TWA: 75 ppm, 350 mg/m³	TWA: 75 ppm, 345 mg/m³	None established	Rat, oral, LD_{50}: 2910 mg/kg; toxic effects not yet reviewed Rat, inhalation, TC_{Lo}: 210 ppm administered for 6 hr to a 6- to 15-day pregnant female produces specific developmental abnormalities

1987 IDLH Level
2400 ppm

* In its "Notice of Intended Changes (for 1990-91)," the ACGIH lists a proposed lower level TWA for chlorobenzene: 10 ppm, 46 mg/m³.[159]
†See NIOSH, *RTECS* (CZ0175000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 270 °F (132 °C) at 760 mm Hg
Melting Point: -50.1 °F (-45.6 °C)
Vapor Pressure: 11.8 mm Hg at 77 °F (25 °C)
Vapor Density (Air = 1): 3.88
Viscosity: 0.790 centipoise at 70 °F (21 °C)
Molecular Weight: 112.56
Specific Gravity (20 °C/4 °C): 1.1058
Water Solubility: Insoluble

Appearance and Odor: A clear, colorless, volatile liquid with a faint, almond-like odor. Threshold odor concentration: 100% recognition, 0.21 ppm.

Section 4. Fire and Explosion Data

Flash Point: 85 °F (29.5 °C), CC	Autoignition Temperature: 1180 °F (638 °C)	LEL: 1.8% v/v	UEL: 9.6% v/v

Extinguishing Media: Use carbon dioxide, dry chemical, halon, water spray, or standard foam to extinguish fires involving chlorobenzene. Use water in flooding quantities as fog since solid streams of water may spread fire. Apply water spray from as far as possible to cool fire-exposed containers.

Unusual Fire or Explosion Hazards: Chlorobenzene is dangerous when exposed to heat or flame. Vapor may travel to an ignition source and flash back.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Do not extinguish fire unless flow can be stopped. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Chlorobenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Chlorobenzene is incompatible with strong oxidizers; contact may cause fires and explosions. It reacts violently with dimethyl sulfoxide. Silver perchlorate forms a solvated, shock-sensitive salt with chlorobenzene (explosion). Chlorobenzene is potentially explosive with powdered sodium or phosphorus trichloride + sodium.

Conditions to Avoid: Avoid all heat and ignition sources and incompatible materials.

Hazardous Products of Decomposition: Thermal oxidative decomposition products of chlorobenzene can include soot, hydrogen chloride, phosgene, and carbon monoxide.

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Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list chlorobenzene as a carcinogen.
Summary of Risks: Chlorobenzene is a fairly strong narcotic and can cause central nervous system (CNS) depression. Overexposure is irritating to the eyes, nasal passages, and upper respiratory tract. It is moderately toxic by inhalation or ingestion and can be absorbed slowly through the skin. Short exposures to liquid may cause skin irritation and defatting, while prolonged or repeated skin contact may result in dermatitis or skin burns. Following absorption of toxic doses, liver and kidney degeneration are also observed. Chlorobenzene may also cause hemolysis.
Medical Conditions Aggravated by Long-Term Exposure: Individuals with skin, liver, kidney, or chronic respiratory disease may be at increased risk from exposure.
Target Organs: Respiratory system, eyes, skin, central nervous system, and liver.
Primary Entry Routes: Inhalation, ingestion, eye and skin contact.
Acute Effects: Symptoms to be expected from acute exposure are headache, eye and upper respiratory tract irritation, dizziness, drowsiness, cyanosis, spastic contractions of extremities, and loss of consciousness, depending on the exposure's concentration and duration. Symptoms of ingestion include pallor, cyanosis, and coma, followed by complete recovery.
Chronic Effects: Frequently repeated contact with chlorobenzene may result in skin burns, eye and upper respiratory tract irritation, headaches, dizziness, somnolence, and dyspeptic disorders (indigestion). Chronic inhalation may result in lung, liver, and kidney damage.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water. Consult a physician immediately. If vomiting occurs, administer more water.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: In a *conscious* patient, attempt to induce vomiting with Syrup of Ipecac. Consider activated charcoal cathartic. Administer charcoal slurry with saline, water, or sorbitol. In an *unconscious* patient, do gastric lavage with suction.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a chlorobenzene spill control and counter measure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and contact with liquid. Take up spilled material with a noncombustible absorbent material and place into containers for disposal. For large spills, dike far ahead of spill to contain. Do not release runoff to sewers or waterways since chlorobenzene is harmful to aquatic life in very low concentrations. Aquatic toxicity: A 20-ppm concentration of chlorobenzene administered to bluegill in fresh water during a 96-hr test period is the median tolerance limit (TLm) at which 50% of the aquatic organisms survive. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U037
CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per Clean Water Act, Sec. 311(b)(4), Sec. 307(a), and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Use an organic vapor-acid gas respirator where appropriate. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets (polyvinyl alcohol is recommended) to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a well-ventilated, fire-resistant area away from heat and ignition sources and oxidizing agents. Outside or detached storage is preferred. Storage and handling must be suitable for an OSHA Class IC flammable liquid. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. Protect containers from physical damage.
Engineering Controls: Avoid vapor inhalation and contact with liquid. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Provide a preplacement questionnaire that emphasizes detecting a history of skin, liver, kidney, or chronic respiratory disease.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Chlorobenzene	**IMO Shipping Name:** Chlorobenzene
DOT Hazard Class: Flammable liquid	**IMO Hazard Class:** 3.3
ID No.: UN1134	**ID No.:** UN1134
DOT Label: Flammable liquid	**IMO Label:** Flammable liquid
DOT Packaging Exceptions: 173.118	**IMDG Packaging Group:** II
DOT Packaging Requirements: 173.119	

MSDS Collection References: 38, 73, 84, 85, 89, 100, 101, 103, 124, 126, 131, 132, 133, 136, 138, 139, 140, 143, 146, 148
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: AC Darlington, MD; Edited by: JR Stuart, MS

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Material Safety Data Sheet

From Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 603

2-CHLOROACETOPHENONE

Issued: May 1986

SECTION 1. MATERIAL IDENTIFICATION

MATERIAL NAME: 2-CHLOROACETOPHENONE

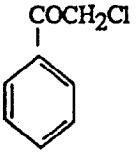
OTHER DESIGNATIONS: alpha-Chloroacetophenone, Chloro Methyl Phenyl Ketone, Mace, Phenacyl Chloride, Phenylchloromethyl Ketone, Phenyl Chloromethyl Ketone, C_8H_7ClO, CAS #0532-27-4.

MANUFACTURER/SUPPLIER:
Haarmann & Reimer Corp., Aroma Chemical Div., PO Box 175, 111 US Hwy. 22, N. Springfield, NJ 07081; Telephone: (201) 686-3132

HMIS
H: 2
F: 1
R: 1
PPE*
*See Sect. 8

R 1
I 4
S 3
K 1

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
2-Chloroacetophenone, CAS #0532-27-4  * Current (1985-86) ACGIH TLV or OSHA PEL.	ca 100	8-hr. TWA: 0.05 ppm or 0.3 mg/m^3* Rat, Oral, LD_{50}: 127 mg/m^3 Human, Inhalation, LCLo: 159 mg/m^3/20 min. Human, Inhalation, TCLo: 20 mg/m^3: Irritation Rabbit, Eye: 3 mg, Severe

SECTION 3. PHYSICAL DATA

Boiling Point, 1 atm ... 477°F (247°C)
Vapor Pressure @ 20°C, mm Hg ... 0.012
Water Solubility @ 20°C ... Insoluble
Vapor Density (Air = 1) ... 5.32
Evaporation Rate ... Not Found

Specific Gravity (H_2O = 1) ... 1.324
Melting Point ... 138°F (59°C)
Percent Volatile by Volume ... ca 100
Molecular Weight ... 154.60

Appearance and odor: Colorless-to-gray crystalline solid with a sharp, irritating floral odor. The odor threshold for 2-chloroacetetophenone is 0.1 mg/m^3.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	LOWER	UPPER
244°F (118°C) CC	Not Found	Not Found	–	–

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, foam, water fog. Water or foam may cause frothing. Use water spray to cool tanks/containers exposed to fire.

This OSHA class IIIB combustible liquid is a slight fire hazard when exposed to heat, sparks, or open flame. When involved in a fire, 2-chloroacetophenone emits toxic and corrosive vapors.
Fire fighters should use self-contained breathing apparatus and fully protective clothing when fighting fires involving this material.

SECTION 5. REACTIVITY DATA

2-Chloroacetophenone is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

This material is incompatible with strong oxidizers. It reacts slowly with water or steam, generating hydrogen chloride.

Thermal decomposition or burning produces toxic vapors and gases such as carbon monoxide and fumes of chlorine.

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SECTION 6. HEALTH HAZARD INFORMATION

2-Chloroacetophenone is not listed as a carcinogen by the NTP, IARC, or OSHA.
This material is a potent irritant and lacrimator (promotes tears). It is highly toxic by inhalation and ingestion. Symptoms of overexposure include tingling in the nose, lacrimation, burning of and/or pain in the eyes, blurred vision, rhinorrhea, burning in the chest, difficulty in breathing, and nausea. In extreme cases pulmonary congestion and edema may result, with onset of edema appearing several hours to days after exposure. Humans exposed to levels of 200 to 340 mg/m^3 could not tolerate exposure for more than 30 seconds. 2-Chloroacetophenone is irritating to the skin and intensely irritating to the eyes. Overexposure of eyes can cause severe conjunctivitis; corneal haziness; pain; and, in severe cases, permanent partial opacity (leukoma). Contact with the skin may cause a burn, especially if the skin is moist or wet. It can also cause dermatitis and skin sensitization. The TLV of 0.05 ppm is set to prevent lacrimation and irritation. The irritation threshold for 2-chloroacetophenone ranges from 0.15 to 0.4 mg/m^3, while the lacrimation threshold is 0.3 to 0.4 mg/m^3. No chronic effects are reported. FIRST AID: EYE CONTACT: Promptly flush eyes, including under the eyelids, with running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Promptly flush skin with running water for at least 15 minutes while removing contaminated clothing and shoes. Get medical help if irritation persists.* INHALATION: Remove victim to fresh air. Restore and/or support his breathing as required. Keep him/her warm and quiet. Observe victim for symptoms of pulmonary edema. Get medical help.* INGESTION: Give victim 1 or 2 glasses of water or milk to drink as quickly as possible. Contact a physician or poison control center. Do not induce vomiting unless directed to do so. Never give anything by mouth to someone who is unconscious or is convulsing.*

GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of large 2-chloroacetophenone spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate the spill area and limit access to necessary personnel only. Remove any leaking containers to a safe place, if feasible. Those involved in cleanup need protection against contact with the solid form and inhalation of dust and vapor (see sect. 8).

Scoop, shovel, or vacuum spilled material into closed containers. Use caution to avoid generating dust. Flush spill area with water and collect flushings and waste water for disposal. Do not flush waste to a sewer, watershed, or waterway.

Place waste in a suitable container for disposal by a licensed contractor, dispose of it in a landfill, or dissolve it in an organic solvent and burn it in an approved incinerator equipped with an afterburner and a scrubber. Follow all Federal, state, and local regulations.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute). For emergency or nonroutine exposures where the TLV may be exceeded, use an appropriate NIOSH-approved respirator.

Impervious gloves, face shield, apron, boots, plastic coveralls, and other protective clothing and equipment should be available and worn as necessary to prevent contact with skin or clothing. Wear safety goggles to prevent any possibility of 2-chloroacetophenone coming in contact with the eyes. Remove contaminated clothing immediately and do not wear it again until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store 2-chloroacetophenone in closed containers in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, and open flame. Storage area must be suitable for combustible solids. Protect containers from physical damage. Ground and bond conveying equipment and storage containers when transferring the solid to prevent the possibility of a dust explosion. Any bulk storage system should have an explosion-relief design. Do not smoke in use or handling areas. Use only with adequate ventilation. Avoid inhalation of dust and vapor and contact with skin, eyes, and clothing. Practice good industrial hygiene when handling this material. Avoid generating dust. Emptied containers retain product residues; handle them accordingly!
Preplacement and periodic physical examinations should be provided to those who work with this material. Individuals with histories of chronic respiratory, skin, or eye disease may be at increased risk from exposure.

DOT Classification: Irritating Material. DOT No. UN1697
Data Source(s) Code: 2, 4, 5, 7, 8, 23, 34, 47, 63, 69, 75, 78, 79-82. CR

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Approvals
Indust. Hygiene/Safety
Medical Review

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Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

Issued: 11/78 **Revision: E, 8/90**

Section 1. Material Identification

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Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.
Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA
3 / 2 / 0 / -

HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8
Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
%Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	Autoignition Temperature: 928 °F (498 °C)	LEL: 1.3% v/v	UEL: 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.
Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

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Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE-NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection References: 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS

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BENZENE HEXACHLORIDE

BHC

Common Synonyms			
1, 2, 3, 4, 5, 6-Hexachlorocyclohexane Lindane BHC Gammexane Tri-6	Solid crystals or powder, or solution	Solid is light to dark brown	Musty odor
	Solid sinks in water. Solution generally floats on water.		

Avoid contact with liquid and solid. Keep people away.
Wear goggles and self-contained breathing apparatus.
Stop discharge if possible.
Call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Solid not flammable, but usually dissolved in combustible liquid. POISONOUS GASES ARE PRODUCED WHEN SOLID IS HEATED OR WHEN SOLUTION BURNS. Wear goggles and self-contained breathing apparatus. Extinguish with foam, dry chemical, or carbon dioxide
Exposure	CALL FOR MEDICAL AID **SOLID OR SOLUTION** **POISONOUS IF SWALLOWED.** **Irritating to skin and eyes.** Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and pollution control officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-water contaminant, poison
Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Not listed
3.2 **Formula:** $C_6H_6Cl_6$
3.3 **IMO/UN Designation:** 6.1/2761
3.4 **DOT ID No.:** 2761
3.5 **CAS Registry No.:** 58-89-9

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Solid
4.2 **Color:** Light tan to dark brown
4.3 **Odor:** Characteristic

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Data not available
5.2 **Symptoms Following Exposure:** Hyperirritability and central nervous excitation: notably vomiting, restlessness, muscle spasms, ataxia, and clonic and tonic convulsions. Subsequent central nervous depression leading to respiratory failure. Occasional dermatitis and urticaria.
5.3 **Treatment of Exposure:** Gastric lavage and saline cathartics (not oil laxatives because they promote absorption). Sedatives: pentobarbital or phenobarbital in amounts adequate to control convulsions. Calcium gluconate intravenously may be used in conjunction with sedatives to control convulsions. Rest and quiet. Do NOT use epinephrine because ventricular fibrillation may result.
5.4 **Threshold Limit Value:** 0.5 mg/m³
5.5 **Short Term Inhalation Limits:** 1 mg/m³ for 30 min.
5.6 **Toxicity by Ingestion:** Gamma isomer (Lindane): Grade 3; LD_{50} 50 to 500 mg/kg (rat) Technical mixture: Grade 2; LD_{50} 0.5 to 5 g/kg
5.7 **Late Toxicity:** Mutagen to human lymphocytes.
5.8 **Vapor (Gas) Irritant Characteristics:** Moderately irritating. Personnel will not usually tolerate moderate or high concentrations.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** Data not available
5.11 **IDLH Value:** 1,000 mg/m³

6. FIRE HAZARDS

6.1 **Flash Point:** Not flammable
6.2 **Flammable Limits in Air:** Not flammable
6.3 **Fire Extinguishing Agents:** Not pertinent
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Toxic gases are generated when solid is heated or when solution burns.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** Not flammable
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not flammable
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

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
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** Data not available

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
0.77 ppm/96 hr/bluegill/TL_m/fresh water
0.138 ppm/96 hr/guppy/TL_m/fresh water
0.034 ppm/10 hr/coho fry/100% lethal/salt water
8.2 **Waterfowl Toxicity:** 2000 mg/kg
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** High

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Fortified grade: 40-45% gamma isomer Lindane: pure gamma isomer
9.2 **Storage Temperature:** Data not available
9.3 **Inert Atmosphere:** Data not available
9.4 **Venting:** Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
II

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Not listed
11.2 **NAS Hazard Rating for Bulk Water Transportation:** Not listed
11.3 **NFPA Hazard Classification:** Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Solid
12.2 **Molecular Weight:** 290.83
12.3 **Boiling Point at 1 atm:** Not pertinent
12.4 **Freezing Point:** Not pertinent
12.5 **Critical Temperature:** Not pertinent
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.891 at 19°C (solid)
12.8 **Liquid Surface Tension:** Not pertinent
12.9 **Liquid Water Interfacial Tension:** Not pertinent
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** Not pertinent
12.12 **Latent Heat of Vaporization:** Not pertinent
12.13 **Heat of Combustion:** Not pertinent
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** Data not available

NOTES

BHC	BENZENE HEXACHLORIDE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
	NOT PERTINENT		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.001		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

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Section 1. Material Identification

Carbon Disulfide (CS_2) Description: Prepared industrially by heating charcoal with vaporized sulfur or by reaction of natural petroleum fractions with sulfur. Used in manufacturing soil disinfectants, electronic vacuum tubes, viscose rayon, cellophane, flotation agents, ammonium salts and carbon tetrachloride; in insecticides, chemical analysis, electroplating, fumigation, oil extraction, dry cleaning and degreasing; and as a solvent for lipids, sulfur, rubber, oils, resin and waxes.
Other Designations: CAS No. 75-15-0, carbon bisulfide, dithiocarbonic anhydride, sulphocarbonic anhydride, Weeviltox.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.
Cautions: Carbon disulfide is a highly flammable, dangerous explosion hazard. It is irritating to eyes, skin, and mucous membranes, and toxic to the central nervous (CNS), peripheral nervous (PNS), and cardiovascular (CVS) systems.

‡ The NFPA health rating of "2" is misleading due to the severity of this material's toxicity to the CNS, CVS, and PNS and its chronic effects. A "3" is more appropriate.

HMIS
H 3*
F 4
R 0
PPG†
* Sec. 6, Chronic Effects
† Sec. 8

NFPA‡

R 1
I 4
S 3§
K 4
§Skin absorption

Section 2. Ingredients and Occupational Exposure Limits

Carbon disulfide, ca 99% (major impurities are sulfur compounds)

1990 OSHA PELs (Skin)
8-hr TWA: 4 ppm (12 mg/m³)
15-min STEL: 12 ppm (36 mg/m³)

1990 NIOSH RELs
TWA: 1 ppm (10 mg/m³)
STEL: 10 ppm (30 mg/m³)

1990 IDLH Level
500 ppm

1991-92 ACGIH TLV (Skin)
TWA: 10 ppm (31 mg/m³)

1990 DFG (Germany) MAKs
TWA: 10 ppm (30 mg/m³)
Peak Exposure Limit: 20 ppm/30 min /4 x/shift, momentary value
Half-life: <2 hr

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 40 mg/m³/91 weeks produced paternal effects (spermatogenesis)
Human, inhalation, LC_{Lo}: 2000 ppm/5 min; no toxic effects noted
Human, oral, LD_{Lo}: 14 mg/kg; toxic effects not yet reviewed
Rat, oral, LD_{50}: 3188 mg/kg

* See NIOSH, *RTECS* (FF6650000), for additional mutation, reproductive and toxicity data.

Section 3. Physical Data

Boiling Point: 115 °F (46.5 °C)
Freezing Point: -168 °F (-110.8 °C)
Vapor Pressure: 300 mm Hg at 68 °F (20 °C)
Vapor Density (air = 1): 2.64
Coefficient of Viscosity: 0.363 at 68 °F (20 °C)
Molecular Weight: 76.13
Specific Gravity: 1.2632 at 68 °F (20 °C)
Water Solubility: Slightly, 220 mg/100 cc water at 71.6 °F (22 °C)
Other Solubilities: Soluble in alcohol, benzene and ether
Refraction Index: 1.66232 at 77 °F (25 °C)

Appearance and Odor: Clear, colorless to slightly yellow liquid with a sweet, chloroform-like odor when pure and a foul, rotten egg smell as the commercial product. The odor threshold is 0.1 to 0.2 ppm.
Comments: From both health effect and fire/explosion perspectives, this liquid's very high vapor pressure at room temperature indicates that airborne concentrations can build quickly to dangerous levels. Take precautions to ensure safety (Sec. 8).

Section 4. Fire and Explosion Data

Flash Point: -22 °F (-30 °C), CC	Autoignition Temperature: 194 °F (90 °C)	LEL: 1.5% v/v	UEL: 50% v/v

Extinguishing Media: Foams are more effective in carbon disulfide fires than previously believed, when water and dry chemical were the preferred extinguishing agents. Four foams tested are listed in order of increasing effectiveness: high-expansion, aqueous film-forming, fluoroprotein, and protein. If foam is unavailable, rely on carbon dioxide (CO_2) or water spray. Do not scatter material with more water than necessary to put out fire.
Unusual Fire or Explosion Hazards: Carbon disulfide's burning rate is 2.7 mm/min. Vapor may travel to an ignition source and flash back. Container may explode in heat of fire. CS_2 poses a vapor explosion hazard indoors, outdoors, and in sewers. Carbon disulfide can be ignited by friction, rusted or hot steam pipes, and may accumulate static electricity. Heat from an ordinary light bulb is enough to cause ignition.
Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is ineffective for fires involving carbon disulfide. Apply cooling water to sides of tanks until long after fire is extinguished. Stay away from ends of tanks. Immediately withdraw from area if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Carbon disulfide is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Carbon disulfide will decompose to its elements in contact with mercury fulminate. It is incompatible with alkali metals, chlorine and other halogens, nitrogen oxide, metal azides, oxidants, aluminum, ethylene diamine and zinc. Carbon disulfide reacts exothermically with phenyl copper-triphenylphosphine complexes.
Conditions to Avoid: Exposure to ignition sources and contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of carbon disulfide can produce carbon monoxide (CO), carbon dioxide (CO_2), and toxic sulfur oxides (SO_x)

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[142] and OSHA[164] do not list carbon disulfide as a carcinogen. **Summary of Risks:** CS_2 enters the body primarily via the lungs (inhalation) but can be absorbed via skin. It is irritating to skin, eyes, and mucous membranes and can cause serious damage to CVS, CNS, and PNS. CS_2 is cardiotoxic (toxic to heart), thrombotoxic (adversely affecting blood-clotting ability), and arrythmagenic (causing irregular heartbeat). A Parkinsonian-like effect is sometimesobserved. Exposure to 60 to 100 ppm for a short time can result in severe intoxication and death. Exposure to 5000 ppm is rapidly fatal. 70 to 90% of CS_2 is metabolized, with lungs and kidney excreting the rest. **Medical Conditions Aggravated by Long-Term Exposure:** Coronary heart disease and CNS disorders. **Target Organs:** Skin, CNS, PNS, CVS, eyes, liver, kidney.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Primary Entry Routes: Inhalation and skin contact/absorption. **Acute Effects:** CS_2 is irritating and corrosive to the eyes, skin, and mucous membranes. Introduction into eyes causes burning pain, red and swelling lids, and conjunctivitis. Skin contact with liquid may lead to burning and second- or third-degree burns. CS_2 defats tissue and skin sensitization may occur. Skin absorption can result in peripheral nerve damage. Other symptoms from inhalation or skin absorption include headache, dizziness, euphoria, convulsions, nausea, vomiting, muscle weakness, and in severe cases may lead to death by respiratory failure. **Chronic Effects:** Chronic exposure to carbon disulfide may increase the risk of arteriosclerosis as well as cause delirium, psychosis, bad dreams leading to insomnia, CNS damage, peripheral neuropathies (abnormal and usually degenerative state of the nerves causing pain and unstimulated sensations), appetite loss, tremors, gastric disturbances, liver dysfunction, optical neuritis, and retinal hemorrhages. In women, chronic exposure to carbon disulfide can cause menstrual disorders. Spontaneous abortions and premature births are reported.

FIRST AID

Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* allow victim to rub or keep eyes tightly shut. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting with 1 to 2 tablespoons of Ipecac (adult dose). After patient vomits, give 2 tablespoons activated charcoal in 8 oz. of water to drink.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Since effects may be delayed, keep victim under observation. The iodine-azide test is useful in detecting degree of exposure and hypersusceptibility of exposed workers. I.V. urea 0.5 to 1.5 g/kg is recommended to inactivate free carbon disulfide in the blood. Vitamin B6 in large doses is recommended. Obtain CBC, EKG, urinalysis, and electrolyte balance.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Plan and design appropriate emergency-response procedures prior to carbon disulfide spills or leaks.* Immediately notify safety personnel, isolate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should wear fully encapsulating, vapor-protective clothing to protect against contamination. If possible, detoxify material before cleanup. For small spills, take up with earth, sand, vermiculite or other absorbent, noncombustible material and place in clean, dry containers with a secure lid for later disposal. For large spills, flush liquid to a special retention basin where it can collect under a layer of water (to prevent ignition or explosion) for disposal or reclamation. Perform all cleanup operations with nonsparking tools. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to water, carbon disulfide should volatilize with a half-life of 2.6 hr (according to model river plan) and should not bioconcentrate significantly in aquatic organisms. In the atmosphere, CS_2 reacts with atomic oxygen and photochemically produced hydroxyl radicals with a half-life of 9 days. **Environmental Toxicity Values:** Sunfish, LC_{100}, 100 µg/L/hr; trout, LC_{100}, 500 µg/L/0.1 hr. **Soil Absorption/Mobility:** Carbon disulfide is highly mobile and volatilizes or leaches into soil. **Disposal:** Large amounts of CS_2 may be distilled for reclamation and packaged for reuse. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. P022

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001 and CWA 311(b)(4)]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355)

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For 10 ppm, use any chemical cartridge respirator with organic vapor cartridges. For 50 ppm, air-purifying respirator with organic vapor cartridges and a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Suggested materials for protective clothing include polyvinyl alcohol (PVA) and polyethylene with breakthrough times of 8 and 4 hr, respectively. **Ventilation:** Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local explosion-proof exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Protect containers from physical damage. Store in iron, glass, porcelain or steel containers. Keep small quantities in cool, dry, well-ventilated area away from incompatibles (Sec. 5). Store large quantities in tanks; add water or inert gas (such as nitrogen) to fill emptying tanks. Submerge tanks in water or locate them above concrete basins large enough to hold the tanks' contents. Equip storage facilities with automatic sprinklers and test regularly. Outside or detached storage is preferred.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground all system parts including piping, valves, and moveable containers. Prohibit electrical installations and heating facilities in or near storage areas. Never transfer carbon disulfide by means of air pressure; use pump, water, or inert gas. Use wooden sticks (no spark potential) to measure the contents of CS_2 tanks and containers.

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers that emphasize eyes, skin, CNS, PNS, CVS, and reproductive system, and perform electrocardiograms.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Carbon bisulfide or Carbon disulfide
DOT Hazard Class: Flammable liquid
ID No.: UN1131
DOT Label: Flammable liquid
DOT Packaging Exceptions: None
DOT Packaging Requirements: 173.121

IMO Shipping Name: Carbon disulphide
IMO Hazard Class: 3.1
ID No.: UN1131
IMO Label: Flammable liquid, Poison
IMDG Packaging Group: I

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 136, 140, 149, 153, 159, 162, 163, 164

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH, **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

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GENIUM PUBLISHING CORP.

No. 603

2-CHLOROACETOPHENONE

Issued: May 1986

SECTION 1. MATERIAL IDENTIFICATION

MATERIAL NAME: 2-CHLOROACETOPHENONE

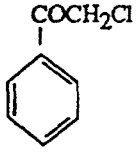
OTHER DESIGNATIONS: alpha-Chloroacetophenone, Chloro Methyl Phenyl Ketone, Mace, Phenacyl Chloride, Phenylchloromethyl Ketone, Phenyl Chloromethyl Ketone, C_8H_7ClO, CAS #0532-27-4.

MANUFACTURER/SUPPLIER:
Haarmann & Reimer Corp., Aroma Chemical Div., PO Box 175, 111 US Hwy. 22, N. Springfield, NJ 07081; Telephone: (201) 686-3132

HMIS
H: 2
F: 1
R: 1
PPE*
*See Sect. 8

R 1
I 4
S 3
K 1

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
2-Chloroacetophenone, CAS #0532-27-4  * Current (1985-86) ACGIH TLV or OSHA PEL.	ca 100	8-hr. TWA: 0.05 ppm or 0.3 mg/m^3* Rat, Oral, LD_{50}: 127 mg/m^3 Human, Inhalation, LCLo: 159 mg/m^3/20 min. Human, Inhalation, TCLo: 20 mg/m^3: Irritation Rabbit, Eye: 3 mg, Severe

SECTION 3. PHYSICAL DATA

Boiling Point, 1 atm ... 477°F (247°C)
Vapor Pressure @ 20°C, mm Hg ... 0.012
Water Solubility @ 20°C ... Insoluble
Vapor Density (Air = 1) ... 5.32
Evaporation Rate ... Not Found

Specific Gravity (H_2O = 1) ... 1.324
Melting Point ... 138°F (59°C)
Percent Volatile by Volume ... ca 100
Molecular Weight ... 154.60

Appearance and odor: Colorless-to-gray crystalline solid with a sharp, irritating floral odor. The odor threshold for 2-chloroacetetophenone is 0.1 mg/m^3.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	LOWER	UPPER
244°F (118°C) CC	Not Found	Not Found	–	–

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, foam, water fog. Water or foam may cause frothing. Use water spray to cool tanks/containers exposed to fire.

This OSHA class IIIB combustible liquid is a slight fire hazard when exposed to heat, sparks, or open flame. When involved in a fire, 2-chloroacetophenone emits toxic and corrosive vapors.
Fire fighters should use self-contained breathing apparatus and fully protective clothing when fighting fires involving this material.

SECTION 5. REACTIVITY DATA

2-Chloroacetophenone is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

This material is incompatible with strong oxidizers. It reacts slowly with water or steam, generating hydrogen chloride.

Thermal decomposition or burning produces toxic vapors and gases such as carbon monoxide and fumes of chlorine.

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SECTION 6. HEALTH HAZARD INFORMATION

2-Chloroacetophenone is not listed as a carcinogen by the NTP, IARC, or OSHA.
This material is a potent irritant and lacrimator (promotes tears). It is highly toxic by inhalation and ingestion. Symptoms of overexposure include tingling in the nose, lacrimation, burning of and/or pain in the eyes, blurred vision, rhinorrhea, burning in the chest, difficulty in breathing, and nausea. In extreme cases pulmonary congestion and edema may result, with onset of edema appearing several hours to days after exposure. Humans exposed to levels of 200 to 340 mg/m^3 could not tolerate exposure for more than 30 seconds. 2-Chloroacetophenone is irritating to the skin and intensely irritating to the eyes. Overexposure of eyes can cause severe conjunctivitis; corneal haziness; pain; and, in severe cases, permanent partial opacity (leukoma). Contact with the skin may cause a burn, especially if the skin is moist or wet. It can also cause dermatitis and skin sensitization. The TLV of 0.05 ppm is set to prevent lacrimation and irritation. The irritation threshold for 2-chloroacetophenone ranges from 0.15 to 0.4 mg/m^3, while the lacrimation threshold is 0.3 to 0.4 mg/m^3. No chronic effects are reported. FIRST AID: EYE CONTACT: Promptly flush eyes, including under the eyelids, with running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Promptly flush skin with running water for at least 15 minutes while removing contaminated clothing and shoes. Get medical help if irritation persists.* INHALATION: Remove victim to fresh air. Restore and/or support his breathing as required. Keep him/her warm and quiet. Observe victim for symptoms of pulmonary edema. Get medical help.* INGESTION: Give victim 1 or 2 glasses of water or milk to drink as quickly as possible. Contact a physician or poison control center. Do not induce vomiting unless directed to do so. Never give anything by mouth to someone who is unconscious or is convulsing.*

GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of large 2-chloroacetophenone spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate the spill area and limit access to necessary personnel only. Remove any leaking containers to a safe place, if feasible. Those involved in cleanup need protection against contact with the solid form and inhalation of dust and vapor (see sect. 8).

Scoop, shovel, or vacuum spilled material into closed containers. Use caution to avoid generating dust. Flush spill area with water and collect flushings and waste water for disposal. Do not flush waste to a sewer, watershed, or waterway.

Place waste in a suitable container for disposal by a licensed contractor, dispose of it in a landfill, or dissolve it in an organic solvent and burn it in an approved incinerator equipped with an afterburner and a scrubber. Follow all Federal, state, and local regulations.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute). For emergency or nonroutine exposures where the TLV may be exceeded, use an appropriate NIOSH-approved respirator.

Impervious gloves, face shield, apron, boots, plastic coveralls, and other protective clothing and equipment should be available and worn as necessary to prevent contact with skin or clothing. Wear safety goggles to prevent any possibility of 2-chloroacetophenone coming in contact with the eyes. Remove contaminated clothing immediately and do not wear it again until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store 2-chloroacetophenone in closed containers in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, and open flame. Storage area must be suitable for combustible solids. Protect containers from physical damage. Ground and bond conveying equipment and storage containers when transferring the solid to prevent the possibility of a dust explosion. Any bulk storage system should have an explosion-relief design. Do not smoke in use or handling areas. Use only with adequate ventilation. Avoid inhalation of dust and vapor and contact with skin, eyes, and clothing. Practice good industrial hygiene when handling this material. Avoid generating dust. Emptied containers retain product residues; handle them accordingly!
Preplacement and periodic physical examinations should be provided to those who work with this material. Individuals with histories of chronic respiratory, skin, or eye disease may be at increased risk from exposure.

DOT Classification: Irritating Material. DOT No. UN1697
Data Source(s) Code: 2, 4, 5, 7, 8, 23, 34, 47, 63, 69, 75, 78, 79-82. CR

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Approvals
Indust. Hygiene/Safety
Medical Review

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GENIUM PUBLISHING CORP.

No. 240

CYANOGEN CHLORIDE

Issued: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: CYANOGEN CHLORIDE

Description (Origin/Uses): Used in organic synthesis and as a poison gas by the military. Cyanogen chloride gas may be formed by the reaction of hypochlorite with cyanide solutions in wastewater-treatment operations for cyanide wastes.

Other Designations: Chlorine Cyanide; ClCN; CAS No. 0506-77-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: Cyanogen chloride is an extremely poisonous gas. Handle it with care!

HMIS
H 4
F 4
R 2
PPG*
*See sect. 8

Genium
R 1
I 4
S 3
K 1

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Cyanogen Chloride, CAS No. 0506-77-4	Ca 100	**ACGIH TLV, 1987-88** TLV-Ceiling:* 0.3 ppm, 0.6 mg/m³ **Toxicity Data**** Human, Inhalation, TC_{Lo}: 10 mg/m³

*Set to prevent undue irritation and to prevent the possibility of cellular metabolic interference from the cyanide anion.
**See NIOSH, *RTECS* (GT2275000), for additional toxicity data.

SECTION 3. PHYSICAL DATA

Boiling Point: 57°F (14°C)
Melting Point: 21°F (-6°C)
Vapor Density (Air = 1): 1.2

Water Solubility (%): Soluble
Molecular Weight: 61.5 Grams/Mole

Appearance and Odor: A colorless gas or liquid; a pungent, penetrating odor like that of almonds, which is detectable at 1 ppm (2.5 mg/m³).

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *By analogy with cyanogen bromide, cyanogen chloride is not expected to be readily combustible unless it is heated. Use extinguishing agents that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: Cyanogen chloride gas is denser than air and may become concentrated in low-lying, confined areas, which should be entered with caution.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Cyanogen chloride is stable if it is kept dry in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: This material may react dangerously with water, acids and acid fumes, and strong oxiding agents.

Conditions to Avoid: Prevent cyanogen chloride's exposure to water and incompatible chemicals. Avoid its exposure to excessive heat.

Hazardous Products of Decomposition: Hydrogen cyanide (HCN) can be produced during cyanogen chloride fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Cyanogen chloride is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: *This material is an extremely poisonous gas.* Severe irritation of the respiratory system, which may develop into fatal pulmonary edema, results from inhalation. This gas reacts with the moisture of the mucous membranes lining the lungs to form hydrogen cyanide and release cyanide, which is a powerful cellular poison.

Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** Skin, eyes, respiratory system. Cyanide poisoning affects each cell with which it comes into contact. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Severe irritation of the nose, eyes, and respiratory system characterized by coughing, shortness of breath, and difficulty in breathing. Pulmonary edema (the lungs fill with fluid) can occur. **Chronic Effects:** Hoarseness, conjunctivitis, and edema of the eyelid.

FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Medically trained personnel should administer oxygen if appropriate. **Ingestion.** Unlikely.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. NOTE TO PHYSICIAN: Treat the exposed person for pulmonary edema, which may be delayed. Hospitalization with monitoring is recommended. Specific medical protocols for cyanide poisoning are readily available. Cyanide poisoning antidote kits are available and should be used where accessible.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any cyanogen chloride liquid or gas leak as an emergency.* Notify safety personnel, evacuate all nonessential personnel, and provide maximum ventilation. Cleanup personnel need protection against skin contact with and inhalation of vapor (see sect. 8). Try to shut off the flow of the leaking cyanogen chloride gas. Contact your supplier for other suggestions about dealing with accidental leaks or spills. Preplan for emergency response and routine use.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z): Not Listed

EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. P033
CERCLA Hazardous Substance, Reportable Quantity: 10 lbs (4.54 kg), per the Clean Water Act (CWA), Section 311 (b) (4)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves; boots; aprons; and clean, impervious, body-covering clothing to prevent any possibility of skin contact. **Ventilation:** Install and operate general and local exhaust-ventilation systems powerful enough to maintain airborne levels of cyanogen chloride gas below the exposure limit cited in section 2. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. **Other:** Use this material in closed engineering systems. Wastewater-treatment plants for cyanide waste may generate cyanogen chloride during routine work operations. Adequate ventilation systems and appropriate engineering controls must be tailored to the work environment.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale cyanogen chloride gas.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store cyanogen chloride gas or liquid in pressurized, airtight containers (cylinders, tanks, etc.) in a cool, dry, well-ventilated area away from water, acids, acid fumes, heat, and strong oxidizing agents.

Special Handling/Storage: Protect containers of cyanogen chloride from heat, shock, physical damage, or exposure to direct sunlight. Store them upright and secure them tightly. Preplan for routine use of this material.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Cyanogen Chloride, Containing Less Than 0.9% Water
DOT Label: Poison Gas and Flammable Gas
DOT ID No. UN1589
DOT Hazard Class: Poison A
IMO Class: 2.3
IMO Label: Poison Gas

References: 1, 84-94, 100, 112, 113, 114.

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OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR

DDT

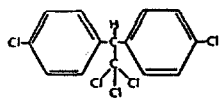
POTENTIAL HUMAN CARCINOGEN

INTRODUCTION

This guideline summarizes pertinent information about DDT 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:** $C_{14}H_9Cl_5$
- **Structure:**



- **Synonyms:** Citox; genitox; dichlorodiphenyltrichloroethane; 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane
- **Identifiers:** CAS 50-29-3; RTECS KJ3325000; DOT 2761
- **Appearance and odor:** Colorless crystals or white to slightly off-white powder with a slightly aromatic odor

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 354.48
2. Boiling point (at 760 mmHg): 260°C (500°F)
3. Specific gravity (water = 1): 1.56
4. Vapor density (air = 1 at boiling point of DDT): 12.2
5. Melting point: 105-109°C (221-228°F)
6. Vapor pressure at 20°C (68°F): 1.5 x 10^{-7} mmHg
7. Practically insoluble in water

- **Reactivity**

1. Incompatibilities: DDT should not be stored in iron containers; DDT should not be mixed with iron and aluminum salts or with alkaline materials. Temperatures greater than 100°C (212°F) may cause decomposition.
2. Hazardous decomposition products: Toxic vapors and gases (e.g., hydrogen chloride) may be released in a fire involving DDT.
3. Caution: DDT should be stored in a tightly closed container in a well-ventilated area.

- **Warning properties**

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 DDT is 1 milligram of DDT per cubic meter of air (mg/m³) as a time-weighted average (TWA) concentration over an 8-hour workshift (Skin). The notation "Skin" refers to the potential contribution to overall exposure by the cutaneous route including the mucous membranes and eyes. The National Institute for Occupational Safety and Health (NIOSH) recommends that DDT be controlled and handled as a potential human carcinogen in the workplace and that exposure be minimized to the lowest feasible limit. The NIOSH recommended exposure limit (REL) is 0.5 mg/m³ as a TWA for up to a 10-hour workshift, 40-hour workweek. The NIOSH REL is the lowest concentration reliably detectable by current NIOSH-validated sampling and analytical methods. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) is 1 mg/m³ as a TWA for a normal 8-hour workday and a 40-hour workweek; the short-term exposure limit (STEL) is 3 mg/m³ (Table 1).

Table 1.—Occupational exposure limits for DDT

	Exposure limits mg/m³
OSHA PEL TWA (Skin)*	1
NIOSH REL TWA (CA)†	0.5§
ACGIH TLV® TWA	1

* (Skin): Potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes.
† (Ca): NIOSH recommends treating as a potential human carcinogen.
§ Lowest reliably detectable level.

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

NOTE: A general ban was ordered by the Environmental Protection Agency on the registration of DDT, effective December 31, 1972. Effective the same date, the ban for uses of DDT by public health officials in disease control programs and by USDA and the military for health quarantine and prescription drugs use was lifted.

HEALTH HAZARD INFORMATION

• Routes of exposure

DDT may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• Summary of toxicology

Effects on animals: Acute oral administration of DDT to rats caused tissue destruction (necrosis) of the liver, mild degeneration of kidney tubules, and changes in electroencephalograms. Chronic oral administration of DDT caused decreased fertility in rats and increased mortality of their offspring, toxic effects on the liver (including necrosis, fat deposition, increased weight, and increased enzyme activity), and liver cancer. In mice, chronic oral administration of DDT produced cancers of the liver, lungs, and lymphatic system.

• Signs and symptoms of exposure

Short-term (acute): Exposure to DDT can cause a prickling sensation of the tongue, lips, and face, a general feeling of ill health, headache, fatigue, vomiting, dizziness, tremors, convulsions, partial paralysis of the hands, and coma. DDT can also cause irritation of the eyes and skin.

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 DDT, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic or laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, and reproductive and nervous systems.

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 DDT 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 contraindications to job placement, include chronic liver disease. Workers should inform their physicians of their potential for exposures to DDT because internal absorption of this chemical pathologically increases the liver's ability to metabolize and eliminate medications which may be prescribed or taken "over the counter."

• 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 develop symptoms that may be attributed to exposure to DDT. 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 physiologic function of the eyes, skin, liver, and reproductive and nervous systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population.

• 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 DDT may cause adverse reproductive effects or diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to DDT 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).

• Method

Sampling and analysis may be performed by collecting DDT vapors with charcoal adsorption tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure DDT may also be used if available. A detailed sampling and analytical method for DDT may be found in the *NIOSH Manual of Analytical Methods* (method number S 274).

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 DDT.

SANITATION

Clothing which is contaminated with DDT 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 DDT from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of DDT's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

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 DDT should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle DDT should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to DDT 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 DDT

Operations	Controls
During preparation and handling of insecticide	Process enclosure, local exhaust ventilation, personal protective equipment
During maintenance of equipment and storage containers	Personal protective equipment

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 DDT, an eye-wash fountain should be provided within the immediate work area for emergency use.

If DDT 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 DDT, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If DDT gets on the skin, wash it immediately with soap and water. If DDT 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 DDT is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. For small quantities of liquids containing DDT, absorb on paper towels and place in an appropriate container.
3. Large quantities of liquids containing DDT may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.
4. If in solid form, DDT may be collected and placed in an appropriate container.
5. DDT dust may be collected by vacuuming with an appropriate high-efficiency filtration system.

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 DDT

Condition	Minimum respiratory protection*
Any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	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
Planned or emergency entry into environments containing unknown or any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	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
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

DIAZINON

DZN

Common Synonyms
O, O-Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate
Alfa-tox
Spectracide
Sarolex

Liquid — Light to dark brown

Sinks in water.

Stop discharge if possible. Keep people away.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
POISONOUS GASES ARE PRODUCED WHEN HEATED.

Exposure

CALL FOR MEDICAL AID.

LIQUID
POISONOUS IF SWALLOWED.
Irritating to skin and eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-poison, water contaminant, high flammability (if solution)
Restrict access
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $C_{12}H_{21}N_2O_3PS$
3.3 IMO/UN Designation: 6.1/1615
3.4 DOT ID No.: 1615
3.5 CAS Registry No.: 333-41-5

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Solid or liquid solution
4.2 Color: Amber to dark brown
4.3 Odor: Data not available

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Goggles or face shield; rubber gloves; protective clothing.
5.2 Symptoms Following Exposure: Ingestion or prolonged inhalation of mist causes headache, giddiness, blurred vision, nervousness, weakness, cramps, diarrhea, discomfort in the chest, sweating, miosis, tearing, salivation and other excessive respiratory tract secretion, vomiting, cyanosis, papilledema, uncontrollable muscle twitches, convulsions, coma, loss of reflexes, and loss of sphincter control. Liquid irritates eyes and skin.
5.3 Treatment of Exposure: INHALATION: remove to fresh air; keep warm; get medical attention at once. EYES: flush with plenty of water for at least 15 min. and get medical attention. SKIN: wash contaminated area with soap and water. INGESTION: get medical attention at once; give water slurry of charcoal; do NOT give milk or alcohol.
5.4 Threshold Limit Value: 0.1 mg/m³
5.5 Short Term Inhalation Limits: Not pertinent
5.6 Toxicity by Ingestion: Grade 3; oral LD_{50} = 76 mg/kg (rat)
5.7 Late Toxicity: May be mutagenic
5.8 Vapor (Gas) Irritant Characteristics: Data not available
5.9 Liquid or Solid Irritant Characteristics: Data not available
5.10 Odor Threshold: Data not available
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 82-105°F C.C. (solutions only; pure liquid difficult to burn)
6.2 Flammable Limits in Air: Not pertinent
6.3 Fire Extinguishing Agents: (for solutions) Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.
6.5 Special Hazards of Combustion Products: Oxides of sulfur and of phosphorus are generated in fires.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Not pertinent
6.8 Electrical Hazard: Data not available
6.9 Burning Rate: (for solutions) 4 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity:
0.025 ppm/96 hr/stonefly nymph/TL_m/fresh water
30 µg/l/48 hr/bluegill/TL_m/fresh water
(becomes bound to soil when used according to directions)
8.2 Waterfowl Toxicity: LD_{50} = 3.54 mg/kg
LC_{50} = 5 days, 90 ppm mallard duck
LC_{50} = 7 days, 68 ppm quail
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical; wettable powders; a variety of emulsifiable solutions in combustible solvents.
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 304.4
12.3 Boiling Point at 1 atm: Very high; decomposes
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.117 at 20°C (liquid)
12.8 Liquid Surface Tension: (est.) 35 dynes/cm = 0.035 N/m at 20°C
12.9 Liquid Water Interfacial Tension: (est.) 40 dynes/cm = 0.040 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: (est.) —12,000 Btu/lb = —6,500 cal/g = —270 X 10³ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

DZN	DIAZINON

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F (estimate)	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F (estimate)	Temperature (degrees F)	Centipoise (estimate)
52	70.280	51	.400	51	1.048	51	4.064
54	70.209	52	.400	52	1.048	52	4.005
56	70.139	53	.400	53	1.048	53	3.948
58	70.070	54	.400	54	1.048	54	3.892
60	70.000	55	.400	55	1.048	55	3.836
62	69.929	56	.400	56	1.048	56	3.782
64	69.860	57	.400	57	1.048	57	3.729
66	69.790	58	.400	58	1.048	58	3.677
68	69.730	59	.400	59	1.048	59	3.625
70	69.660	60	.400	60	1.048	60	3.575
72	69.589	61	.400	61	1.048	61	3.525
74	69.520	62	.400	62	1.048	62	3.476
76	69.450	63	.400	63	1.048	63	3.428
78	69.379	64	.400	64	1.048	64	3.381
80	69.309	65	.400	65	1.048	65	3.335
82	69.240	66	.400	66	1.048	66	3.290
84	69.169	67	.400	67	1.048	67	3.245
86	69.099	68	.400	68	1.048	68	3.201
		69	.400	69	1.048	69	3.158
		70	.400	70	1.048	70	3.116
		71	.400	71	1.048	71	3.074
		72	.400	72	1.048	72	3.033
		73	.400	73	1.048	73	2.993
		74	.400	74	1.048	74	2.954
		75	.400	75	1.048	75	2.915
		76	.400	76	1.048	76	2.877

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68	.004		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
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GENIUM PUBLISHING CORP.

No. 492

ETHYLENE DIBROMIDE

(Revision A)
Issued: September 1982
Revised: April 1989

SECTION 1. MATERIAL IDENTIFICATION

Material: ETHYLENE DIBROMIDE

Description (Origin/Uses): Made from ethylene and bromine; also from acetylene and hydrogen bromide. Widely used as a scavenger of lead in leaded gasoline; formerly used as a grain fumigant (an ongoing controversy over this use continues because of ethylene dibromide's status as a suspected carcinogen); and in waterproofing preparations.

Other Designations: 1,2-Dibromoethane; 1,2-Ethylene Dibromide; $C_2H_4Br_2$; CAS No. 0106-93-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS		NFPA	
H	3	R	1
F	0	I	3/4
R	0	S	2
PPG*		K	0
*See sect. 8			

SECTION 2. INGREDIENTS AND OCCUPATIONAL EXPOSURE LIMITS

Ethylene Dibromide, ca 100%

OSHA PEL
8-hr TWA: 20 ppm
Ceiling: 30 ppm
Maximum Peak above Ceiling:
50 ppm for 5 min in 8-hr Shift

ACGIH TLV, 1988-89
Not recommended for this suspected human carcinogen.

NIOSH REL, 1984
8-hr TWA: 0.045 ppm, 0.38 mg/m³
15-min Ceiling: 0.13 ppm, 1 mg/m³
Toxicity Data*
Woman, Oral, LD_{Lo}: 90 mg/kg

*See NIOSH, *RTECS* (KH9275000), for additional data with references to reproductive, mutagenic, tumorigenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 268 °F (131 °C)
Melting Point: 48.4 °F (9.1 °C)
Vapor Density (Air = 1): 6.5
Vapor Pressure: 11 Torr at 68 °F (20 °C)

Molecular Weight: 188 g/mol
Specific Gravity (H_2O = 1): 2.172 at 77 °F (25 °C)
Solubility in Water (%): Slight
% Volatile by Volume: ca 100

Appearance and Odor: A clear, colorless, nonflammable, heavy, viscous liquid; sweetish odor resembling chloroform.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: *	Autoignition Temperature: *	LEL: *	UEL: *

Extinguishing Media: *Ethylene dibromide will not burn. Use extinguishing agents that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Select safety and handling equipment carefully (see sect. 5, Conditions to Avoid).

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Ethylene dibromide is stable in closed containers during routine operations at room temperature. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Ethylene dibromide can react dangerously with metals such as aluminum (Al), magnesium (Mg), zinc (Zn), calcium (Ca), sodium (Na), and potassium (K), as well as with strong alkalies, strong oxidizing agents, and liquid ammonia.

Conditions to Avoid: Prevent exposing ethylene dibromide to light and/or heat in the presence of water (including moist air) because it can slowly hydrolyze and produce hydrogen bromide (HBr). Select safety and handling equipment carefully because ethylene dibromide attacks certain forms of plastics and resins that can be found in pipes, pumps, or respirators.

Hazardous Products of Decomposition: Thermal oxidative degradation of ethylene dibromide can produce toxic gases such as carbon monoxide (CO) and hydrogen bromide (HBr).

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SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: The IARC lists ethylene dibromide as a probable human carcinogen (group 2B); the NTP considers it an anticipated human carcinogen (group B); and the ACGIH classifies it as a suspected human carcinogen (group A2).
Summary of Risks: Ethylene dibromide is very toxic by inhalation, skin absorption, and ingestion. Progressive deterioration to death has occurred in instances of accidental industrial exposure. Symptoms include general weakness, vomiting, diarrhea, chest pain, cough, shortness of breath, and abdominal pain and will progress to cause damage to all major organ systems. Rapid absorption through the skin causes additional toxicity. Reproductive hazards and carcinogenicity are well documented in studies of animal experimentation and may be applicable to humans. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, heart, liver, kidneys. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Ethylene dibromide causes severe irritation of mucous membranes, the eyes, and the skin. Skin contact results in severe, burning pain followed by redness and blistering. Larger exposure results in rapid progressive damage to the kidneys, liver, heart, and lungs with depression of the central nervous system. **Chronic Effects:** Low doses have been tolerated in animals without effect. Reproductive and cancer studies in animals show clear effect.

FIRST AID
Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin:** Rinse the affected area with flooding amounts of water; wash it with soap and water. **Inhalation:** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Keep him or her warm and at rest until medical help is available. **Ingestion:** Unlikely. If accidental ingestion should occur, have the exposed person drink 1 to 2 glasses of water and induce vomiting. **Get in-plant, paramedic, or community medical help for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Delayed pulmonary lesions can develop after inhalation exposure; monitor exposed persons for developing respiratory problems.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *It is necessary to preplan and design prior, appropriate response techniques for accidental releases of ethylene dibromide.* Notify safety personnel, evacuate nonessential personnel, and provide adequate ventilation in the event of a spill involving this material. Cleanup personnel must wear personal protective equipment (see sect. 8) to prevent this liquid's contact with the skin or eyes or inhalation of its vapor. The dense ethylene dibromide vapor can flow along surfaces, collect in low-lying areas, and become concentrated. Be especially careful to test the air before entering sumps, cellars, or similar enclosed spaces. Large spills require a professional, competent response specifically tailored to the particular incident. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations
Listed as RCRA Hazardous Waste No. U067 (40 CFR 261.33)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg), [*per CWA, §311(b)(4) and RCRA, §3001]
SARA Extremely Hazardous Stubstance (40 CFR 355): Not Listed
SARA Toxic Chemical (40 CFR 372.65): Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent any contact of ethylene dibromide with your skin. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne concentrations of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store ethylene dibromide in tightly closed steel containers in a cool, dry, well-ventilated area away from incompatible chemicals (see sect. 5). **Special Handling/Storage:** Storing ethylene dibromide under a dry nitrogen gas blanket has been recommended. **Other Precautions:** Workers must avoid all contact with ethylene dibromide (cancer and reproductive hazards). Regularly monitor employees for any adverse health effects from exposure to this material.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Ethylene Dibromide
DOT Hazard Class: ORM-A
DOT ID No.: UN1605
DOT Packaging Requirements: 49 CFR 173.620
DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: Ethylene Dibromide
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II

References: 1, 6, 26, 38, 84-94, 100, 116, 118, 119, 122

Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 359
ETHYLENE DICHLORIDE
(Formerly 1,2-Dichloroethane)
(Revision C)
Issued: November 1978
Revised: August 1987

SECTION 1. MATERIAL IDENTIFICATION

23

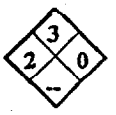
CHEMICAL NAME: ETHYLENE DICHLORIDE (Changed to reflect common industrial practice)

DESCRIPTION (Origin/Uses): Made from acetylene and HCl. Used as a degreaser, a scavenger in leaded gasoline, as an intermediate in the manufacture of vinyl chloride, in paint removers, in wetting and penetration agents, in ore flotation processes, as a fumigant, and as a solvent for fats, oils, waxes, and gums.

OTHER DESIGNATIONS: 1,2-Dichloroethane; *sym*-Dichloroethane; Dutch Liquid; Dutch Oil; EDC; Ethane Dichloride; Ethylene Chloride; 1,2-Ethylene Dichloride; Glycol Dichloride; $C_2H_4Cl_2$; NIOSH *RTECS* KI0525000; CAS #0107-06-2

MANUFACTURERS/SUPPLIERS: Available from several suppliers, including: Dow Chemical USA, 2020 Dow Center, Midland, MI 48640; Telephone: (517) 636-1000

COMMENTS: Ethylene dichloride is a flammable, toxic liquid.

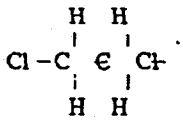


HMIS			
H	1	R	1
F	3	I	4
R	0	S	2
PPE*		K	4

* See Sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

Ingredients	%	HAZARD DATA
Ethylene Dichloride, CAS #0107-06-2; NIOSH *RTECS* #KI0525000	100	ACGIH Values 1987-88 TLV-TWA: 10 ppm, 40 mg/m^3 OSHA PEL* 1986-87 8-Hr TWA: 50 ppm; Ceiling: 100 ppm (15 Min.) NIOSH REL 1986-87 10-Hr TWA: 1 ppm Ceiling: 2 ppm (15 Min.) Toxicity Data Man, Inhalation, TC_{Lo}: 4000 ppm/1 Hr Human, Oral, TD_{Lo}: 428 mg/kg Man, Oral, TD_{Lo}: 892 mg/kg Man, Oral, LD_{Lo}: 714 mg/kg Rat, Oral, LD_{50}: 670 mg/kg



*The maximum allowable peak concentration (above the ceiling level value) of ethylene dichloride is 200 ppm for 5 minutes in any 3-hour period.

COMMENTS: Additional data concerning toxic doses and tumorigenic, reproductive, and mutagenic effects is listed (with references) in the NIOSH *RTECS* 1983-84 supplement, pages 865-66.

SECTION 3. PHYSICAL DATA

Boiling Point ... 182.3°F (83.5°C)
Vapor Pressure ... 87 Torr at 77°F (25°C)
Water Solubility ... Soluble in about 120 Parts Water
Vapor Density (Air = 1) ... 3.4
Evaporation Rate (n-BuAc = 1) ... Not Listed
Specific Gravity ... 1.2569 at 69°F (20°C)
Freezing Point ... -31.9°F (-35.5°C)
Molecular Weight ... 98.96 Grams/Mole

Appearance and odor: Colorless, clear liquid. Sweet, chloroformlike odor is typical of chlorinated hydrocarbons. The recognition threshold (100% of test panel) for ethylene dichloride is 40 ppm. Odor detection probably indicates an excessive exposure to vapor. High volatility and flammability, coupled with its toxicity and carcinogenic potential, make this material a major health hazard.

COMMENTS: Ethylene dichloride is miscible with alcohol, chloroform, and ether.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
See Below	775°F (413°C)	% by Volume	6.2	15.9

EXTINGUISHING MEDIA: Use chemical, carbon dioxide, alcohol foam, water spray/fog, or dry sand to fight fires involving ethylene dichloride. Direct water sprays may be ineffective extinguishing agents, but they may be successfully used to cool fire-exposed containers. Use a smothering effect to extinguish fires involving this material. UNUSUAL FIRE/EXPLOSION HAZARDS: Ethylene dichloride is a dangerous fire and explosion hazard when exposed to sources of ignition such as heat, open flames, sparks, etc. Its vapors are heavier than air and can flow along surfaces to distant, low-lying sources of ignition and flash back. If it is safe to do so, remove this material from the fire area. Ethylene dichloride burns with a smoky flame.

SPECIAL FIRE-FIGHTING PROCEDURES: Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode.

COMMENTS: Flash Point and Method: 56°F (13°C) CC; 65°F (18°C) OC.

OSHA Flammability Class (29 CFR 1910.106): IB. DOT Flammability Class (49 CFR 173.115): Flammable Liquid

SECTION 5. REACTIVITY DATA

Ethylene dichloride is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES include strong oxidizing agents. Explosions have occurred with mixtures of this material and liquid ammonia or dimethylaminopropylamine. Finely divided aluminum or magnesium metal may be hazardous in contact with ethylene dichloride.

CONDITIONS TO AVOID: Eliminate sources of ignition such as excessive heat, open flames, or electrical sparks, particularly in low-lying areas, because the explosive, heavier-than-air vapors will concentrate there.

PRODUCTS OF HAZARDOUS DECOMPOSITION can include vinyl chloride, chloride fumes, and phosgene. Phosgene is an extremely poisonous gas. Products of thermal-oxidative degradation (i.e., fire conditions) must be treated with appropriate caution.

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SECTION 6. HEALTH HAZARD INFORMATION

Ethylene dichloride is listed as an anticipated human carcinogen by the NTP and as a probable human carcinogen (Group 2B), by the IARC. It was found to be an animal-positive carcinogen by the IARC. NCI reported positive results (mouse, rat) from its carcinogenesis bioassay. SUMMARY OF RISKS: Ethylene dichloride is considered to be one of the more toxic of the common chlorinated hydrocarbons. Deaths from accidental ingestion of this material have been reported. Inhalation of vapors reportedly caused three fatalities. Excessive inhalation of ethylene dichloride vapors can cause respiratory irritation, intoxication, narcotic and anesthetic effects, vomiting, dizziness, depression, and diarrhea. The hepatoxic (injurious to liver) effects of this material are significant. The systemic effects from overexposure can appear in the liver, kidneys, digestive tract, blood, lungs, adrenal glands, and the central nervous system. Tests on animals have revealed reproductive failure and fetal resorption. There may be increased risk to nursing infants of exposed mothers. TARGET ORGANS: Central nervous system, eyes, kidneys, liver, heart, adrenal glands, and skin. PRIMARY ENTRY: Inhalation, absorption through skin, oral, or eye contact. ACUTE EFFECTS: Skin contact causes irritation, defatting, and, if repeated or prolonged, burning. Eye contact causes irritation and serious injury (clouding of the cornea) if it is not removed promptly. CHRONIC EFFECTS: Injuries to the liver (hepatoxicity) and kidneys, weight loss, low blood pressure, jaundice, oliguria (reduced excretion of urine), or anemia. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: Persons taking anticoagulants could experience an increase in tendency to bleed. Persons taking insulin face an increased risk of lowered blood sugar. FIRST AID: Be prepared to restrain a hyperactive victim. EYE CONTACT: Flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Immediately flush the affected area with water. Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help.* INHALATION: Remove victim to fresh air; restore and/or support his breathing as needed. Get medical help.* INGESTION: Never give anything by mouth to someone who is unconscious or convulsing. Rinse victim's mouth with water. Oxygen and artificial respiration may be needed. Get medical help.* * GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Before using ethylene dichloride, it is essential that proper emergency procedures be established and made known to all personnel involved in handling it. Notify safety personnel of ethylene dichloride spills or leaks and implement containment procedures. Remove and eliminate all possible sources of ignition such as heat, sparks, and open flames from the area. Cleanup personnel should use protection against inhalation of vapors and contact with liquid. Contain spills by using an absorbent material such as dry sand or vermiculite. Use nonsparking tools to mix waste material thoroughly with absorbent and place it in an appropriate container for disposal. Flush trace residues with large amounts of water. Do not flush waste to sewers or open waterways. WASTE DISPOSAL: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Waste may be burned in an approved incinerator equipped with an afterburner and a scrubber. Follow Federal, state, and local regulations.

Ethylene dichloride is designated as a hazardous substance by the EPA (40 CFR 116.4). Ethylene dichloride is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U077

EPA Reportable Quantity (40 CFR 117.3): 5000 lbs (2270 kgs)

Aquatic Toxicity Rating, TLm 96: 1000 - 100 ppm

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Ethylene dichloride is particularly harmful to the eyes, and direct contact results in corneal opacity (permanent clouding of the eye). GLOVES: Wear impervious rubber gloves to prevent skin contact. RESPIRATOR: Use a NIOSH-approved respirator per the NIOSH *Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of ethylene dichloride requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. Warning: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. OTHER: Wear rubber boots, aprons, and other protective clothing suitable for use conditions to prevent skin contact. Remove contaminated clothing and launder it before wearing it again. Discard contaminated shoes. VENTILATION: Provide maximum explosion-proof local fume exhaust ventilation systems to maintain the airborne concentrations of ethylene dichloride vapors below the exposure limits cited in section 2. Install properly designed hoods that maintain a minimum face velocity of 100 lfm (linear feet per minute). SAFETY STATIONS: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. SPECIAL CONSIDERATIONS: Vapors are heavier than air and will collect in low-lying areas. Eliminate sources of ignition in these areas and again provide good ventilation there. COMMENTS: Practice good personal hygiene. Keep materials off of your clothes and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Immediately remove ethylene dichloride-saturated clothing to avoid flammability and health hazards. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store ethylene dichloride in tightly closed containers in a cool, dry, well-ventilated area away from sources of ignition. Protect containers from physical damage and from exposure to excessive heat. Avoid direct physical contact with strong acids, bases, oxidizing agents, and reducing agents. SPECIAL HANDLING/STORAGE: Use nonsparking tools. Outside or detached storage is preferred. Store and handle ethylene dichloride in accordance with the regulations concerning OSHA class IB flammable liquids. ENGINEERING CONTROLS: During transfer operations involving ethylene dichloride, the liquid and its vapors must not be exposed to nearby sources of ignition from engineering systems that are not explosion proof. Preplan emergency response procedures.

TRANSPORTATION DATA (per 49 CFR 172.101-2):

DOT Hazard Class: Flammable Liquid

DOT Label: Flammable Liquid

IMO Class: 3.2

DOT Shipping Name: Ethylene Dichloride

DOT ID No. UN 1184

IMO Label: Flammable Liquid, Poison

References: 1-9, 12, 19, 21, 26, 43, 47, 73, 87-102. CK

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Approvals

Indust. Hygiene/Safety

Medical Review

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Material Safety Data Sheets Collection:

Sheet No. 703
1,2-Dichloroethylene

Issued: 4/90

Section 1. Material Identification

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1,2-Dichloroethylene Description: An industrial solvent composed of 60% cis- and 40% trans-isomers. Both isomers, cis and trans, are made by partial chlorination of acetylene. Used as a general solvent for organic materials, lacquers, dye extraction, thermoplastics, organic synthesis, and perfumes. The trans-isomer is more widely used in industry than either the cis-isomer or the mixture. Toxicity also varies between the two isomers.

Other Designations: CAS No. 0540-59-0; $C_2H_2Cl_2$; acetylene dichloride; *cis*-1,2-dichloroethylene; *sym*-dichloroethylene; *trans*-1,2-dichloroethylene, dioform.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R	1
I	2
S	2
K	1

NFPA

HMIS
H 2
F 3
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

1,2-Dichloroethylene, ca 100%

OSHA PEL
8-hr TWA: 790 mg/m³, 200 ppm

ACGIH TLV, 1989-90
TLV-TWA: 790 mg/m³, 200 ppm

NIOSH REL, 1987
790 mg/m³, 200 ppm

Toxicity Data*
Rat, oral, LD_{50}: 770 mg/kg; toxic effects not yet reviewed
Frog, inhalation, TC_{Lo}: 117 mg/m³ inhaled for 1 hr affects the peripheral nerve and sensation (flaccid paralysis without anesthesia); behavior (excitement); lungs, thorax, or respiration (respiratory depression)

* See NIOSH, *RTECS* (KV9360000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 119 °F/48 °C
Melting Point: -56 to -115 °F/-49 to -82 °C/
Vapor Pressure: 180 to 264 torr at 68 °F/20 °C
Vapor Density (Air = 1): 3.4
Molecular Weight: 96.95 g/mol
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 1.27 at 77 °F/25 °C
Water Solubility: Insoluble

Appearance and Odor: A colorless, low-boiling liquid with a pleasant odor.

Section 4. Fire and Explosion Data

Flash Point: 37 °F/2.8 °C, CC	Autoignition Temperature: 860 °F/460 °C	LEL: 5.6% v/v	UEL: 12.8% v/v

Extinguishing Media: Use dry chemical, CO_2, halon, water spray, or standard foam. Water may be ineffective unless used to blanket the fire.

Unusual Fire or Explosion Hazards: This material's vapors are a dangerous fire hazard and moderate explosion hazard when exposed to any heat or ignition source or oxidizer.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit. Vapors may travel to heat or ignition sources and flash back. Stay upwind and out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: This material is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: This material is incompatible with alkalies, nitrogen tetraoxide, difluoromethylene, strong oxidizers, and dihypofluorite. When in contact with copper or copper alloys or by reaction with potassium hydroxide, explosive chloroacetylene may be released.

Conditions to Avoid: Addition of hot liquid to cold 1,2-dichloroethylene may cause sudden emission of vapor that could flash back to an ignition source.

Hazardous Products of Decomposition: Thermal oxidative decomposition of 1,2-dichloroethylene can produce highly toxic fumes of chlorine (Cl^-).

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists 1,2-dichloroethylene as a carcinogen.
Summary of Risks: 1,2-Dichloroethylene's most important effect is its irritation of the central nervous system (CNS) and narcosis. This material is toxic by inhalation, ingestion, and skin contact. It is also irritating to the eyes. The trans-isomer at 2200 ppm causes nausea, vertigo, and burning of the eyes. The trans-isomer is twice as potent as the cis-isomer. If renal effects occur, they are transient.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system, eyes, respiratory system.
Primary Entry Routes: Inhalation, ingestion, skin and eye contact.
Acute Effects: Inhalation of 1,2-dichloroethylene causes narcosis, respiratory tract irritation, nausea, vomiting, tremor, weakness, central nervous depression, and epigastric (the abdomen's upper midregion) cramps. Contact with the liquid causes eye and skin (on prolonged contact) irritation. Ingestion causes slight depression to deep narcosis.
Chronic Effects: None reported.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Have trained personnel administer 100% oxygen, preferably with humidification.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Intravenous injections of calcium gluconate may relieve cramps and vomiting. Treat central nervous system effects symptomatically.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: ***Design and practice a 1,2-dichloroethylene spill control and countermeasure plan (SCCP).*** Notify safety personnel, remove all heat and ignition sources, evacuate hazard area, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Absorb small spills on paper towels. After evaporating the 1,2-dichloroethylene from these paper towels in a fume hood, burn the paper in a suitable location away from combustible material. Collect and atomize large quantities in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001, per Clean Water Act, Sec. 307(a)]†
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
† Listed as 1,2-*trans*-dichloroethylene.

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. 1,2-dichloroethylene attacks some forms of plastics, rubber, and coatings.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and oxidizing materials. Outside or detached storage is preferred. If stored inside, place containers in a standard flammable liquids storage cabinet or room. Protect containers from physical damage.
Engineering Controls: Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. 1,2-dichloroethylene is a dangerous fire hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement questionnaires which emphasize detecting a history of chronic respiratory disease.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 7, 26, 38, 73, 84, 85, 87, 88, 100, 101, 103, 109, 126, 127, 136, 137
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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POISON GAS

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

DATE: 3 Dec 1990
HCSDS NO: 20058A

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

D, AND THD (See Addendum A)

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

ANUFACTURER'S NAME: Department of the Army

ANUFACTURER'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

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

HEMICAL 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

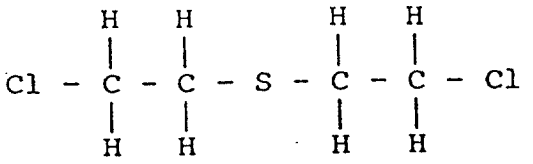
RADE NAME AND SYNONYMS:

ID	Senfgas	H
ulfur mustard	S-lost	HS
prit	Sulphur mustard gas	
ampstoff "Lost"	S-yperite	
ost	Yellow Cross Liquid	
ard Gas	Yperite	

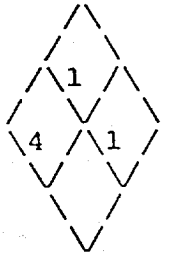
HEMICAL FAMILY: chlorinated sulfur compound

ORMULA/CHEMICAL STRUCTURE:

C4(H8)Cl2(S)



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



SECTION II - COMPOSITION

NGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
ulfur Mustard	C4(H8)Cl2(S)	100	0.003 mg/m3 (8 hr-TWA)

SECTION III - PHYSICAL DATA

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

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

APOR DENSITY (AIR=1): 5.5

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

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

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

PPEARANCE 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

SECTION IV - FIRE AND EXPLOSION DATA

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

LAMMABILITY LIMITS (% by volume): Unknown

XTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing ethods that will splash or spread mustard.
PECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing he fire should be immediately evacuated from the area. Fires involving HD hould be contained to prevent contamination to uncontrolled areas. When esponding to a fire alarm in buildings or areas containing agents, fire-

ighting personnel should wear full firefighter protective clothing (without AP clothing) during chemical agent firefighting and fire rescue operations. espiratory protection is required. Positive pressure, full facepiece, IOSH-approved self-contained breathing apparatus (SCBA) will be worn where [illegible] is danger of oxygen deficiency and when directed by the fire chief or [illegible]ical accident/incident (CAI) operations officer. The M9 or M17 series ask may be worn in lieu of SCBA when there is no danger of oxygen eficiency. In cases where firefighters are responding to a chemical accient/incident for rescue/reconnaissance purposes vice firefighting, they ill wear appropriate levels of protective clothing (see Section 8).

SECTION V - HEALTH HAZARD DATA

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

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

Iedian doses of HD in man are:

[illegible] (skin) = 100 mg/kg
[illegible]50 (skin) = 2000 mg-min/m3 at 70 - 80 DEG F (humid environment)
= 1000 mg-min/m3 at 90 DEG F (dry environment)
Ct50 (eyes) = 200 mg-min/m3
Ct50 (inhalation) = 1500 mg-min/m3 (Ct unchanged with time)
D50 (oral) = 0.7 mg/kg

Iaximum safe Ct for skin and eyes are 5 and 2 mg-min/m3, respectively.

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

OCALLY, HD affects both the eyes and the skin. SKIN damage occurs after ercutaneous resorption. Being lipid soluble, HD can be resorbed into all rgans. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency eriod 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. [illegible] inhaled, the upper respiratory tract (nose, throat, trachea) is [illegible]amed 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,

esults 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.

SECTION VI - REACTIVITY DATA

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.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

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,

lay or fine sand and neutralized as soon as possible using copious amounts f 5.25 percent Sodium Hypochlorite solution.

coop 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 laced between the interior and exterior containers. Decontaminate and abel IAW EPA and DOT regulations. Dispose of the material IAW waste disosal methods provided below. Dispose of the material used to decontaminate xterior of drum IAW Federal, state and local regulations. Conduct general rea monitoring with an approved monitor (see Section 8) to confirm that the tmospheric concentrations do not exceed the airborne exposure limit (see ections 2 and 8).

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

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

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

coop 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

nd held for shipment back to the DA issue point. Decontamination of waste r excess material shall be accomplished in accordance with the procedures utlined above with the following exception:

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

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

OTE: Some states define decontaminated surety material as a RCRA hazardous aste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

ESPIRATORY PROTECTION:

oncentration mg/m3	Respiratory Protection/Ensemble Required
ess 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/m3 level of detection. (b) M9, M17 or M40 mask is available and donned if ceiling concentrations exceed 0.003 mg/m3. (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 respiratiors. (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.)
reater than .003 as an -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.

ILATION:

ocal Exhaust. Mandatory. Must be filtered or scrubbed.

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

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

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

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

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

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

ONITORING: 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).

SECTION IX - SPECIAL PRECAUTIONS

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 transfering 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 thoughly with special attention given to hair, face, neck, and hands using ity 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,

evelopment, Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-ight containers when in storage.

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

SECTION X - TRANSPORTATION DATA

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

OT HAZARD CLASS: Poison A

OT LABEL: Poison Gas

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

OT PLACARD: POISON GAS

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

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

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hile the Chemical Research Development and Engineering Center, epartment of the Army believes that the data contained herein are actual and the opinions expressed are those of qualified experts egarding the results of the tests conducted, the data are not to be taken s a warranty or representation for which the Department of the Army or hemical Research Development and Engineering Center assumes legal esponsibility. They are offered solely for your consideration, nvestigation, and verification. Any use of these data and information must e determined by the user to be in accordance with applicable ederal, State, and local laws and regulations.

ADDENDUM A
ADDITIONAL INFORMATION FOR THICKENED HD

RADE NAME AND SYNONYMS: Thickened HD, THD

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

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

IRE AND EXPLOSION DATA: Same as HD.

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

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

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

PECIAL PROTECTION INFORMATION: Same as HD.

PECIAL PRECAUTIONS: Same as HD with the following addition. Handling the HD requires careful observation of the "stringers" (elastic, thread-like ttachments) formed when the agents are transferred or dispensed. These tringers must be broken cleanly before moving the contaminating device or ispensing device to another location, or unwanted contamination of a orking surface will result.

P SPORTATION DATA: Same as HD.

MALATHION

MLT

Common Synonyms	Liquid	Yellow to dark brown	Skunk-like odor
Cythion Insecticide	Sinks in water. Freezing point is 37°F.		

AVOID CONTACT WITH LIQUID. Keep people away.
Wear chemical protective suit with self-contained breathing apparatus.
Stop discharge if possible.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE AND WHEN HEATED.
Containers may explode in fire.
Wear chemical protective suit with self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, water, or foam.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

LIQUID
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
Irritating to eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-poison, water contaminant
Restrict access
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $C_{10}H_{19}O_6PS_2$
3.3 IMO/UN Designation: 6.1/2783
3.4 DOT ID No.: 2783
3.5 CAS Registry No.: 121-75-5

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Yellow to dark brown.
4.3 Odor: Characteristic skunk-like mercaptan

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Wear self-contained breathing apparatus (or respirator for organophosphate pesticides) and rubber clothing while fighting fires of malathion with chlorine bleach solution. All clothing contaminated by fumes and vapors must be decontaminated.

5.2 Symptoms Following Exposure: Exposure to fumes from a fire or to liquid causes headache, blurred vision, constricted pupils of the eyes, weakness, nausea, cramps, diarrhea, and tightness in the chest. Muscles twitch and convulsions may follow. The symptoms may develop over a period of 8 hours.

5.3 Treatment of Exposure: Speed is essential. INHALATION: in the nonbreathing victim immediately institute artificial respiration, using the mouth-to-mouth, the mouth-to-nose, or the mouth-to-oropharyngeal method. Call physician INGESTION: administer milk, water or salt-water and induce vomiting repeatedly. SKIN OR EYE CONTACT: flood and wash exposed skin areas thoroughly with water. Remove contaminated clothing under a shower. Administer atropine, 2 mg(1/30 gr) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3-6 min. until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 1 mg of atropine. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. Give 2-PAM (Pralidoxime; Protopam), 2.5 gm in 100 ml of sterile water or in 5% dextrose and water, intravenously, slowly. In 15-30 min.; if sufficient fluid is not available, give 1 gm of 2-PAM in 3 ml of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur.

5.4 Threshold Limit Value: 10 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5g/kg(rat)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: None likely
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.

(Continued)

6. FIRE HAZARDS

6.1 Flash Point: >325°F
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Dry chemical, carbon dioxide, water spray, foam
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Vapors and fumes from fires are hazardous. They include sulfur dioxide and phosphoric acid.
6.6 Behavior in Fire: Gives off hazardous fumes. Area surrounding fire should be diked to prevent water runoff.
6.7 Ignition Temperature: Data not available
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Data not available
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: None
7.2 Reactivity with Common Materials: No hazardous reaction
7.3 Stability During Transport: Not pertinent
7.4 Neutralizing Agents for Acids and Caustics: Liquid bleach solution for decontamination.
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: 0.09 ppm/96 hr/bluegill/TL_m/fresh water
0.033-0.083 ppm/96 hr/marine crustacean/LC_{50}
8.2 Waterfowl Toxicity: LD_{50} = 1485 mg/kg
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: CYTHION Insecticide; Malathion ULV Concentrate Insecticide. Many powders, dusts, and spray solutions are sold under a variety of trade names.
9.2 Storage Temperature: Below 120°F. Decomposition (non-hazardous) occurs at higher temperatures.
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 330.36
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: 37°F = 2.9°C = 276°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.234 at 25°C (liquid)
12.8 Liquid Surface Tension: 37.1 dynes/cm = 0.0371 N/m at 24°C
12.9 Liquid Water Interfacial Tension: 19 dynes/cm = 0.019 N/m at 24°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Data not available
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

5. HEALTH HAZARDS (Continued)

5.10 Odor Threshold: Data not available
5.11 IDLH Value: 5000 mg/m³

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

MLT	MALATHION

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
77	77.089	85	.380		N	70	45.270
78	77.089	90	.384		O	72	42.680
79	77.089	95	.389		T	74	40.260
80	77.089	100	.393			76	37.990
81	77.089	105	.398		P	78	35.870
82	77.089	110	.402		E	80	33.880
83	77.089	115	.406		R	82	32.020
84	77.089	120	.411		T	84	30.270
85	77.089	125	.415		I	86	28.620
86	77.089	130	.420		N	88	27.080
87	77.089	135	.424		E	90	25.630
88	77.089	140	.429		N	92	24.270
89	77.089	145	.433		T	94	22.990
90	77.089	150	.438			96	21.780
91	77.089					98	20.650
92	77.089					100	19.580
93	77.089					102	18.580
94	77.089					104	17.630
95	77.089					106	16.740
96	77.089					108	15.900
97	77.089					110	15.100
98	77.089					112	14.350
99	77.089					114	13.650
100	77.089					116	12.980
101	77.089					118	12.350
102	77.089					120	11.750

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
77.02	.014		N		N		N
			O		O		O
			T		T		T
			P		P		P
			E		E		E
			R		R		R
			T		T		T
			I		I		I
			N		N		N
			E		E		E
			N		N		N
			T		T		T

MALATHION

MLT

Common Synonyms	Liquid	Yellow to dark brown	Skunk-like odor
Cythion Insecticide	Sinks in water. Freezing point is 37°F.		

AVOID CONTACT WITH LIQUID. Keep people away.
Wear chemical protective suit with self-contained breathing apparatus.
Stop discharge if possible.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE AND WHEN HEATED.
Containers may explode in fire.
Wear chemical protective suit with self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, water, or foam.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

LIQUID
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
Irritating to eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-poison, water contaminant
Restrict access
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $C_{10}H_{19}O_6PS_2$
3.3 IMO/UN Designation: 6.1/2783
3.4 DOT ID No.: 2783
3.5 CAS Registry No.: 121-75-5

4. OBSERVABLE CHARACTERISTICS

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4.2 Color: Yellow to dark brown.
4.3 Odor: Characteristic skunk-like mercaptan

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5.1 Personal Protective Equipment: Wear self-contained breathing apparatus (or respirator for organophosphate pesticides) and rubber clothing while fighting fires of malathion with chlorine bleach solution. All clothing contaminated by fumes and vapors must be decontaminated.

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5.4 Threshold Limit Value: 10 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5g/kg(rat)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: None likely
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.

(Continued)

6. FIRE HAZARDS

6.1 Flash Point: >325°F
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Dry chemical, carbon dioxide, water spray, foam
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Vapors and fumes from fires are hazardous. They include sulfur dioxide and phosphoric acid.
6.6 Behavior in Fire: Gives off hazardous fumes. Area surrounding fire should be diked to prevent water runoff.
6.7 Ignition Temperature: Data not available
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Data not available
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: None
7.2 Reactivity with Common Materials: No hazardous reaction
7.3 Stability During Transport: Not pertinent
7.4 Neutralizing Agents for Acids and Caustics: Liquid bleach solution for decontamination.
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

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8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

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9.2 Storage Temperature: Below 120°F. Decomposition (non-hazardous) occurs at higher temperatures.
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: OPM-A
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 330.36
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: 37°F = 2.9°C = 276°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.234 at 25°C (liquid)
12.8 Liquid Surface Tension: 37.1 dynes/cm = 0.0371 N/m at 24°C
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12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Data not available
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

5. HEALTH HAZARDS (Continued)

5.10 Odor Threshold: Data not available
5.11 IDLH Value: 5000 mg/m³

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

MLT	MALATHION

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
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78	77.089	90	.384		O	72	42.680
79	77.089	95	.389		T	74	40.260
80	77.089	100	.393			76	37.990
81	77.089	105	.398		P	78	35.870
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89	77.089	145	.433		T	94	22.990
90	77.089	150	.438			96	21.780
91	77.089					98	20.650
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93	77.089					102	18.580
94	77.089					104	17.630
95	77.089					106	16.740
96	77.089					108	15.900
97	77.089					110	15.100
98	77.089					112	14.350
99	77.089					114	13.650
100	77.089					116	12.980
101	77.089					118	12.350
102	77.089					120	11.750

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
77.02	.014		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

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Material Safety Data Sheets Collection:

Sheet No. 373
Methyl Ghloride

Issued: 5/81 Revision: B, 3/92

Section 1. Material Identification

Methyl Chloride (CH_3Cl) Description: Derived by chlorination of methane or by action of hydrochloric acid on methanol in either the liquid or vapor phase. Available in a pure form, technical grade, and two refrigerant grades. Used principally as an intermediate in industrial synthesis such as the manufacture of silicones, butyl rubber, tetramethyl lead, methyl cellulose, dyes, perfumes, and quaternary drugs; as a methylating and chlorinating agent in organic chemistry; in petroleum refineries as an extractant for greases, oils, and resins; as an anti-knock agent; and as a propellant in polystyrene foam production. Formerly used (still in other countries) as a refrigerant, and a local anesthetic.

Other Designations: CAS No. 74-87-3, Artic, chloromethane, monochloromethane.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Methyl chloride is extremely flammable. It is an acute central nervous system (CNS) depressant, and can produce chronic liver, kidney, and neurological damage.

R 1
I 3
S 2*
K 4
* Skin absorption

NFPA
4
2 0
-

HMIS
H 2
F 4
R 0
PPG†
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Methyl chloride (pure grade), ca 99.5%. Most likely contaminants are water vapor and hydrogen chloride gas.

1990 OSHA PELs
8-hr TWA: 50 ppm (105 mg/m³)
15-min STEL: 100 ppm (205 mg/m³)

1990 IDLH Level
10,000 ppm

1990 NIOSH REL
Lowest Feasible Concentration
Limit of Quantitation (LOQ): 1.6 ppm

1991-92 ACGIH TLVs (Skin)
TWA: 50 ppm (103 mg/m³)
STEL: 100 ppm (207 mg/m³)

1990 DFG (Germany) MAKs
TWA: 50 ppm (105 mg/m³)
Class B Carcinogen
Half-life: <2 hr
Peak Exposure Limit: 100 ppm/30 min (average value)/2 per shift

1985-86 Toxicity Data*
Human, inhalation, LC_{Lo}: 20,000 ppm/2 hr caused nausea or vomiting, convulsions (effect on seizure threshold) and affected the eyes
Rat, inhalation, TC_{Lo}: 1500 ppm/70-day-old male produced effects on fertility

* See NIOSH, *RTECS* (PA6300000), for additional mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: -10.7 °F (-23.7 °C)
Freezing Point: -142 °F (-97 °C)
Vapor Pressure: 5 atm at 68 °F (20 °C); 760 mm Hg at -10.7 °F (-23.7 °C)
Gas Density (air = 1): 2.47
Refraction Index: 1.3712 at -10.7 °F (-23.7 °C)
Viscosity: 0.1834 cP at 68 °F (20 °C)
Molecular Weight: 50.49
Density: 0.92 at 68 °F (20 °C)
Water Solubility: Slightly soluble, 0.5%
Other Solubilities: Soluble in alcohol, benzene, carbon tetrachloride and ethanol; miscible with chloroform, ether, and glacial acetic acid.
Saturated Vapor Density: 0.6053 lb/ft³ at 65 °F (18.3 °C)

Appearance and Odor: Colorless gas at room temperature (liquid upon compression), with a sweet odor unnoticed at dangerous concentrations.

Section 4. Fire and Explosion Data

Flash Point: -50 °F (-46 °C)	Autoignition Temperature: 1170 °F (632 °C)	LEL: 8.1% v/v	UEL: 17.4% v/v

Extinguishing Media: Methyl chloride is extremely flammable and burns with a smoky flame. For small fires, let burn unless leak can be stopped immediately. For large fires, use flooding quantities of water as fog, or regular foam.

Unusual Fire or Explosion Hazards: Gas may travel to an ignition source and flash back. Container may explode in heat of fire. Methyl chloride poses a gas explosion hazard indoors, outdoors, and in sewers.

Special Fire-fighting Procedures: Since fire produces toxic thermal decomposition products, including hydrogen chloride and phosgene, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is not effective for methyl chloride fires. If possible without risk, remove container from fire area. Apply cooling water to sides of fire-exposed containers until long after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holder; if impossible, withdraw from area and let fire burn. Withdraw from area immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Methyl chloride is stable when dry and at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Ethylene, chemically active metals such as sodium, potassium, powdered aluminum, zinc, and magnesium or sodium-potassium alloys; can explode on contact with interhalogens such as bromine trifluoride or bromine pentafluoride; and hydrolyzes with water to form hydrochloric acid and methanol.

Conditions to Avoid: Exposure to ignition source or contact with incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of methyl chloride above 752 °F (400 °C) or in strong UV light in the presence of air and moisture can produce carbon monoxide (CO), carbon dioxide (CO_2), hydrogen chloride (HCl), and phosgene ($COCl_2$).

Section 6. Health Hazard Data

Carcinogenicity: Methyl chloride carcinogenicity is controversial. These agencies define methyl chloride carcinogenicity: IARC, Class 3 (not classifiable as to human carcinogenicity);[164] Germany (DFG), MAK Class B (justifiably suspected as having carcinogenic potential);[163] and NIOSH, Class X (carcinogen defined without further explanation).[165] The NTP[142] and OSHA[164] do not list methyl chloride as a carcinogen.

Summary of Risks: Methyl chloride is a CNS depressant and can cause kidney and liver damage. Its vapors pose little hazard to eyes or skin, but contact with the liquid can cause frostbite and corneal lesions. In high concentrations it can produce asphyxia by displacing oxygen in the air. The majority of fatalities resulted from leaks or defects in refrigerator plants. Other exposures resulted from sawing or hot wire cutting styrofoam which releases methyl chloride from the foam cells. Recovery begins almost immediately upon removal from exposure, but can be prolonged and permanent neurologic impairment is reported. Chronic effects may last for years. Most cases of intoxication have involved concentrations above 500 ppm. There is human mutagenic (relating to gene mutation in human mammalian cells) and experimental teratogenic (relating to fetotoxicity, musculoskeletal abnormalities in the rat fetus) data on methyl chloride.

Medical Conditions Aggravated by Long-Term Exposure: CNS disorders, anemia, alcoholism, kidney or liver disease.

Target Organs: CNS, liver, kidney, skin.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Inhalation symptoms from CNS depression include staggering gait, difficult speech, nausea, vomiting, headache, nystagmus (rapid, involuntary, right to left motion of the eyeballs), dizziness, blurred vision, and, less frequently, coma or convulsive seizures may occur. The "drunken-like" behavior observed in many victims can cause further injury or harm others from resulting incoordination and impaired judgement, especially by mechanical misoperation (car, machinery). Kidney and liver damage resulted from severe acute exposures. Skin contact with liquid methyl chloride may cause frostbite. The liquid may damage eyes causing stinging, inflammation of the lids, cloudiness and opaqueness, and corneal lesions due to inflammation. Ingestion is very unlikely since liquid is very cold (-42 °F boiling point)!
Chronic Effects: Chronic effects are somewhat similar, including anorexia, diminished vision, dizziness, tremor, incoordination, nervousness, emotional instability, and insomnia. Permanent CNS effects may be noted in some patients.
FIRST AID *Emergency personnel should protect against contamination.*
Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* allow victim to rub or keep eyes tightly shut. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Methyl chloride vaporizes easily and poses an inhalation and flammable/explosion hazard. Properly dispose of contaminated clothing. Rinse with flooding amounts of water for at least 15 min. *Do not* use hot or tepid water (especially for frost-bitten areas); water around 42 °F is best for gradual warming. Gently wash exposed area with soap and water. *Do not* rub or apply pressure to affected areas, especially if frostbitten.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Methyl chloride is a gas and cannot be ingested. The ingestion of the compressed gas (liquid) is highly unlikely.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Keep victim under observation since effects may be delayed. Frostbite is possible upon skin contact, treat accordingly. Monitor blood with baseline CBC and obtain hepatic enzyme samples to assess degree of any possible liver injury.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. If possible without risk, stop leak. Cleanup personnel should wear fully encapsulating, vapor-protective clothing and SCBAs. Use water spray to reduce vapor. For small liquid spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers with a secure lid. For large spills, dike far ahead of spill for later disposal. Be aware that under normal pressure and room temperature methyl chloride is a gas and that ventilation is the best removal method. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Transport: When released to the atmosphere, methyl chloride diffuses upward and reacts with hydroxyl radicals. In water, it volatilizes (half-life: 2.4 hr in a typical river). On land methyl chloride does not significantly absorb to soil. Due to its high vapor pressure it volatilizes or leaches into groundwater where it should very slowly biodegrade or hydrolyze.
Ecotoxicity Values: *Lepomis macrochirus*, LC_{50}, 550 ppm/96 hr; *Menidia beryllina*, LC_{50}, 270 ppm/96 hr.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U045
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001 and CWA, Sec. 307 (a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For <1000 ppm use any supplied-air respirator. For <5000 ppm use any supplied-air respirator with a full facepiece, helmet, or hood. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. The charcoal in most gas mask cartridges and canisters is not totally effective as a sorbent for methyl chloride.
Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a respiratory protection program that includes at least: medical review, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Other: Wear gloves, boots, aprons, and gauntlets to prevent all skin contact with cryogenic (freezing) chemicals. Polyvinyl alcohol is a recommended material for personal protective gear.
Ventilation: Provide general and local dilution exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). It is best to have in place nonsparking ventilation fans and sealed, spark-proof motors so that in the event of a spill or release, explosions are prevented.
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in cool, dry, well-ventilated area away from ignition sources and incompatibles (Sec. 5). Outside or detached storage is preferred, and steel containers are recommended. Check cylinders and equipment often for leaks.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. If entering enclosures with high methyl chloride levels, wear appropriate respirators together with a safety belt and lifeline under the supervision of a helper on the outside.
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, blood, kidney and liver disorders. Inform employees of the hazards associated with working with methyl chloride.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Methyl chloride
DOT Hazard Class: Flammable gas
ID No.: UN1063
DOT Label: Flammable gas
DOT Packaging Exceptions: 173.306
DOT Packaging Requirements: 173.304, 173.314, 173.315

IMO Shipping Name: Methyl Chloride
IMO Hazard Class: 2.3
ID No.: UN1063
IMO Label: Poison Gas, Flammable Gas
IMDG Packaging Group: ---

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 131, 132, 133, 136, 139, 140, 148, 149, 153, 159, 162-164, 167
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Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 310
METHYLENE CHLORIDE
(Revision F)

Issued: September 1985
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

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Material Name: METHYLENE CHLORIDE

Description (Origin/Uses): Used widely in paint removers, as a solvent for plastics, as a degreasing agent, in propellant mixtures for aerosol sprays, and as a blowing agent in foams.

Other Designations: Dichloromethane; Freon 30®; Methane Dichloride; Methylene Bichloride; Methylene Dichloride; CH_2Cl_2; CAS No. 0075-09-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS
H 2
F 1
R 0
PPG*
*See sect. 8

R 1
I 3
S 3
K 1

NFPA
1
2 0
-

SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

Methylene Chloride, ca 100%

OSHA PEL
8-Hour TWA: 500 ppm
Ceiling: 1000 ppm Acceptable Maximum Peak above the Ceiling: 2000 ppm for 5 Minutes in Any 2-Hour Period

ACGIH TLV, 1988-89
TLV-TWA: 50 ppm, 175 mg/m³
(Adopted 1988-89)

Toxicity Data*
Rat, Oral, LD_{50}: 2136 mg/kg
Human, Inhalation, TC_{Lo}: 500 ppm (8 Hours)

*See NIOSH, *RTECS* (PA8050000), for additional data with references to irritative, reproductive, mutagenic, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 103.55°F (39.75°C) at 76 Torrs
Melting Point: -142°F (-96.7°C)
Vapor Density (Air = 1): 2.9
Vapor Pressure: 440 Torrs at 77°F (25°C)

Molecular Weight: 84.94 Grams/Mole
Solubility in Water (%): 1% by Weight
Specific Gravity (H_2O = 1): 1.3255 at 68°F (20°C)
% Volatile by Volume: Ca 100

Appearance and Odor: A clear, colorless, volatile liquid; distinctive, penetrating, ethereal odor. The odor will not serve as a useful warning property because concentrations of 100 ppm are not easily perceptible. Most persons can detect this odor at above 300 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: 1033°F (556°C)	LEL: 12% v/v	UEL: 19% v/v

Extinguishing Media: *Methylene chloride is not flammable under ordinary conditions. However, flammable vapor-air mixtures can form at approximately 212°F (100°C). Use water spray to cool fire-exposed containers and to flush spills away from exposures. Use extinguishing agents that will put out the surrounding fire. **Unusual Fire or Explosion Hazards:** Methylene chloride vapor is heavier than air and may collect and concentrate in low-lying, confined spaces. The high vapor pressure of methylene chloride means that when it is spilled, its vapor concentration in air can increase rapidly. If this vapor is heated, an explosion hazard is associated with the vapor-air mixture. Containers of this material may rupture violently if they are involved in fires. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Methylene chloride is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Methylene chloride can react dangerously with nitrogen tetroxide, liquid oxygen, potassium, sodium, sodium-potassium alloys, lithium, potassium hydroxide with N-methyl-N-nitroso urea, potassium *t*-butoxide, and finely powdered aluminum and magnesium. **Conditions to Avoid:** Avoid all exposure to sources of ignition, heat, and incompatible chemicals. Prolonged exposure to water may cause hydrolysis to highly corrosive hydrochloric acid when the temperature is above 140°F (60°C). In oxygen-enriched atmospheres or when heated (>212°F [100°C]), methylene chloride vapor can be readily ignited. **Hazardous Products of Decomposition:** Exposure to high temperature (from open flame, hot surfaces, uninsulated steam lines, welding arcs, etc.) can produce toxic and corrosive thermal-oxidative products of decomposition such as hydrogen chloride, carbon monoxide, and even small quantities of phosgene gas, which is extremely poisonous.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Methylene chloride is listed as a suspected human carcinogen by the ACGIH (which classifies it as a group A2 carcinogen). **Summary of Risks:** Accidental contact of liquid methylene chloride with skin or eyes causes painful irritation and possible burns if not promptly removed. Exposure by way of contaminated gloves, clothing, or paint remover formulations can produce these same irritant effects. Long-term exposure to mild or moderate doses of methylene chloride may cause a delayed (24 to 48 hours) onset of dizziness, headache, mental confusion, slurred speech, double vision, and sleeplessness. Medical recovery can be slow. Overexposure to methylene chloride can cause elevated levels of carboxy hemoglobin in the blood (this same effect results from overexposure to carbon monoxide). **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, CNS, liver, kidneys, and blood. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Headache, giddiness, stupor, irritability, fatigue, tingling in the limbs, and narcosis that is not usually fatal if the exposure is terminated before anesthetic death occurs. **Chronic Effects:** The ACGIH classification of this material as a suspected human carcinogen implies that cancer is a possible effect of chronic exposure to methylene chloride. **FIRST AID:** Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with

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SECTION 6. HEALTH HAZARD INFORMATION, cont.

flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water and then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Note to Attending Physician:** Do not administer adrenalin. **Ingestion.** Unlikely. Should this type of exposure occur, do not induce vomiting because of the danger of aspiration. If spontaneous vomiting should occur, position the exposed person's head below his or her trunk to resist aspiration. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Absorbed methylene chloride is stored in body fat and metabolizes to carbon monoxide. This produced carbon monoxide increases and sustains carboxyhemoglobin levels in the blood, which concommitantly reduces the oxygen-carrying capacity of the blood. NIOSH advises preplacement and annual medical exams that emphasize liver, kidney, eye, skin, CNS, and respiratory system functions and a complete blood count. Simultaneous exposure to tobacco smoke, alcohol, and carbon monoxide, along with heavy manual labor, increases the body burden of a worker as well as the toxic hazards of the methylene chloride. In significant exposures, serum methylene chloride levels are of no clinical importance. Neurologic and hepatic status as well as carboxy hemoglobin should be monitored.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against this liquid's contact with the skin or eyes as well as inhalation of its vapor. Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, NO. U080
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), § 307 (a), and the Resource Conservation and Recovery Act (RCRA), § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious neoprene, PVA, or Viton gloves, boots, aprons, and gauntlets, etc., to prevent any skin contact with liquid methylene chloride. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the exposure limits cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Floor or sump ventilation may be necessary. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Other:** Because the health effects of carbon monoxide and methylene chloride are additive (see sect. 6), workplaces should be equipped with automatic sensing equipment that identifies workroom atmospheric levels of both of these materials. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale methylene chloride vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store methylene chloride in closed, moisture-proof containers in a cool, dry, well-ventilated area away from sources of ignition, strong oxidizers, caustics, and incompatible chemicals (see sect. 5). Protect containers from physical damage. **Special Handling/Storage:** Prevent moist air from entering storage containers. Provide ventilation at the floor level in storage areas because methylene chloride vapor is denser than air. Installation of a dryer and a safety seal on each tank is recommended. Aluminum is not recommended for use as a storage material; appropriate storage materials include galvanized iron, black iron, or steel. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Dichloromethane *or* Methylene Chloride
DOT Hazard Class: ORM-A
ID No. UN1593
DOT Packaging Requirements: 49 CFR 173.605
DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: Dichloromethane
IMO Hazard Class: 6.1
IMO Label: Saint Andrew's Cross (X)*
IMDG Packaging Group: III

*Harmful-Stow away from Foodstuffs.

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Material Safety Data Sheets Collection:

Sheet No. 517
Pentachlorophenol

Issued: 10/83 Revision: A, 11/90

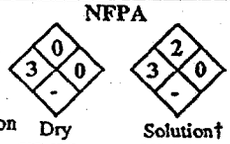
Section 1. Material Identification

Pentachlorophenol (C_6HCl_5O) Description: Derived by chlorination of phenol in the presence of a catalyst. Used as a fungicide, a bactericide, a molluscicide, an algicide, an insecticide (termite control) and herbicide (pre-harvest defoliant); in sodium pentachlorophenate; in wood preservation (telephone poles, pilings, etc.), wood products, starches, dextrins, and glues. Other registered industrial uses include boat and building construction; treatment of cable coverings, canvas belting, nets, and construction lumber and poles; mold control in petroleum drilling and production; incorporation in paints, pulp, pulp stock, paper, cooling tower water, and hardboard and particle board. Registered homeowner uses include maintenance of boats, trailers, station wagons, siding, fences, and outdoor furniture.
Other Designations: CAS No. 0087-86-5, chlorophen, PCP, penchlorol, penta.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.
Cautions: Pentachlorophenol is *highly toxic by skin absorption, ingestion, and inhalation.* The agent is highly irritating. General metabolism, the heart, the circulatory system, the liver, and the kidneys may be affected.

R	1
I	3
S	2*
K	0

* Skin absorption

NFPA



Dry	Solution†
HMIS	HMIS
H 3	H 3
F 0	F 2
R 0	R 0
PPG‡	PPG‡
‡ Sec. 8	‡ Sec. 8

† PCP is freely soluble in alcohol, ether, and benzene. Depending on medium, PCP's health and flammability hazards increase in solution with such media.

Section 2. Ingredients and Occupational Exposure Limits

Pentachlorophenol, ca 100%*

1989 OSHA PEL
8-hr TWA (skin): 0.5 mg/m³

1990-91 ACGIH TLV
TWA (skin): 0.5 mg/m³

1985-86 Toxicity Data†
Rat, oral, LD_{50}: 27 mg/kg ingested affects the vascular (blood pressure elevation), endocrine (hyperglycemia), nutritional, and gross metabolic (body temperature increase) systems
Rat, inhalation, LC_{50}: 355 mg/m³ inhaled affects behavior (excitement; muscle contraction or spasticity) and respiration (shortness of breath)

1987 IDLH Level
150 mg/m³

1988 NIOSH REL
None established

* Technical grade pentachlorophenol contains traces of hexa, hepta, and octachlorodibenzo-p-dioxins; hexa, hepta, and octachlorodibenzofurans; and hexachlorobenzene.
† See NIOSH, *RTECS* (SM6300000), for additional irritative, mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 588 to 590 °F (309 to 310 °C),* 592 °F (311 °C) (decomposes)†
Melting Point: 374 °F (190 °C),* 374 °F (190 °C)†
Vapor Pressure: 0.00011 mm Hg at 77 °F (25 °C)
Vapor Density (Air = 1): 9.2
Molecular Weight: 266.35
Specific Gravity (22 °C/4 °C): 1.978
Water Solubility: 14 mg/l at 20 °C

Appearance and Odor: Light brown or tan flake or solid with a phenolic odor and pungent taste. Odor detection is at 1.6 mg/l.

* Pentachlorophenol solution
† Dry pentachlorophenol

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Since pentachlorophenol is noncombustible, use extinguishing media appropriate to the surrounding fire: dry chemical, water spray, carbon dioxide, or foam. Use the water spray to cool fire-exposed containers.
Unusual Fire or Explosion Hazards: When involved in a fire, pentachlorophenol emits toxic fumes. Wood treated with 5% pentachlorophenol solution or pentachlorophenol in petroleum solvents such as mineral spirits or kerosine are combustible.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Avoid skin contact. If feasible, remove containers from fire area. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Pentachlorophenol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Pentachlorophenol solutions subjected to sunlight or ultraviolet light undergo photochemical degradation.
Chemical Incompatibilities: Pentachlorophenol is incompatible with strong oxidizers and alkalies.
Conditions to Avoid: Avoid contact with heat and ignition sources (open flame, electric arcs, or hot surfaces) which can cause thermal decomposition.
Hazardous Products of Decomposition: Thermal oxidative decomposition of pentachlorophenol can produce hydrogen chloride, chlorine, and chlorinated hydrocarbons. Prolonged heating above 392 °F (200 °C) produces traces of octachlorodibenzo-para-dioxin.

Section 6. Health Hazard Data

Carcinogenicity: There is animal evidence of an increase in liver and endocrine tumors in some research studies, but not in others. Also, PCP shares some structural similarity to other carcinogens. However, NTP, IARC, and OSHA do not list PCP as a carcinogen. It may be toxic to the fetus, especially during early pregnancy.
Summary of Risks: Airborne exposure is irritating to the eyes, skin, throat, and lungs, and may cause acute and possibly chronic effects (see below). Levels above 1 mg/m³ may cause cough, sneezing, and tearing of the eyes, especially in unacclimated workers. Skin contact is also irritating and provides an efficient way for the chemical to enter the body and cause systemic poisoning. Skin rashes (dermatitis) including chloracne (a severe and persistent cystic form of acne characterized by blackheads, whiteheads, and yellow cysts) may result from repeated or prolonged contact with even dilute solutions (e.g., 1%). Ingestion may cause severe systemic poisoning.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Medical Conditions Aggravated by Long-Term Exposure: Individuals with kidney, liver, endocrine, and metabolic disorders may be at a higher risk from exposure to pentachlorophenol. Consult a physician.
Target Organs: Cardiovascular system, endocrine system, general metabolism, liver, kidneys, respiratory system, eyes, skin, and central nervous system (CNS).
Primary Entry Routes: Inhalation, skin absorption, ingestion, eye contact.
Acute Effects: Acute exposures are irritating and may cause tachycardia (rapid heartbeat), tachypnea (rapid breathing), hypertension (high blood pressure), fevers, muscular weakness, anorexia (loss of appetite), sweating, dizziness, and nausea. Very high doses may cause unconsciousness, seizures (convulsions), or death due to cardiac arrest. The risk of acute poisoning may increase in hot weather.
Chronic Effects: Absorption of PCP and/or its contaminants may cause chloracne. Bronchitis and weight loss may develop. Animal studies suggest that liver and kidney damage may occur.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing with artificial respiration, CPR if necessary, and oxygen if available.
Ingestion: Call a physician or Poison Control Center immediately. Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce vomiting. If possible, induce vomiting under medical supervision. Do not instill milk or other materials containing vegetable or animal fats since they are likely to enhance absorption.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Severe systemic poisoning results primarily from uncoupling of mitochondrial oxidative phosphorylation, with ensuing hyperpyrexia. Promote heat loss and aggressively manage hyperthermia with physical methods. *Antipyretics (including aspirin), atropine, and phenothiazines are contraindicated.* Force diuresis to reduce body burden. Carefully follow and treat fluid/electrolyte and acid/base alterations. Treat supportively and reduce anxiety. Diagnostic testing should include rectal temperature, PCP urine or plasma levels, blood chemistries (including electrolytes, LFTs, BUN, creatinine), and CBC. Treat ingestion with emesis, gastric lavage, and saline cathartic.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and remove all heat and ignition sources. Cleanup personnel need full protection against vapor inhalation and contact with solution or solid. Collect dry spilled material in a metal container for reclamation or disposal. For liquid spills, collect with an absorbent solid and place in a metal container for disposal. For large liquid spills, dike far ahead of liquid spill to contain. Wash residue with soap and water. Prevent spills from entering sewers, streams, and open waters. Pentachlorophenol is toxic to fish and wildlife. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), RCRA Waste No. U242
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [* per Clean Water Act, Sec. 311(b)(4), Sec. 307(a), and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, where concentrations of pentachlorophenol exceed or are likely to exceed .5 mg/m^3, wear a NIOSH-approved organic vapor-dust filter type respirator; a full facepiece is needed at concentrations >2.5 mg/m^3. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA; SCBA can be used to 150 mg/m^3. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves (polyvinyl chloride, neoprene or nitrile latex), boots, aprons, and gauntlets to prevent skin contact. Extremely high concentrations may require a full containment suit. Always consult an industrial hygienist.
Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below both OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing. Use separate lockers for street clothes.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in properly labeled and closed containers in a cool, dry, well-ventilated, low fire hazard area away from heat and ignition sources and combustible materials. Protect containers from physical damage. Outside or detached storage is preferred. Accumulated sludge at the bottom of dipping tanks may concentrate toxic impurities at much higher levels than original product. Do not reuse drums. Clean empty drums, liners, and block wrappings in accordance with 40 CFR 261.7(b)(3) prior to returning for reconditioning, recycling, or other disposal.
Engineering Controls: Educate workers about pentachlorophenol's hazards. Avoid skin contact and vapor or dust inhalation. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.
Medical Surveillance: Preplacement and periodic medical evaluations should include a complete history and physical examination and a biochemical profile (including LFTs, BUN, creatinine, and electrolytes). Consider baseline pulmonary function tests. Perform biologic monitoring for PCP levels at the end of work shifts (plasma) and toward end of workweek (urine). 24-hr urine collections are more accurate than spot testing.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Chlorophenols, liquid	**IMO Shipping Name:** Chlorophenols, solid
IMO Hazard Class: 6.1	**IMO Hazard Class:** 6.1
ID No.: UN2021	**ID No.:** UN2020
IMO Label: St. Andrews Cross	**IMO Label:** St. Andrews Cross
IMDG Packaging Group: III	**IMDG Packaging Group:** III

MSDS Collection References: 1, 38, 73, 84, 85, 88, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 313
Perchloroethylene

Issued: 11/78 **Revision: E, 9/92**

Section 1. Material Identification

Perchloroethylene (C_2Cl_4) Description: By chlorination of hydrocarbons and pyrolysis of the carbon tetrachloride that is formed, or by catalytic oxidation of 1,1,2,2-tetrachloroethane. Used in dry cleaning and textile processing, metal degreasing, insulating fluid and cooling gas in electrical transformers, production of adhesives, aerosols, paints, and coatings; as a chemical intermediate, a solvent for various applications, extractant for pharmaceuticals, a pesticide intermediate, and an antihelminthic (parasitic worm removal) agent in veterinary medicine.
Other Designations: CAS No. 127-18-4, Ankilostin, carbon dichloride, Didakene, ethylene tetrachloride, Perchlor, Perclene, Perk, Tetracap, tetrachloroethylene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 3
S 2*
K 0
* Skin absorption

NFPA
0
2 0
-

HMIS
H 2†
F 0
R 0
PPE‡
† Chronic effects
‡ Sec. 8

Cautions: Perchloroethylene is a central nervous system depressant, causes liver and kidney damage (from acute or chronic exposures), and is considered an IARC Class 2B carcinogen (animal sufficient evidence, human inadequate data).

Section 2. Ingredients and Occupational Exposure Limits

Perchloroethylene, < 99%. Impurities include a small amount of amine or phenolic stabilizers.

1991 OSHA PEL
8-hr TWA: 25 ppm (170 mg/m^3)

1990 IDLH Level
500 ppm

1990 NIOSH REL
NIOSH-X Carcinogen
Limit of Quantitation: 0.4 ppm

1992-93 ACGIH TLVs
TWA: 50 ppm (339 mg/m^3)
STEL: 200 ppm (1357 mg/m^3)

1990 DFG (Germany) MAK
TWA: 50 ppm (345 mg/m^3)
Category II: substances with systemic effects
Half-life: < 2 hr
Peak Exposure Limit: 100 ppm, 30 min average value, 4/shift

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 280 ppm/2 hr caused conjunctival irritation and anesthesia.
Human, lung: 100 mg/L caused unscheduled DNA synthesis.
Rat, oral, LD_{50}: 3005 mg/kg; caused somnolence, tremor, and ataxia.
Rat, inhalation, TC_{Lo}: 200 ppm/6 hr given intermittently over 2 years produced leukemia and testicular tumors.
Rabbit, eye: 162 mg caused mild irritation.
Rabbit, skin: 810 mg/24 hr caused severe irritation.

* See NIOSH, *RTECS* (KX3850000), for additional irritation, mutation, reproductive, tumorigenic, & toxicity data.

Section 3. Physical Data

Boiling Point: 250 °F (121.2 °C)
Freezing Point: -8 °F (-23.35 °C)
Vapor Pressure: 13 mm Hg at 68 °F (20 °C)
Surface Tension: 31.74 dyne/cm at 68 °F (20 °C)
Viscosity: 0.84 cP at 77 °F (25 °C)
Refraction Index: 1.50534 at 68 °F (20 °C)
Molecular Weight: 165.82
Density: 1.6311 at 59 °F (15/4 °C)
Water Solubility: 0.02% at 77 °F (25 °C)
Other Solubilities: Miscible with alcohol, ether, benzene, chloroform, and oils.
Odor Threshold: 47 to 71 ppm (poor warning properties since olfactory fatigue is probable)
Evaporation Rate: 0.15 gal/ft^2/day at 77 °F (25 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.081 lb/ft^3 or 1.296 kg/m^3

Appearance and Odor: Colorless liquid with an ether-like odor.

Section 4. Fire and Explosion Data

Flash Point: Nonflammable	Autoignition Temperature: Nonflammable	LEL: None reported	UEL: None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2). For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: Vapors are heavier than air and collect in low-lying areas.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Perchloroethylene is stable up to 932 °F (500 °C) in the absence of catalysts, moisture, and oxygen but deteriorates rapidly in warm, moist climates. It is slowly decomposed by light. Amine or phenolic stabilizers are usually added. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Slowly (faster in presence of water) corrodes aluminum, iron, and zinc. It is incompatible with chemically active metals (i.e., barium, beryllium, and lithium (explodes with lithium shavings), strong oxidizers, sodium hydroxide, caustic soda, potash, and nitric acid. Perchloroethylene forms an explosive mixture with dinitrogen tetraoxide and reacts with activated charcoal at 392 °F (200 °C) to yield hexachloroethane and hexachlorobenzene. **Conditions to Avoid:** Contact with moisture and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of perchloroethylene can produce carbon dioxide and toxic chlorine, hydrogen chloride, and phosgene gas (also produced by contact with UV light).

Section 6. Health Hazard Data

Carcinogenicity: Perchloroethylene is listed as a carcinogen by The IARC (Group 2B, animal sufficient evidence, human inadequate data),[164] NTP (Class 2, reasonably anticipated as a carcinogen, with limited human evidence and sufficient animal evidence),[169] NIOSH (Class-X, carcinogen defined with no further explanation),[164] and DFG (MAK-B, justifiably suspected of having carcinogenic potential)[164]. There is some controversy regarding human carcinogenicity because even though there is an increased number of cancers of the skin, colon, lung, urogenital tract, and lympho-sarcomas; the dry cleaning workers studied were also exposed to other chemicals. **Summary of Risks:** Perchloroethylene is stored in the fatty tissue and slowly metabolized with the loss of chlorine. The half-life of its urinary metabolite (trichloroacetic acid) is 144 hours. Perchloroethylene exerts the majority of its toxicity on the central nervous system causing symptoms ranging from light-headedness and slight 'inebriation' to unconsciousness. Liver damage is possible after severe acute or minor long-term exposure. It has a synergistic effect with toluene.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Medical Conditions Aggravated by Long-Term Exposure: Nervous, liver, kidney, or skin disorders. **Target Organs:** Liver, kidney, eyes, upper respiratory tract, skin, and central nervous system. **Primary Entry Routes:** Inhalation and skin and eye contact. **Acute Effects:** Exposure to high levels can cause liver damage which may take several weeks to develop. Vapor exposure can cause slight smarting of the eyes and throat (in high concentrations). In human studies, exposure to 2000 ppm/5 min caused mild CNS depression; 600 ppm/10 min caused numbness around the mouth, dizziness, and incoordination; 100 ppm/7 hr caused mild eye, nose, and throat irritation, flushing of the face and neck, headache, somnolence, and slurred speech. Skin contact may produce dermatitis because of perchloroethylene's defatting action (more common after repeated exposure). Direct eye contact causes tearing and burning but no permanent damage. Ingestion is rare but can cause irritation of the lips, mouth and gastrointestinal tract, irregular heartbeat, nausea & vomiting, diarrhea (possibly blood stained), drowsiness, unconsciousness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Prolonged exposure can cause impaired memory, extremity (hands, feet) weakness, peripheral neuropathies, impaired vision, muscle cramps, liver damage (fatty degeneration, necrosis, yellow jaundice, and dark urine) and kidney damage (oliguric uremia, conjestion and granular swelling).

FIRST AID ***Rescuers must not enter areas with potentially high perchloroethylene levels without a self-contained breathing apparatus.*** **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. *Never administer adrenalin!* **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Be sure victim's head is positioned to avoid aspiration of vomitus into the lungs. **Note to Physicians:** Monitor level of consciousness, EEG (abnormalaties may indicate chronic toxicity), blood enzyme levels (for 2 to 3 wk after exposure), EKG, adequacy of respirations & oxygenation, and liver and kidney function. *BEIs:* C_2Cl_4 in expired air (10 ppm), sample prior to last shift of work week; C_2Cl_4 in blood (1 mg/L), sample prior to last shift of work week; trichloroacetic acid in urine (7 mg/L), sample at end of workweek.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources (although noncombustible, it forms toxic vapors from thermal decomposition). For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of spill and await reclamation or disposal. Report any release in excess of 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, perchloroethylene evaporates and some leaches to groundwater. It may absorb slightly to soils with heavy organic matter. Biodegradation may be important in anaerobic soils. In water, it is subject to rapid volatilization with an estimated half-life from <1 day to several weeks. In air, it exists mainly in the vapor-phase and is subject to photooxidation with a half-life of 30 minutes to 2 months. **Ecotoxicity Values:** Guppy (*Poecilia reticulata*), LC_{50} = 18 ppm/7 days; fathead minnow (*Pimephales promelas*), LC_{50} = 18.4 mg/L/96 hr, flow through bioassay. **Disposal:** Consider recovery by distillation. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) or fluidized bed incineration at 842 to 1796 °F (450 to 980 °C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U210
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per CWA Sec. 307 (a)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear a faceshield (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a supplied-air respirator or SCBA with a full facepiece operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, Neoprene, or Viton to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from sunlight, and incompatibles. Do not store sludge from vapor degreasers in tightly-sealed containers and keep outside until disposal is arranged. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Check stabilizer levels frequently and ventilation equipment (air velocity, static pressure, air valve) at least every 3 months. Install an air dryer in ventlines to storage tanks to prevent moisture from rusting and weakening the tank and contaminating or discoloring its contents. Purge all tanks before entering for repairs or cleanup. Build a dike around storage tanks capable of containing all the liquid. Ground tanks to prevent static electricity. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize liver, kidney, and nervous system function, and the skin. Alcoholism may be a predisposing factor.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Tetrachloroethylene
DOT Hazard Class: 6.1
ID No.: UN1897
DOT Packing Group: III
DOT Label: Keep away from food
Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 355
Phenol

Issued: 9/80 Revision: C, 11/90

Section 1. Material Identification

33

Phenol (C_6H_5OH) Description: One of many aromatic compounds in coal tar. Made by alkylating benzene with propylene then oxidizing the resulting cumene to produce phenol and acetone. Used as a feedstock in manufacturing various phenolic resins, caprolactum, bis-phenol-A, and other chemicals and drugs; a disinfectant; a fuel-oil sludge inhibitor; a reagent in chemical analysis; in producing or manufacturing a large variety of aromatic compounds including fertilizers, illuminating gas, coke, explosives, lampblack, paints, paint removers, asbestos goods, wood preservatives, textiles, perfumes, bakelite, rubber, and other plastics; in medical and industrial organic compounds and dyes; and in germicidal paints and slimicides. Phenol has been identified in cigarette smoke and automobile exhaust.

Other Designations: CAS No. 0108-95-2, carbolic acid, hydroxybenzene, monohydroxy benzene, oxybenzene, phenic acid, phenyl alcohol, phenyl hydroxide.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: Phenol has a marked corrosive effect on any tissue. Eye contact may cause severe damage and *blindness*. Its primary entry route is through *skin absorption*. Systemic absorption may cause *liver and kidney damage, convulsions (seizures), or death.*

R 1
I 4
S 3*
K 2
* Skin absorption

NFPA

HMIS
H 3
F 2
R 0
PPG†
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Phenol, ca 100%

1989 OSHA PEL (Skin)
8-hr TWA: 5 ppm, 19 mg/m³

1990-91 ACGIH TLV (Skin)
TWA: 5 ppm, 19 mg/m³

1988 NIOSH REL
TWA: 5 ppm, 19 mg/m³
Ceiling: 15.6 ppm, 60 mg/m³

1985-86 Toxicity Data*
Mammal, inhalation, LC_{50}: 74 mg/m³
Rat, oral, LD_{50}: 317 mg/kg; toxic effects include behavorial changes (convulsions or effect on seizure threshold)
Rabbit, eye, TC_{Lo}: 5 mg produces severe irritation

1987 IDLH Level
250 ppm

* See NIOSH, *RTECS* (SJ3325000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 359.15 °F (181.75 °C) at 760 mm Hg
Melting Point: 109.4 °F (43 °C)
Vapor Pressure: 0.3513 mm Hg at 77 °F (25 °C)
Vapor Density (Air = 1): 3.24
pH: 6 (aqueous solution)
Molecular Weight: 94.11
Specific Gravity (20 °C/4 °C): 1.0576
Water Solubility: 1 g dissolves in about 15 ml H_2O
Viscosity: 12.7 centipoise at 64.9 °F (18.3 °C)

Appearance and Odor: White crystalline solid with a characteristic sharp medicinal sweet, tangy odor detectable above 0.05 ppm. Phenol turns pink or red if it contains impurities or is exposed to heat or light.

Section 4. Fire and Explosion Data

Flash Point: 175 °F (79 °C), CC	Autoignition Temperature: 1319 °F (715 °C)	LEL: 1.7% v/v	UEL: 8.6% v/v

Extinguishing Media: Use water spray, carbon dioxide, dry chemical, or alcohol-type foam to extinguish fires involving phenol. Do not use a solid stream of water since the stream scatters and spreads fire. Use water spray to cool fire-exposed tanks/containers.

Unusual Fire or Explosion Hazards: Phenol presents a moderate fire hazard when exposed to heat, flame, or oxidizers. When heated, it emits toxic fumes and vapors that form explosive mixtures with air. Air mixtures containing 3 to 10% phenol are explosive. Solid phenol burns with difficulty, giving off heavy smoke.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. Be aware of runoff from fire control methods. Water containing phenol can cause severe chemical burns. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Phenol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: In general, phenol is incompatible with strong oxidizing agents and halogens. It coagulates colodion and proteins. A potentially explosive reaction occurs with formaldehyde, peroxydisulfuric acid, peroxymonosulfuric acid, sodium nitrite + heat, and aluminum chloride + nitromethane (at 110 °C/100 bar). A violent reaction occurs with butadiene, sodium nitrite + trifluoroacetic acid, and aluminum chloride + nitrobenzene at 248 °F (120 °C). Combining phenol with mineral oxidizing acids results in fire; with acetaldehyde results in violent condensation; with isocyanates results in heat generation and violent polymerization, with calcium hypochlorite results in an exothermic reaction producing toxic fumes which may ignite; and with nitrides results in heat and flammable gas generation. Hot phenol is corrosive to many metals, including aluminum, lead, magnesium, and zinc. Reaction with these materials causes phenol to discolor.

Conditions to Avoid: Avoid heating phenol above 122 °F (90 °C).

Hazardous Products of Decomposition: Thermal oxidative decomposition of phenol can produce oxides of carbon and water.

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list phenol as a carcinogen. Although no specific evidence of human cancer exists, its carcinogenicity to mice emphasizes the need for precaution when handling this material. Phenol also causes human mutations (genetic changes).

Summary of Risks: Phenol is a general protoplasmic poison that is corrosive to any living tissue it contacts. Toxicity most likely results from dermal (skin) contact or ingestion. Skin absorption occurs readily with a rapid onset of symptoms or death (within 30 min to several hours). Contact with eyes may cause severe damage and blindness. Ingestion of 1 g may be fatal. Although phenol is irritating to the respiratory tract, due to its low volatility and good warning properties, inhalation is typically less of a concern. Chronic toxic effects are uncommon, but may include digestive disturbances, neurological disorders, skin rash (dermatitis), and liver and kidney damage.

Medical Conditions Aggravated by Long-Term Exposure: Individuals with chronic respiratory disorders, pre-existing skin disorders, convulsive disorders, or kidney or liver abnormalities may be at increased risk from phenol exposure.

Target Organs: Liver, kidneys, nervous system, and skin.

Primary Entry Routes: Skin absorption, eye contact, ingestion, and inhalation.

Acute Effects: Skin contact results in white, wrinkled discoloration, followed by a severe burn or systemic poisoning if removed improperly.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Phenol ingestion can cause gangrene and corrosion of lips, mouth, throat, esophagus, and stomach if not properly decontaminated (see First Aid). Although not immediately painful, skin contact can cause serious burns and systemic toxicity. In addition to skin burns and respiratory tract irritation, systemic absorption may cause pallor, anorexia (appetite loss), nausea, vomiting, diarrhea, weakness, muscle aches, darkened urine, headache, tinnitus (ringing in ears), sweating, convulsions, cyanosis (bluish coloration of lips and/or fingertips), shock, unconsciousness, respiratory failure, and death. After ingestion, major percutaneous (skin), or inhalation exposures, collapse and death can be rapid. Ingestion can cause severe tissue corrosion or gangrene affecting lips, mouth, throat, esophagus, and stomach. Eye contact can cause severe corrosive damage to the eye (conjunctival edema, corneal opacification, and hypesthesia) and possible blindness.

Chronic Effects: Chronic phenol poisoning is rarely reported. Symptoms include vomiting, difficulty swallowing, diarrhea, appetite loss, headache, fainting, dizziness, darkened urine, and mental disturbances. Chronic exposure can cause death from liver and kidney damage. Repeated skin contact with phenol or phenol-bearing products can result in dermatitis with dark pigmentation (ochronosis) of skin and whites of eyes (sclerae).

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician immediately.

Skin: Speedy action is critical. Flood exposed area with water and quickly remove contaminated clothing. *As soon as possible*, repeatedly spray or swab with the decontaminating agent polyethyleneglycol-300 (PEG). Immerse extremities in PEG. Rescue personnel should protect themselves from skin contact with phenol. Do not use greases, powders, or ointments to treat phenol burns. *Never* delay phenol removal if PEG is not readily available. Use soap and water instead.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: *Speed is essential in the treatment of oral poisoning.* Immediately consult a physician and poison center. Never give anything by mouth to an unconscious or convulsing person. Administer to that *conscious* person 15 to 30 cc castor oil or another vegetable oil, and be prepared to induce vomiting upon a physician's advice. Vegetable oils slow phenol absorption and reduce local damage.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treat ingestion with gastric lavage using 40% aqueous Bacto-Peptone, milk, or water until phenolic odor is eliminated. Then give 15 to 50 cc castor or vegetable oil. Debride necrotic skin. Monitor vital signs, fluid status, electrolytes, BUN, renal and hepatic function, and electrocardiogram. Manage sedation, seizures, renal failure, and fluid electrolyte imbalances symptomatically as indicated.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and skin and eye contact with a self-contained breathing apparatus and full personal protective clothing and equipment. Absorb small spills with some noncombustible inert material and place in a closed metal container for disposal. Dike large spills and allow material to cool and solidify. Using nonsparking tools, shovel solid into steel containers for disposal. Thoroughly flush spill area with water, use caustic soda solution for neutralization, and collect flushings and wash water for disposal. Do not allow phenol to enter sewers, watersheds, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120). Notify proper authorities including the National Response Center (800-424-8802).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4), Sec. 307(a), and per RCRA, Sec. 3001]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355): RQ, 1000 lb; Threshold Planning Quantity (TPQ), 500/10,000 lb

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Where potential exists for exposures near or over 19 mg/m^3, use a MSHA/NIOSH-approved full facepiece respirator with an organic vapor cartridge/canister and dust/mist prefilter. Increased protection is obtained from full facepiece powered-air purifying respirators. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. ACGIH recommends neoprene or butyl rubber as good-to-excellent protective materials.

Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heated surfaces, open flame, and ignition sources. Outside or detached storage is preferred. Protect containers from physical damage.

Engineering Controls: Enclose all operations, eliminating all possible phenol exposure routes. Educate workers about phenol's hazards and potential dangers. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Provide local exhaust ventilation at the site of chemical release. Practice good personal hygiene and housekeeping procedures.

Medical Surveillance: Provide preplacement or periodic medical examinations that emphasize central nervous system (CNS), hepatic, renal, and skin. Tests should include BUN, creatinine, LFTs, and urinalysis. Phenol can be detected in urine in free or conjugated forms. The ACGIH biological exposure index (BEI) is 250 mg total phenol/g creatinine or 15 mg/hr.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Phenol	**IMO Shipping Name:** Phenol
DOT Hazard Class: Poison B	**IMO Hazard Class:** 6.1
ID No.: UN1671	**ID No.:** UN1671
DOT Label: Poison	**IMO Label:** Poison
DOT Packaging Exceptions: 173.364	**IMDG Packaging Group:** II
DOT Packaging Requirements: 173.369	

MSDS Collection **References:** 1, 2-12, 15, 19, 23, 24, 26, 31, 34, 37, 38, 59, 73, 79, 84, 85, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138-140, 143, 146, 148, 149

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 66

PHOSGENE
(Revision B)
Issued: May 1980
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION 25

Material Name: PHOSGENE

Description (Origin/Uses): Used as an intermediate in the manufacture of chemicals like isocyanates; carbamates; organic carbonates and chloroformates; and related resins, pesticides, herbicides, and dyes; formerly used as a military poison gas.

Other Designations: Carbonyl Chloride; Carbon Oxychloride; Chloroformyl Chloride; $COCl_2$; NIOSH *RTECS* No. SY5600000; CAS No. 0075-44-5

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS
H 4
F 0
R 0
PPG*
*See sect. 8

R 1
I 4
S 3
K 0

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Phosgene, CAS No. 0075-44-5	ca 100	IDLH* Level: 2 ppm **OSHA PEL** 8-Hr TWA: 0.1 ppm, 0.4 mg/m³ **ACGIH TLV, 1987-88** TLV-TWA: 0.1 ppm, 0.4 mg/m³ **NIOSH REL** 10-Hr TWA: 0.1 ppm, 0.4 mg/m³ 15-Min Ceiling: 0.2 ppm, 0.8 mg/m³ **Toxicity Data**** Human, Inhalation, LC_{50}: 3200 mg/m³ Man, Inhalation, LC_{Lo}: 360 mg/m³ (30 Min) Human, Inhalation, TC_{Lo}: 25 ppm (30 Min)

*Immediately dangerous to life and health
**See NIOSH, *RTECS*, for additional data.

SECTION 3. PHYSICAL DATA

Boiling Point: 47°F (8°C)
Vapor Density (Air = 1): 3.4
Water Solubility: Phosgene is slightly soluble in and slowly hydrolized by water.

Molecular Weight: 99 Grams/Mole
Vapor Pressure: 1215 Torrs at 68°F (20°C)

Appearance and Odor: An easily liquefied colorless gas; odor resembles that of newly mown hay. **Danger:** Rapid olfactory fatigue occurs, so do not rely on odor as a warning signal. Leave the area immediately when odor is first detected.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
*	*	% by Volume	*	*

Extinguishing Media: *Phosgene does not burn. Use agents that will put out the surrounding fire. If it is safe, try to remove phosgene cylinders from the fire. Use a water spray to protect persons attempting this removal and to cool fire-exposed containers. Continue to cool phosgene cylinders and/or holding tanks well after the fire is out to prevent pressure ruptures.

Unusual Fire or Explosion Hazards: Treat any fire situation in which phosgene is involved as an emergency. This gas is more than three times as dense as air, so it will collect in low-lying areas such as sumps, wells, and underground piping systems and could remain there for extended periods of time. Use extreme caution in these areas as well as in the fire area itself.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Fire fighters must use the maximum personal protective equipment available to safely extinguish phosgene fires from an explosion-proof or remote location. If possible, operate extinguishing agents from unmanned locations.

SECTION 5. REACTIVITY DATA

Phosgene is stable in closed, pressurized containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous reactions involving phosgene with isopropanol and metals like sodium, potassium, and aluminum have been reported.

Conditions to Avoid: Do not expose this material to heat when it is liquefied under pressure in storage tanks or cylinders because it may explode. Avoid direct exposure to incompatible chemicals or to sources of ignition such as open flame, lighted tobacco products, electric sparks, and unprotected heaters.

Hazardous Products of Decomposition: When heated to decomposition, phosgene readily emits toxic gases such as carbon monoxide (CO). Phosgene itself is a very hazardous material. Always use it in a carefully supervised manner to ensure safe working conditions.

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SECTION 6. HEALTH HAZARD INFORMATION

Phosgene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: This material is a very poisonous gas that attacks the upper respiratory tract (URT). **Warning:** The onset of serious respiratory effects, including life-threatening pulmonary edema, may be substantially delayed from the time of the initial exposure (periods from 2 to 24 hours have been reported). When inhaled, it is slowly hydrolized to hydrochloric acid (HCl) and carbon dioxide (CO_2). Symptoms of exposure to this gas may progress to cyanosis (bluish coloration of the skin due to lack of oxygen); whether or not fatal pulmonary edema occurs depends upon the specifics of the exposure. **Medical Conditions Aggravated by Long-Term Exposure:** Existing ailments of the respiratory system may be worsened by long-term exposure to phosgene. Preplacement and periodic medical exams emphasizing the lungs are strongly recommended for workers who handle it.
Target Organs: Skin, eyes, and URT. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Severe irritation of the URT, wheezing and difficulty in breathing; skin and eye burns. **Chronic Effects:** Emphysema, fibrosis, and other respiratory deficiencies.
FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water. Treat exposed person for chemical skin burns as required. Remove clothing under a deluge safety shower. **Inhalation.** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. A medically trained person should administer oxygen to him or her. Observe exposed person for delayed pulmonary effects. **Ingestion.** This type of exposure to phosgene is highly unlikely because it is a gas.

Treat any exposure to phosgene as an emergency! GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. Any worker exposed to phosgene must be medically observed for at least 24 hours to monitor developing symptoms. Caution: Rescuers must use protective equipment!

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any phosgene spill or leak as an emergency.* Preplan for emergency exposure and instruct workers in details of emergency-response measures. Notify safety personnel, evacuate all nonessential personnel, provide maximum ventilation, keep upwind of the spill or leak, and be particularly careful to stay out of low-lying areas. Cleanup personnel must wear protection against contact with and inhalation of vapor (see sect. 8). Sodium hydroxide or anhydrous ammonia have been used to neutralize phosgene leaks. Do not spray the spill or leak with water because this increases vaporization and release of the phosgene. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. P095
CERCLA Hazardous Substance, Reportable Quantity: 10 lbs (4.54 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious butyl, neoprene, or PVC gloves; boots; aprons; and clean, impervious, body-covering clothing to prevent any possibility of skin contact. **Ventilation:** Install and operate general and local ventilation systems that are powerful enough to maintain airborne levels of phosgene below the OSHA PEL standard cited in section 2. All ventilation systems must be of maximum explosion-proof design (e.g., nonsparking, electrically grounded and bonded, etc.). **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Store emergency equipment, clothing, and respirators just outside the area where this gas is being used.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store phosgene in a cool, dry, well-ventilated area away from oxidizing agents, sources of ignition, and incompatible chemicals (see sect. 5). Use outside or detached storage. Store cylinders upright and secure them tightly.
Special Handling/ Storage: Phosgene is shipped and stored as a pressurized gas in cylinders and tank cars. Protect them from physical damage and inspect them regularly for cracks, leaks, or faulty valves. Electrically ground and bond all containers to prevent static sparks. Do not drag or slide cylinders; move them in a carefully supervised manner with a suitable hand truck. Prevent accidental moisture contamination of storage facilities. **Engineering Controls:** Phosgene must be used in closed engineering systems to prevent dispersion of gas into the work area. If the particular work area warrants it, consider installing an automatic air-monitoring system to detect excessive levels of gas. **Comments:** A sustained, conscientious effort by all workers who use phosgene is required to ensure safe working conditions. Keep the valve-protection cap in place until immediately before use. Insert a check valve or trap into the transferral line to prevent a backflow into the original container. Use a pressure-reducing regulator when connecting a storage container to a lower-pressure piping system. A trained chemist or safety specialist familiar with the physical and chemical properties of phosgene should be present during all work operations.
Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Phosgene	**DOT Label:** Poison Gas	**IMO Class:** 2.3
DOT ID No. UN1076	**DOT Class:** Poison A	**IMO Label:** Poison Gas and Corrosive

References: 1, 2, 12, 73, 84-94, 100, 103.

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Material Safety Data Sheets Collection:

Sheet No. 683
Polychlorinated Biphenyls (PCBs)

Issued: 11/88 Revision: A, 9/92

Section 1. Material Identification 39

Polychlorinated Biphenyls [$C_{12}H_{10-n}Cl_n$ (n=3, 4, 5)] Description: A class of nonpolar chlorinated hydrocarbons with a biphenyl nucleus (two benzene nuclei connected by a single C-C bond) in which any or all of the hydrogen atoms have been replaced by chlorine. Commercial PCBs are mixtures of chlorinated biphenyl isomers with varying degrees of chlorination. Prepared industrially by the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst such as ferric chloride or iron filings. Except for limited research and development applications, PCBs have not been produced in the US since 1977. When large quantities of PCBs were manufactured in the US, they were marketed under the tradename Aroclor (Monsanto) and were characterized by four digit numbers. The first two digits indicating biphenyls (12), triphenyls (54), or both (25, 44); the last two digits indicating the weight percent of chlorine. PCBs' thermal stability, nonflammability, and high dielectric capability made them very useful in electrical equipment. Formerly used as additives in hydraulic fluids, heat transfer systems, lubricants, cutting oils, printer's ink, fire retardants, asphalt, brake linings, automobile body sealants, plasticizers, adhesives, synthetic rubber, floor tile, wax extenders, dedusting agents, pesticide extenders, and carbonless reproducing paper. PCBs are still used in certain existing electrical capacitors and transformers that require enhanced electrical protection to avoid heating from sustained electric faults.

Other Designations: CAS No. 1336-36-3, Aroclor, Clophen, Chlorextol, chlorinated biphenyls, chlorinated diphenyl, chlorinated diphenylene, chloro biphenyl, chloro-1,1-biphenyl, Dykanol, Fenclor, Inerteen, Kaneclor, Montar, Noflamol, Phenoclor, Pyralene, Pyranol, Santotherm, Sovol, Therminol FR-1

R 1
I 4
S 3*
K 1
* Skin absorption

NFPA
1 2 0 –

HMIS
H 2‡
F 1
R 0
PPE†
† Sec. 8
‡ Chronic Effects

Cautions: PCBs are potent liver toxins that may be absorbed through skin. Potentially, chronic or delayed toxicity is significant because PCBs accumulate in fatty tissue and may reasonably be anticipated to be carcinogens. PCBs are a bioaccumulative environmental hazard. When burned, decomposition products may be more hazardous than the PCBs.

Section 2. Ingredients and Occupational Exposure Limits

PCBs, contain various levels of polychlorinated dibenzofurans and chlorinated naphthalenes as contaminants

1991 OSHA PELs, Skin
8-hr TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
8-hr TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

1990 DFG (Germany) MAK, Danger of Cutaneous Absorption
TWA (Chlorodiphenyl, 42% chlorine): 0.1 ppm (1 mg/m^3)
Category III: Substances with systemic effects, onset of effect > 2 hr., half-life > shift length (strongly cumulative)
Short-term Level: 1 ppm, 30 min., average value, 1 per shift

TWA (Chlorodiphenyl, 54% chlorine): 0.05 ppm (0.5 mg/m^3)
Category III: (see above)
Short-term Level: 0.5 ppm, 30 min., average value, 1 per shift

1985-86 Toxicity Data*
Rat, oral, TD: 1250 mg/kg administered intermittently for 25 weeks produced liver tumors.
Mammal, oral, TD_{Lo}: 325 mg/kg administered to female for 30 days prior to mating and from the 1st to the 36th day of gestation produced effects on newborn (stillbirth; live birth index; viability index).

1990 NIOSH REL
TWA (Chlorodiphenyl, 42% chlorine): 0.001 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.001 mg/m^3

1992-93 ACGIH TLVs, Skin *
TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

* These guidelines offer reasonably good protection against systemic intoxication, but may not guarantee that chloroacne won't occur.
† See NIOSH, *RTECS* (TQ1350000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: 644-707 °F (340-375 °C)
Melting Point: 42%: -2.2 °F (-19°C); 54%: 14 °F (-10 °C)
Vapor Pressure: 1 mm Hg at 100 °F (38 °C); 10^{-6} to 10^{-3} mm at 20 °C
Molecular Weight: 188.7 to 398.5

Specific Gravity: 1.3 to 1.8 at 20 °C
Water Solubility: Low solubility (0.007 to 5.9 mg/L)
Other Solubilities: Most common organic solvents, oils, and fats; slightly soluble in glycerol and glycols.

Appearance and Odor: PCBs vary from mobile oily liquids to white crystalline solids and hard non-crystalline resins, depending upon chlorine content.

* Physical and chemical properties vary widely according to degree and to the position of chlorination.

Section 4. Fire and Explosion Data

Flash Point: 286-385 °F (141-196 °C) OC*	Autoignition Temperature: 464 °F (240 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing media suitable to the surrounding fire. Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water spray may be ineffective. Use water spray to cool fire-exposed containers or transformers. Do not scatter PCBs with high-pressure water streams. **Unusual Fire or Explosion Hazards:** Combustion products (hydrogen chloride, phosgene, polychlorinated dibenzofurans, and furans) are more hazardous than the PCBs themselves. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Approach fire from upwind to avoid highly toxic decomposition products. Structural firefighter's protective clothing will provide *limited* protection. Do not release runoff from fire control methods to sewers or waterways. Dike for later disposal.

* Flash points shown are a range for various PCBs. Some forms do not have flash points.

Section 5. Reactivity Data

Stability/Polymerization: PCBs are very stable materials but are subject to photodechlorination when exposed to sunlight or UV (spectral region above 290 nanometers). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** PCBs are chemically inert and resistant to oxidation, acids, and bases. **Conditions to Avoid:** Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition [1112-1202 °F (600-650 °C)] of PCBs can produce highly toxic derivatives, including polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), hydrogen chloride, phosgene and other irritants.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] and NTP[169] list PCBs as an IARC probable carcinogen (overall evaluation is 2A; limited human data; sufficient animal data) and NTP anticipated carcinogen, respectively. **Summary of Risks:** PCBs are potent liver toxins that can be absorbed through unbroken skin in toxic amounts without immediate pain or irritation. PCBs have low acute toxicity, but can accumulate in fatty tissue and severe health effects may develop later. Generally, toxicity increases with a higher chlorine content; PCB-oxides are more toxic. The toxic action on the liver also increases with simultaneous exposure to other liver toxins, e.g. chlorinated solvents, alcohol, and certain drugs. Pathological pregnancies (abnormal pigmentations, abortions, stillbirths, and underweight births) have been associated with increased PCB serum levels in mothers; PCBs can be passed in breast milk. PCBs can affect the reproductive system of adults. **Medical Conditions Aggravated by Long-Term Exposure:** Skin, liver, and respiratory disease. **Target Organs:** Skin, liver, eyes, mucous membranes, and respiratory tract. **Primary Entry Routes:** Inhalation, dermal contact, ingestion. **Acute Effects:** Exposure to PCB vapor or mist is severely irritating to the skin, eyes, nose, throat, and upper respiratory tract. Intense acute exposure to high concentrations may result in eye, lung, and liver injury. Systemic effects include nausea, vomiting, increased blood pressure, fatigue, weight loss, jaundice, edema and abdominal pain. Cognitive, neurobehavior and psychomotor impairment and memory loss have also been seen after acute exposure. **Chronic Effects:** Repeated exposure to PCBs can cause chloroacne; redness, swelling, dryness, thickening and darkening of the skin and nails; swelling and burning of the eyes, and excessive eye discharge; distinctive hair follicles; gastrointestinal disturbances; neurological symptoms including headache, dizziness, depression, nervousness, numbness of the extremities, and joint and muscle pain; liver enlargement; menstrual changes in women; and chronic bronchitis. Cancer, primarily liver, is also a possible result of exposure, but data is inconclusive.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Rinsing eyes with medical oil (olive, mineral) initially may remove PCB and halt irritation better than water rinsing alone. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. *Multiple soap and water washings are necessary.* Avoid the use of organic solvents to clean the skin. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** In most cases, accidental PCB ingestion will not be recognized until long after vomiting would be of any value. Never give anything by mouth to an unconscious or convulsing person. Vomiting of the pure substance may cause aspiration. Consult a physician. **Note to Physicians:** Monitor patients for increased hepatic enzymes, chloroacne, and eye, gastrointestinal, and neurologic symptoms listed above. Diagnostic tests include blood levels of PCBs and altered liver enzymes.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and isolate hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. For small spills, take up with sand or other noncombustible material and place into containers for later disposal. For larger spills, dike far ahead of spill to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** PCBs have been shown to bio-concentrate significantly in aquatic organisms. **Ecotoxicity:** Bluegill, TLm: 0.278 ppm/96 hr. Mallard Duck, LD_{50}: 2000 ppm. **Environmental Degradation:** In general, the persistence of PCBs increases with an increase degree of chlorination. **Soil Absorption/Mobility:** PCBs are tightly absorbed in soil and generally do not leach significantly in most aqueous soil systems. However, in the presence of organic solvents, PCBs may leach rapidly through the soil. Volatilization of PCBs from soil may be slow, but over time may be significant. **Disposal:** Approved PCB disposal methods include: incineration with scrubbing, high-efficiency boilers, landfills, and EPA-approved alternative disposal methods. Each disposal method has various criteria. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 311(b)(4) and 307(a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Minimum respiratory protection should include a combination dust-fume-mist and organic vapor cartridge or canister or air-supplied, depending upon the situation. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Butyl rubber, neoprene, Teflon, and fluorocarbon rubber have break through times greater than 8 hrs. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Segregate contaminated clothing in such a manner so that there is no direct contact by laundry personnel. Implement quality assurance to ascertain the completeness of the cleaning procedures. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a closed, labelled, container in a ventilated area with appropriate air pollution control equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Inform employees of the adverse health effects associated with PCBs. Limit access to PCB work areas to authorized personnel. Consider preplacement and periodic medical examinations with emphasis on the skin, liver, lung, and reproductive system. Monitor PCB blood levels. Consider possible effects on the fetus. Keep medical records for the entire length of employment and for the following 30 yrs.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Polychlorinated biphenyls
DOT Hazard Class: 9
ID No.: UN2315
DOT Packing Group: II
DOT Label: CLASS 9
Special Provisions (172.102): 9, N81

Packaging Authorizations
a) **Exceptions:** 173.155
b) **Non-bulk Packaging:** 173.202
c) **Bulk Packaging:** 173.241

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 100 L
b) **Cargo Aircraft Only:** 220 L

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** 34

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 163, 164, 168, 169, 174, 175, 180

Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy MPH, CIH; **Medical Review:** AC Darlington, MD

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 677

1,1,2,2-TETRACHLOROETHANE

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION

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Material Name: 1,1,2,2-TETRACHLOROETHANE

Description (Origin/Uses): Used as a solvent primarily for cleaning and extraction procedures and as a chemical intermediate in the manufacture of trichloroethylene and tetrachloroethylene; and as an analytic reagent by textile manufacturers in polymer characterization tests.

Other Designations: Acetylene Tetrachloride; *sym*-Tetrachloroethane; $CHCl_2CHCl_2$; CAS No. 0079-34-5

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Genium

HMIS			
H	2	R	1
F	0	I	4
R	0	S	–
PPG*		K	–

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
1,1,2,2-Tetrachloroethane, CAS No. 0079-34-5	Ca 100	**OSHA PEL (Skin*)** 8-Hr TWA: 1 ppm, 7 mg/m³ **ACGIH TLV (Skin*), 1988-89** TLV-TWA: 1 ppm, 7 mg/m³ **Toxicity Data**** Human, Oral, TD_{Lo}: 30 mg/kg Human, Inhalation, TC_{Lo}: 1000 mg/m³ (30 Mins) Rat, Oral, LD_{50}: 800 mg/kg

*This material can be absorbed through intact skin, which contributes to overall exposure.
**See NIOSH, *RTECS* (KI8575000), for additional data with references to reproductive, tumorigenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 295°F (146°C)
Melting Point: -47°F (-44°C)
% Volatile by Volume: Ca 100
Vapor Pressure: 6 Torrs at 77°F (25°C)*
Molecular Weight: 168 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 1.58658 at 77°F (25°C)

Appearance and Odor: A colorless, nonflammable, heavy, mobile liquid; sweetish, suffocating, characteristic chloroform odor. The odor recognition threshold is reported to be less than 3 ppm.

*At 77°F (25°C) the concentration of 1,1,2,2-tetrachloroethane in saturated air is approximately 7900 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature*	LEL*	UEL*

Extinguishing Media: *1,1,2,2-Tetrachloroethane does not burn. Use extinguishing agents that will put out the surrounding fire. **Unusual Fire or Explosion Hazards:** None reported. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode to protect against the effects of the nearby fire.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: 1,1,2,2-Tetrachloroethane is stable in closed containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Hazardous reactions between 1,1,2,2-tetrachloroethane and 2,4-dinitrophenyl disulfide, nitrogen tetroxide, chemically active metals such as potassium; and strong caustics such as potassium hydroxide, sodium, sodium-potassium alloy, hot iron, aluminum, and zinc in the presence of steam are reported. **Conditions to Avoid:** Prevent exposure to the incompatible chemicals listed above. Contact with water causes appreciable hydrolysis that will degrade and decompose this liquid. **Hazardous Products of Decomposition:** Thermal-oxidative degradation of 1,1,2,2-tetrachloroethane can produce highly toxic gases such as carbon monoxide (CO) and oxides of chlorine (ClO_x).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: NIOSH lists 1,1,2,2-tetrachloroethane as a carcinogen.
Summary of Risks: 1,1,2,2-Tetrachloroethane is absorbed through intact skin in significant amounts; one human fatality has been attributed to this route of exposure. This liquid is considered to be one of the most toxic of the common chlorinated hydrocarbons, particularly with respect to the liver. Severely acute exposure causes depression of the central nervous system (CNS), which can cause death within 12 hours. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, CNS, gastrointestinal system, liver, and kidneys. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** The initial symptoms of exposure are lacrimation, salivation, and irritation of the nose and throat; continued exposure can lead to nausea, vomiting, and narcosis. Also, low blood pressure and cardiac rhythm abnormalities; respiratory depression; nausea, vomiting, burns of the esophagus, and diarrhea; and anesthesia with dizziness leading to loss of consciousness and coma; plus possible transient liver and kidney changes. **Chronic Effects:** The two sets of manifestations are (1) malaise, drowsiness, decreased appetite, then nausea and retching, a bad taste in the throat, constipation, headache, pale stools, jaundice, and dark urine, as well as mental confusion, stupor, and coma; and (2) hand

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SECTION 6. HEALTH HAZARD INFORMATION, cont.

tremors, sensation of deafness, numbness in hands and feet, a decrease in reflexes, headache, and nausea. FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected areas with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Keep the exposed person warm and at rest until medical help is available. **Ingestion.** Unlikely. Should this type of exposure occur, give the exposed person 3 glasses of water to drink and induce vomiting, then repeat this procedure. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Workers exposed to this liquid should be evaluated with a full battery of tests for the liver, kidneys, and CNS systems, as well as the blood.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, and provide adequate ventilation. Cleanup personnel must be properly clothed and equipped to protect the skin and eyes against any contact with the liquid as well as inhalation of its vapor (see sect. 8). Vacuum the spilled 1,1,2,2-tetrachloroethane and pump it into suitable containers for disposal. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Waste, No. U209
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a); and the Resource Conservation and Recovery Act (RCRA), § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of this liquid is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent skin contact with this liquid. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale 1,1,2,2-tetrachloroethane vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store 1,1,2,2-tetrachloroethane in closed, airtight containers in a cool, dry, well-ventilated area away from incompatible chemicals (see sect. 5). **Special Handling/Storage:** Provide storage areas with adequate ventilation to prevent concentrations of the vapor from building up beyond the occupational exposure limits cited in section 2.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Tetrachloroethane
DOT Hazard Class: ORM-A
ID No. UN1702
DOT Packaging Requirements: 49 CFR 173.620
DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: 1,1,2,2-Tetrachloroethane
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II

References: 1, 38, 84-94, 100, 116, 117, 120, 122.

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Material Safety Data Sheets Collection:

Sheet No. 317
Toluene

Issued: 8/79 Revision: E, 9/92

Section 1. Material Identification

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Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.

Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

R 1
I 3
S 2*
K 3
* Skin absorption

NFPA: 3 / 2 / 0 / -

HMIS
H 2- Chronic effects
F 3
R 0
PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m^3)
15-min STEL: 150 ppm (560 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m^3)
STEL: 150 ppm (560 mg/m^3)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m^3)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m^3)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinations, and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 °F (110.6 °C)
Melting Point: -139 °F (-95 °C)
Molecular Weight: 92.15
Density: 0.866 at 68 °F (20/4 °C)
Surface Tension: 29 dyne/cm at 68 °F (20 °C)
Viscosity: 0.59 cP at 68 °F (20 °C)
Refraction Index: 1.4967 at 20 °C/D

Water Solubility: Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 °F (20 °C); 36.7 mm Hg at 86 °F (30 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0797 lb/ft^3 or 1.2755 kg/m^3
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 °F (4.4 °C) CC	Autoignition Temperature: 896 °F (480 °C)	LEL: 1.27% v/v	UEL: 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/min and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact with heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list toluene as a carcinogen. **Summary of Risks:** Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm^2/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to its lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia with biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palpebral fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluene causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next page

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Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, kidney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and symptoms associated with inhalation. **Chronic Effects:** Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and alcohol intolerance. Repeated heavy exposure may result in encephalopathies (cerebellar ataxia and cognitive dysfunction), liver enlargement, and kidney dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend. **FIRST AID** **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. **Note to Physicians:** Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/g creatinine); Toluene in venous blood, sample at shift end (1.0 mg/L).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dike far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 °F (450 to 980 °C), rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C), or liquid injection incineration at 1202 to 2912 °F (650 to 1600 °C). Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Blue gill, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 36.2 mg/L/96 hr. **Environmental Degradation:** If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photochemically produced hydroxyl radicals. **Disposal:** Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
[* per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307 (a)]
Listed as a SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 100 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 200 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facepiece, or any air-purifying respirator with a full facepiece having a chin-style, front or back mounted organic vapor canister. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove toluene from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquids warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, wells, storage tanks). Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Toluene	Packaging Authorizations	Quantity Limitations	Vessel Stowage Requirements
DOT Hazard Class: 3	a) Exceptions: 150	a) Passenger Aircraft or Railcar: 5L	Vessel Stowage: B
ID No.: UN1294	b) Non-bulk Packaging: 202	b) Cargo Aircraft Only: 60L	Other: --
DOT Packing Group: II	c) Bulk Packaging: 242		
DOT Label: Flammable Liquid			
Special Provisions (172.102): T1			

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; Industrial Hygiene Review: PA Roy, CIH, MPH; Medical Review: AC Darlington, MD, MPH

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Section 1. Material Identification

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Trichloroethylene (C_2HCl_3) Description: Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation. Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added. Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives; in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen). Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus).
Other Designations: CAS No. 79-01-6; acetylene trichloride; Algylen; Anamenth; Benzinol; Cecolene; Chlorylen; Dow-Tri; ethylene trichloride; Germalgene; Narcogen; Triasol; trichloroethene; TCE; 1,1,3-trichloroethylene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA
2 / 2 / 0 / -

HMIS
H 2†
F 2
R 0
PPE‡
† Chronic Effects
‡ Sec. 8

Cautions: TCE is irritating and toxic to the central nervous system (CNS). Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty.

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)].

1991 OSHA PELs
8-hr TWA: 50 ppm (270 mg/m^3)
15-min STEL: 200 ppm (1080 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
10-hr TWA: 25 ppm (~135 mg/m^3)

1992-93 ACGIH TLVs
TWA: 50 ppm (269 mg/m^3)
STEL: 200 ppm (1070 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 50 ppm (270 mg/m^3)
Category II: Substances with systemic effects
Half-life: 2 hr to shift length
Peak Exposure Limit: 250 ppm, 30 min average value; 2 peaks/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 160 ppm/83 min caused hallucinations and distorted perceptions.
Human, lymphocyte: 5 mL/L caused DNA inhibition.
Rabbit, skin: 500 mg/24 hr caused severe irritation.
Rabbit, eye: 20 mg/24 hr caused moderate irritation.
Mouse, oral, TD_{Lo}: 455 mg/kg administered intermittently for 78 weeks produced liver tumors.

* See NIOSH, *RTECS* (KX4550000), for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point: 189 °F (87 °C)
Freezing Point: -121 °F (-85 °C)
Viscosity: 0.0055 Poise at 77 °F (25 °C)
Molecular Weight: 131.38
Density: 1.4649 at 20/4 °C
Refraction Index: 1.477 at 68 °F (20 °C/D)
Odor Threshold: 82 to 108 ppm (*not an effective warning*)

Vapor Pressure: 58 mm Hg at 68 °F (20 °C); 100 mm Hg at 32 °F (0 °C)
Saturated Vapor Density (Air = 0.075 lbs/ft^3; 1.2 kg/m^3): 0.0956 lbs/ft^3; 1.53 kg/m^3
Water Solubility: Very slightly soluble; 0.1% at 77 °F (25 °C)
Other Solubilities: Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids.
Surface Tension: 29.3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor.

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC	Autoignition Temperature: 788 °F (420 °C)	LEL: 8% (25 °C); 12.5% (100 °C)	UEL: 10% (25 °C); 90% (100 °C)

Extinguishing Media: A Class 1C Flammable Liquid. Although it has a flash point of 90 °F, TCE burns with difficulty. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Vapor/air mixtures may explode when ignited. Container may explode in heat of fire. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection against TCE. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetraoxide, perchloric acid). Contact with 1-chloro-2,3-epoxy propane or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO_2) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). **Summary of Risks:** TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrythmias, and death due to cardiac arrest. Mild liver dysfunction was also seen at levels high enough to produce CNS effects. Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin. Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms. The euphoric effect of TCE has led to craving, and habitual sniffing of its vapors.

Continue on next page

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Section 6. Health Hazard Data, *Continued*

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown). There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects. TCE is eliminated unchanged in expired air and as metabolites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the nervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. **Skin** contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.
FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may inhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 µg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, *sample at end of workweek.* BEI = 4 mg/L (trichloroethanol) in blood, *sample at end of shift at end of the workweek.* These tests are not 100% accurate indicators of exposure; monitor TCE in expired air as a confirmatory test.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, LC_{50} = 44,700 µg/L/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 40.7 mg/L/96 hr. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a Log K_{oc} of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31): No. U228 & F002 (*spent solvent*)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles (cup-type or rubber framed, equipped with impact-resistant glass), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. At any detectable concentration, wear a SCBA with a full facepiece operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made from Viton or Neoprene to prevent skin contact. *Do not* use natural rubber or polyvinyl chloride (PVC). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers; small amounts in dark (amber) colored glass bottles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Trichloroethylene
DOT Hazard Class: 6.1
ID No.: UN1710
DOT Packing Group: III
DOT Label: Keep Away From Food
DOT Special Provisions (172.102): N36, T1

Packaging Authorizations
a) **Exceptions:** 173.153
b) **Non-bulk Packaging:** 173.203
c) **Bulk Packaging:** 173.241

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 60L
b) **Cargo Aircraft Only:** 220L

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MD

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Section 1. Material Identification

Vinyl Chloride (C_2H_3Cl) Description: Derived from ethylene dichloride and alcoholic potassium, by reaction of acetylene and hydrogen chloride (as gas or liquids), or by oxychlorination where ethylene reacts with hydrochloric acid and oxygen. Inhibitors such as butyl catechol, hydroquinone, or phenol are added to prevent polymerization. Used in the plastics industry for the production of polyvinyl chloride resins, in organic synthesis and formerly as a refrigerant, extraction solvent, and propellant (banned in 1974 because of its carcinogenic activity).

Other Designations: CAS No. 75-01-4, chloroethylene, chloroethene, ethylene monochloride, Trovidur, VC, VCM.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Vinyl chloride is a confirmed human carcinogen. Vapor inhalation leads to central nervous system (CNS) depression. The liquid can cause frostbite. It is a flammable gas at room temperature and polymerizes on exposure to air or sunlight. Avoid exposure to VC through engineering controls and wearing PPE

R	2	NFPA
I	4	
S	4	
K	4	

HMIS
H 3*
F 4
R 2
PPE - Sec. 8
* Chronic effects

Section 2. Ingredients and Occupational Exposure Limits

Vinyl Chloride, ca 98 to 99%. Impurities include water, acetaldehyde, hydrogen chloride, hydrogen peroxide, methyl chloride, butane, 1,3-butadiene, chlorophene, diacetylene, vinyl acetylene, and propine.

1991 OSHA PELs
8-hr TWA: 1 ppm
Ceiling: 5 ppm; OSHA-X

1990 NIOSH REL
NIOSH-X

1992-93 ACGIH TLV
TWA: 5 ppm (13 mg/m^3)
TLV-A1

1990 DFG (Germany) TRK*
Existing Installations: 3 ppm
MAK-A1

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: Intermittent exposure to 200 ppm for 14 yr caused liver tumors.
Man, inhalation, TC_{Lo}: 30 mg/m^3/5 yr caused spermatogenesis.
Human, inhalation, TC: Continuous exposure to 300 mg/m^3 for an undetermined number of weeks caused blood tumors.
Rat, oral, LD_{50}: 500 mg/kg; toxic effects not yet reviewed

* TRK (technical exposure limit) is used in place of MAK when a material is a carcinogen. Unlike an MAK below which no adverse effects are expected, the TRK is a limit set below which adverse effects may still occur. This is based on the theory that 1 molecule of a carcinogenic substance may still produce a tumor. The TRK is set to allow for an acceptable risk (for example, 1 tumor in 1 million persons may be an acceptable risk).
† See NIOSH, *RTECS* (KU9625000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 7 °F (-13.9 °C)
Freezing Point: -245 °F (-159.7 °C)
Molecular Weight: 62.5
Specific Gravity: 0.9106 at 68 °F (20 °C)
Ionization Potential: 9.99 eV
Refraction Index: 1.370 at 20 °C/D
Surface Tension: 23.1 dyne/cm at -4 °F (-20 °C)
Odor Threshold: 2000 to 5000 ppm*
Vapor Density (Air = 1): 2.155

Water Solubility: Slightly soluble, 0.1% at 77 °F (25 °C)
Other Solubilities: alcohol, benzene, carbon tetrachloride, ether, hydrocarbon and oils.
Vapor Pressure: 2530 mm Hg at 68 °F (20 °C), 400 mm Hg at -18.4 °F (-28 °C)
Critical Temperature: 304.7 °F (151.5 °C)
Critical Pressure: 56.8 atm
Viscosity: 0.01072 cP at 68 °F (20 °C), *gas*; 0.28 cP at -4 °F (-20 °C), *liquid*
Appearance and Odor: A gas at room temperature. Usually found as a compressed/cooled liquid. The colorless liquid forms a vapor with a pleasant ethereal odor.

*The actual vapor concentration that can be detected by humans has not been adequately determined and varies from one individual to another, from impurities, and probably from exposure duration. The odor threshold is not an accurate warning of exposure.

Section 4. Fire and Explosion Data

Flash Point: -108.4 °F (-78 °C) OC	Autoignition Temperature: 882 °F (472 °C)	LEL: 3.6% v/v	UEL: 33% v/v

Extinguishing Media: For small fires, use dry chemical or carbon dioxide. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Large fires can be practically inextinguishable. Vapors may travel to an ignition source and flash back. VC may polymerize in cylinders or tank cars and explode in heat of fire. Vapors pose an explosion hazard indoors, outdoors, and in sewers. VC decomposes in fire to hydrogen chloride, carbon monoxide, carbon dioxide, and phosgene. Burning rate = 4.3 mm/min. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Stop gas leak if possible. Let tank, tank car, or tank truck burn unless leak can be stopped. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if this is impossible, withdraw from area and let fire burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Long term exposure to air may result in formation of peroxides which initiates explosive polymerization of the chloride. VC can polymerize on exposure to light or in presence of a catalyst. **Chemical Incompatibilities:** VC can explode on contact with oxide of nitrogen, may liberate hydrogen chloride on exposure to strong alkalies, and is incompatible with copper, oxidizers, aluminum, and peroxides. In the presence of moisture, VC attacks iron and steel. **Conditions to Avoid:** Exposure to sunlight, air, heat, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of vinyl chloride can produce carbon oxides, and chloride gas.

Section 6. Health Hazard Data

Carcinogenicity: Vinyl chloride is listed as a carcinogen by the IARC (Class 1, *sufficient human evidence*),[164] NTP (Class 1, *sufficient human evidence*),[169] NIOSH (Class X, *carcinogen defined without further categorization*),[163] ACGIH (TLV-A1, *confirmed human carcinogen*),[163] DFG (MAK-A1, *capable of inducing malignant tumors in humans*),[163] and OSHA (Class X, *carcinogen defined without further categorization*).[164] Liver tumors (angiosarcomas) are confirmed from VC exposure. Other tumors of the CNS, respiratory system, blood, and lymphatic system have occurred from exposure to the polyvinyl chloride manufacture process but VC itself may not be the causative agent. **Summary of Risks:** Vapor inhalation causes varying degrees of CNS depression with noticeable anesthetic effects at levels of 1% (10,000 ppm). Studies have shown loss of libido and sperm in men exposed to VC and in Russian studies, 77% of exposed women experienced ovarian dysfunction, benign uterine growths, and prolapsed genital organs. However, no teratogenic effects have been seen in offspring of exposed workers.

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Section 6. Health Hazard Data, *continued*

It appears that metabolism is necessary before many of VC's toxic effects occur. Some vinyl chloride is exhaled unchanged but most is metabolized to chloroacetaldehyde. Skin absorption may occur if liquid is confined on skin but absorbed amount would be small. It is possible that the phenol inhibitor may be absorbed as well. The compressed liquid can cause frostbite. Vapors are severely irritating to the eyes. Chronic exposure can cause cancer and a triad of syndromes known as *vinyl chloride disease*. **Medical Conditions Aggravated by Long-Term Exposure:** Liver, cardiac, pulmonary, and connective tissue disorders. **Target Organs:** Liver, CNS, respiratory and lymphatic systems, bone, and connective tissue of the skin. **Primary Entry Routes:** Inhalation, skin/eye contact. **Acute Effects:** CNS effects include fatigue, headache, vertigo, ataxia, euphoria, visual disturbances, dulling of auditory cues, numbness and tingling in the extremities, narcosis, unconsciousness, and death due to respiratory failure. Respiratory problems include dyspnea, asthma, and pneumonoconiosis. **Chronic Effects:** Repeated exposure has lead to liver cancer; confirmed because of the otherwise rarity of its type (angiosarcoma). Tumors in other organs have occurred in the polyvinyl chloride industry but agents other than VC may be responsible; authorities are still debating this issue. A triad of other effects are associated with VC exposure. Acro-osteolysis is associated with hand cleaning of polymerization vessels and characterized by dissolution of bone in the hands, especially when associated with resorption. Raynaud's Phenomenon is a vascular disorder marked by recurrent spasm of the capillaries and especially those of the fingers and toes on exposure to cold. This is usually accompanied by pain and in severe cases may progress to local gangrene. Sclerodermatous skin changes (affecting the dorsal hands and distal forearms) are seen and described as a slowly progressive disease marked by deposition of fibrous connective tissue in the skin. The skin becomes thickened and raised nodules appear. Arthralgias (pain in one or more joints) and blood changes with decreased platelet number and capillary abnormalities may also occur.
FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. For frostbite, immerse affected area in 107.6 °F (42 °C) water until completely rewarmed. *Do not* use dry heat. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Unlikely! VC is a gas above 7 °F (-14°C). **Note to Physicians:** Endotracheal intubation may be required if significant CNS or respiratory depression occur. Diagnostic test: thiodiglycolic acid in urine (normally < 2 mg/g creatinine).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. If possible without risk, stop gas flow. Shut off ignition sources. Report any release > 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** VC reacts with hydroxyl radicals in the trophosphere with a half-life of 1.2 days. The half-life = a few hr in photochemical smog. Reaction products in the air include chloroacetaldehyde, hydrogen chloride, chloroethylene, epoxide, formaldehyde, formyl chloride, formic acid, and carbon monoxide. In soil, VC rapidly volatilizes. What does not evaporate will be highly mobile and may leach into groundwater. In water, VC is not expected to hydrolyze, bioconcentrate, or absorb to sediment. It will rapidly volatilize with an estimated half-life of 0.805 hr for evaporation from a river 1 meter deep with a current of 3 meter/sec and a wind velocity of 3 meter/sec. In waters containing photosensitizers such as humic acid, photodegradation will be rapid. **Soil Absorption/Mobility:** From an estimated solubility of 2,700 ppm, a Koc of 56 is established for VC which indicates high soil mobility and potential to leach into groundwater. **Disposal:** Dilute any waste compressed liquid to a 1% solution and remove phenol inhibitor as sodium. Pour onto vermiculite, sodium bicarbonate, or a sand & soda ash mixture (90/10). Add slaked lime if fluoride is present. Mix in paper boxes, place in incinerator, cover with scrap wood and paper, and ignite with excelsior train. Another method is to dissolve waste in a flammable solvent and spray in incinerator firebox equipped with an afterburner and alkali scrubber. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U043
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 307 (a); CAA, Sec. 112, & RCRA, Sec. 3001]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. According to NIOSH[148], for any detectable concentration use a SCBA or supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode. See 29 CFR 1910.1017 for detailed OSHA respirator recommendations. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton or chlorinated polyethylene to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL's (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate work clothes from street clothes, launder before reuse and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a cool, dry, well-ventilated area in clearly labeled containers. Outside or detached storage is preferred. Large amounts should be stored in steel containers under pressure. Keep separate from incompatibles (Sec. 5). Venting, under pressure should be safety relief. At atm, venting should be pressure vacuum. Regularly monitor inhibitor levels. To avoid static sparks, electrically ground and bond all equipment used with VC. Avoid open flames, spark formation and electric discharges around VC. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Install Class 1, Group D electrical equipment. **Administrative Controls:** Inform VC exposed personnel of hazards associated with its use. Preplacement and periodic medical exams of workers exposed above the action level is mandatory under OSHA 29 CFR (1910.017). Monitor for liver cancer, scleroderma, pneumonitis, clotting abnormalities, and acro-osteolysis.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Vinyl Chloride
DOT Hazard Class: 2.1
ID No.: UN1086
DOT Packing Group: --
DOT Label: Flammable Gas
Special Provisions (172.102): B44

Packaging Authorizations
a) **Exceptions:** 173.306
b) **Non-bulk Packaging:** 173.304
c) **Bulk Packaging:** 173.314 & 173.315

Quantity Limitations
a) **Passenger Aircraft or Railcar:** Forbidden
b) **Cargo Aircraft Only:** 150 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** B
b) **Other:** 40

***SDS Collection* References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 175
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 708
Vinylidene Chloride

Issued: 4/90

Section 1. Material Identification

Vinylidene Chloride Description: Prepared from ethylene chloride. Also prepared from vinyl chloride by successive chlorination and dehydrochlorination steps. Used primarily as a co-monomer in producing vinylidene copolymers (Saran®, Velon®) for films and coatings. Also used in producing methyl chloroform, vinyl chloride resins, plastics, chloracetyl chloride; in adhesives; as a component of synthetic fibers; a chemical intermediate in vinylidene fluoride synthesis; and for 1,1,1-trichloroethane. A common constituent in our environment, measurable quantities of vinylidene chloride are found in poorly ventilated areas with a high concentration of plastics. It is a notable contaminant in recycled air environments such as nuclear submarines and spacecraft.
Other Designations: CAS No. 0075-35-4; $C_2H_2Cl_2$; 1,1-DCE; 1,1-dichloroethene; *asym*-dichloroethylene; VDC; vinylidene dichloride.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.
Comment: At temperatures above 32 °F/0 °C and especially in the presence of oxygen or other suitable catalysts, vinylidene chloride polymerizes to a plastic. Therefore, commercial products may contain small proportions of inhibitors to preserve the monomer.

R 3
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NFPA
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HMIS
H 2
F 4
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Vinylidene chloride, ca 100%

OSHA PEL
8-hr TWA: 1 ppm, 4 mg/m³

ACGIH TLVs, 1989-90
TLV-TWA: 5 ppm, 20 mg/m³
TLV-STEL: 20 ppm, 79 mg/m³

NIOSH REL, 1987
None established

Toxicity Data*
Mouse, skin, TD_{Lo}: 4840 mg/kg has tumorigenic effects on skin, appendages, lungs, thorax, and respiration
Rat, inhalation, LC_{50}: 6350 ppm/4 hr
Human, inhalation, TC_{Lo}: 25 ppm produces changes in behavior (general anesthetic), the liver, kidney, ureter, and bladder

* See NIOSH, *RTECS* (YZ8061000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 89.1 °F/31.7 °C at 760 mm Hg
Melting Point: -188.5 °F/-122.5 °C
Vapor Pressure: 591 mm Hg at 77 °F/25 °C
Vapor Density (Air = 1): 3.4
Molecular Weight: 96.94 g/mol
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 1.2129 at 68 °F/20 °C
Water Solubility: Sparingly soluble (0.04 % wt/vol in water at 68 °F/20 °C)

Appearance and Odor: Colorless, volatile liquid with a mild, sweet odor that resembles chloroform. Most persons can detect vinylidene chloride at 1000 ppm, but others can detect it at less than 500 ppm. Neither odor is adequate to warn of excessive exposure.

Section 4. Fire and Explosion Data

Flash Point: -19 °F/-28 °C	Autoignition Temperature: 1058 °F/570 °C	LEL: 5.6% v/v	UEL: 11.4% v/v

Extinguishing Media: Use dry chemical, alcohol foam, or carbon dioxide. Use water to cool fire-exposed containers.
Unusual Fire or Explosion Hazards: Vinylidene chloride is a very flammable and volatile liquid with a burning rate of 2.7 mm/min. This material is a very dangerous fire hazard and moderately explosive when exposed to heat or flame. It may explode spontaneously since the vapor forms explosive mixtures with air. At elevated temperatures, polymerization may take place and containers may rupture.
Special Fire-fighting Procedures: Since vinylidene chloride may be poisonous if inhaled or absorbed through the skin, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode with a fully encapsulating suit. Keep unnecessary people away from the hazard area. Vapors may travel to an ignition source and flash back. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Vinylidene chloride is self-reactive. If stored between -40 °F/-40 °C and 77 °F/25 °C in air without an inhibitor, this material rapidly absorbs oxygen and forms a violently explosive peroxide. The heat of polymerization is -185 cal/g (inhibited). When unstable, vinylidene chloride decomposes into chlorine, hydrogen chloride, phosgene, and formaldehyde. Hazardous polymerization can occur if exposed to sunlight, air, copper, aluminum, or heat.
Chemical Incompatibilities: This material reacts violently with chlorosulfonic acid, nitric acid, and oleum; and vigorously with oxidizing materials.
Hazardous Products of Decomposition: Thermal oxidative decomposition of vinylidene chloride can produce highly toxic fumes of chlorine (Cl_2) and hydrogen chloride (HCl).

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists vinylidene chloride as a carcinogen, although the ACGIH suggests it is a suspected carcinogen. Various animal studies suggest a high rate of cancer in species-specific testing; application to humans does not appear valid.
Summary of Risks: Vinylidene chloride is an irritant to the skin, eyes, and mucous membranes, although any inhibitor in vinylidene chloride may partly cause the irritation. VDC is narcotic at concentrations greater than 4000 ppm, and has caused liver and kidney injury in experimental animals. Solutions containing the inhibitor MEHQ (monomethyl ether of hydroquinone) may cause leucoderma (white skin) and serious eye injury.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes, central nervous system, liver, and kidneys.
Primary Entry Routes: Inhalation.
Acute Effects: Inhalation of VDC causes narcosis and respiratory irritation. Concentrations of 4000 ppm lead to symptoms of drunkenness and eventually unconsciousness if the exposure continues. In monkey studies, exposure to 200 ppm caused acute liver injury with a mechanism similar to carbon tetrachloride. Animal studies indicate acute kidney changes in high-level exposures. Eye contact may cause conjunctivitis, transient corneal injury, and iritis. VDC also causes skin and mucous membrane irritation.
Chronic Effects: With chronic inhalation, vinylidene chloride may cause hepatic and renal dysfunction. In monkey studies, long-term inhalation at a 48-ppm level caused liver and kidney damage and death.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Solutions containing increased MEHQ concentrations are caustic and should not be removed by emesis. There is no specific treatment for VDC intoxication, but if significant amounts have been ingested, monitor the patient for liver and kidney failure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a vinylidene chloride spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel from hazard area, remove all heat and ignition sources, and ventilate area. Cleanup personnel should protect against inhalation and skin and eye contact. For lab spills, absorb the spill with paper towels and place in a hood to allow liquid to evaporate. For large spills, absorb bulk spill with cement powder, fly ash, sawdust, or commercial sorbents. Place waste in appropriate disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, Sec. 31 (b)(4), Sec. 307(a); per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Respiratory canisters containing alkaline materials should not be used because dichloro acetylene can be formed. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Rubber gloves are recommended.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLVs (Sec. 2). Local explosion-proof exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store vinylidene chloride in tanks with nickel, glass, or baked phenolic linings at 14 °F/-10 °C in the absence of light, air, water, and other polymerization initiators under a nitrogen blanket (at 10-psi pressure and an oxygen content less than 100 ppm). Outside or detached storage is preferable. If stored inside, store in a standard flammable liquids storage cabinet separate from oxidizing materials and incompatible materials (Sec. 5).
Engineering Controls: VDC requires special handling, precautions, and employee training. Do not handle VDC without adequate ventilation and personal protective gear. Limit exposures to vinylidene chloride by improving housekeeping procedures. Keep VDC away from all heat and ignition sources. All engineering systems should be of maximum explosion-proof design, electrically grounded, and bonded.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Vinylidene chloride, inhibited
DOT Hazard Class: Flammable liquid
ID No.: UN1303
DOT Label: Flammable liquid
DOT Packaging Requirements: 173.119
DOT Packaging Exceptions: 173.118

IMO Shipping Name: Vinylidene chloride, inhibited
IMO Hazard Class: 3.1
IMO Label: Flammable liquid
IMDG Packaging Group: I
ID No.: UN1303

MSDS Collection References: 7, 26, 38, 53, 73, 84, 85, 87, 89, 100, 103, 124, 126, 127, 129, 134, 136
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD M8

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Material Safety Data Sheets Collection:

Sheet No. 300
Acetone

Issued: 11/77 Revision: F, 9/92

Section 1. Material Identification

Acetone (CH_3COCH_3) Description: Derived by the dehydrogenation or oxidation of isopropyl alcohol with a metallic catalyst, the oxidation of cumene, the vapor phase oxidation of butane; and as a by-product of synthetic glycerol production. Used as a solvent for paint, varnish, lacquer, fat, oil, wax, resin, rubber, plastic, and rubber cement; to clean and dry parts of precision equipment; in the manufacture of chemicals (methyl isobutyl ketone, methyl isobutyl carbinol, methyl methacrylate, bisphenol-A, acetic acid (ketene process), mesityl oxide, diacetone alcohol, chloroform, iodoform, bromoform), explosives, aeroplane dopes, rayon, photographic films, isoprene; acetylene gas storage cylinders; in purifying paraffin; in nail polish remover; in the extraction of various principles from animal and plant substances; in hardening and dehydrating tissues; in cellulose acetate (especially as spinning solvent); as a solvent for potassium iodide and permanganate; as a delusterant for cellulose acetate fibers; in the specification testing of vulcanized rubber products.

Other Designations: CAS No. 67-64-1, AI3-01238, Chevron acetone, dimethylformaldehyde, dimethylketal, dimethyl ketone, β-ketopropane, methyl ketone, propanone, 2-propanone, pyroacetic acid, pyroacetic ether.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Acetone vapor is a dangerous fire and explosion hazard. High vapor concentrations may produce narcosis (unconsciousness). Prolonged or repeated skin contact causes dryness, irritation, and mild dermatitis.

R	1
I	1
S	1*
K	3

* Slight skin absorption

NFPA: 3 / 1 / 0 / –

HMIS
H 1
F 3
R 0
PPE*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Acetone, 99.5% plus 0.5% water

1991 OSHA PELs *
8-hr TWA: 750 ppm (1800 mg/m³)
15-min STEL: 1000 ppm (2400 mg/m³)

1990 IDLH Level
20,000 ppm

1990 NIOSH REL
TWA: 250 ppm (590 mg/m³)

1992-93 ACGIH TLVs
TWA: 750 ppm (1780 mg/m³)
STEL: 1000 ppm (2380 mg/m³)

1990 DFG (Germany) MAK
1000 ppm (2400 mg/m³)
Category IV: Substances eliciting very weak effects (MAK >500 mL/m³)
Peak: 2000 ppm, 60 min, momentary value†, 3 peaks/shift

1985-86 Toxicity Data ‡
Human, eye: 500 ppm
Human, inhalation, TC_{Lo}: 500 ppm produced olfaction effects, conjunctival irritation, and other changes involving the lungs, thorax, or respiration.
Rat, oral, LD_{50}: 5800 mg/kg altered sleep time and produced tremors.
Mammal, inhalation, TC_{Lo}: 31500 μg/m³/24 hr administered to pregnant female from the 1st to 13th day of gestation produced effects on fertility (post-implantation mortality).

* In the cellulose acetate fiber industry, enforcement of the OSHA TWA for "doffers" was stayed on 9/5/89 until 9/1/90; the OSHA STEL *does not* apply to that industry.
† Momentary value is a level which the concentration should never exceed.
‡ See NIOSH, *RTECS* (AL3150000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 133.2°F (56.2 °C) at 760 mm Hg
Freezing Point: -139.6 °F (-95.35 °C)
Vapor Pressure: 180 mm Hg at 68 °F (20 °C), 400 mm Hg at 103.1 °F (39.5 °C)
Saturated Vapor Density (Air = 1.2 kg/m³, 0.075 lb/ft³): 1.48 kg/m³, .093 lb/ft³
Refractive Index: 1.3588 at 20 °C
Appearance and Odor: Colorless, highly volatile liquid; sweetish odor.
Molecular Weight: 58.08
Specific Gravity: 0.7899 at 20 °C/4 °C
Water Solubility: Soluble
Other Solubilities: Alcohol, benzene, dimethyl formamide, chloroform, ether, and most oils.
Odor Threshold: 47.5 mg/m³ (low), 1613.9 mg/m³ (high)*

* Odor thresholds recorded as a range from the lowest to the highest concentration.

Section 4. Fire and Explosion Data

Flash Point: 0 °F (-18 °C), CC	Autoignition Temperature: 869 °F (465 °C)	LEL: 2.6% v/v	UEL: 12.8% v/v

Extinguishing Media: *Do not* extinguish fire unless flow can be stopped. For small fires, use dry chemical, carbon dioxide (CO_2), water spray or alcohol-resistant foam. For large fires, use water spray, fog, or alcohol-resistant foam. Use water in flooding quantities as fog because solid streams may be ineffective. **Unusual Fire or Explosion Hazards:** Acetone is a dangerous fire and explosion hazard; it is a Class IB flammable liquid. Vapors may travel to a source of ignition and flash back, fire-exposed containers may explode, and a vapor explosion hazard may exist indoors, outdoors, or in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides limited protection. If feasible, remove all fire-exposed containers. Otherwise, apply cooling water to sides of containers until well after fire is extinguished. If the fire becomes uncontrollable or container is exposed to direct flame, consider evacuation of a one-third mile radius. In case of rising sound from venting safety device or any discoloration of tank during fire, withdraw immediately. For massive cargo fires, use unmanned hose holder or monitor nozzles. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Acetone is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Acetone may form explosive mixtures with hydrogen peroxide, acetic acid, nitric acid, nitric acid + sulfuric acid, chromic anhydride, chromyl chloride, nitrosyl chloride, hexachloromelamine, nitrosyl perchlorate, nitryl perchlorate, permonosulfuric acid, thiodiglycol + hydrogen peroxide. Acetone reacts vigorously with oxidizing materials and ignites on contact with activated carbon, chromium trioxide, dioxygen difluoride + carbon dioxide, and potassium-*tert*-butoxide. Other incompatibles include air, bromoform, bromine, chloroform + alkalies, trichloromelamine, and sulfur dichloride. **Conditions to Avoid:** Keep acetone away from plastic eyeglass frames, jewelry, pens, pencils, and rayon garments. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of acetone can produce CO_2 and carbon monoxide (CO).

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list acetone as a carcinogen. **Summary of Risks:** Acetone has been placed among solvents of comparatively low acute and chronic toxicities. In industry, the most common effects reported are headache from prolonged vapor inhalation and skin irritation resulting from its defatting action. Exposures to less than 1000 ppm acetone vapor produces only slight eye, nose, and throat irritation. Acetone does not have sufficient warning properties to prevent repeated exposures. It is narcotic at high concentrations, i.e., above 2000 ppm. Concentrations above 12000 ppm cause loss of consciousness.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** Respiratory and central nervous systems, skin. **Primary Entry Routes:** Inhalation, skin and eye contact, ingestion. Liquid acetone is slowly absorbed through the skin. **Acute Effects:** Human systemic effects by inhalation include eye, nose and throat irritation; nausea and vomiting; changes in EEG (electroencephalogram) and carbohydrate metabolism; muscle weakness; drunken behavior; mental confusion and visual disturbance. In extreme cases, breathing high concentrations may produce coma. Human systemic effects by ingestion include gastrointestinal irritation, kidney damage (often indicated by albumin and red and white blood cells in the urine), liver damage (indicated by high levels of urobilin and early appearance of bilirubin), coma, metabolic changes, and systemic effects described for inhalation. Direct eye contact by liquid acetone may produce painful burning and stinging; watering of eyes; conjuctival inflammation; and corneal injury. Skin contact produces a cold feeling, dryness, and mild irritation.
Chronic Effects: Cases of chronic poisoning resulting from prolonged exposure to low concentrations of acetone are rare. Workers exposed to 1000 ppm, 3 hrs per day for 7-15 yrs, complained of dizziness, asthenia (lack or loss of strength), and chronic inflammation of the airways, stomach, and duodenum. Prolonged or repeated skin contact with liquid acetone may defat the skin and cause eczematoid dermatitis.
FIRST AID
Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing because it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air, monitor for respiratory distress, and administer 100% humidified supplemental oxygen as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. **After first aid, get appropriate in-plant, paramedic, or community medical support.**
Note to Physicians: In symptomatic patients, monitor serum and urine acetone, fluid intake, blood glucose, and arterial pH. Because of the prolonged elimination half-life of acetone, the symptomatic patient may need medical supervision for many hours (up to 30 hrs). Patients may develop hyperglycemia and ketosis mimicking acute diabetic coma. The hyperglycemia may persist for several days following acute exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against inhalation and skin or eye contact. If feasible and without risk, stop leak. Use water spray to reduce vapor, but it may not prevent ignition in closed spaces. For small spills, take up with sand or other noncombustible absorbent material and using nonsparking tools, place into containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. Do not release to sewers or waterways. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Toxicity:** LC_{50} *Salmo gairdneri* (rainbow trout): 5540 mg/L/96 hr at 54 °F (12 °C). LC_{50} (oral) Ring-necked pheasant: >40,000 ppm. **Environmental Degradation:** Acetone biodegrades when released into the environment. The biological oxygen demand for 5 days (BOD5) is 46-55%. **Soil Absorption/Mobility:** Acetone volatilizes, leaches, and biodegrades if released on soil. **Disposal:** Acetone is a good candidate for fluidized bed, rotary kiln incineration, or catalytic oxidation. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): Hazardous Waste No. U002 (Ignitability), (40 CFR 261.31): F003 (spent solvent)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [* per Clean Water Act, Sec. 311(b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For concentrations < 1000 ppm, wear any chemical cartridge respirator with organic vapor cartridge(s) and wear eye protection to avoid irritation or damage. For concentrations <6250 ppm, wear any supplied-air respirator operated in a continuous-flow mode. For concentrations < 12,500 ppm, wear any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister. For concentrations < 20,000 ppm, wear any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Polyethylene/ethylene vinyl alcohol, Teflon, or butyl rubber with breakthrough times > 8 hr is recommended for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry well-ventilated area away from heat, sparks, flames, and other incompatibles. Keep large stocks away from inhabited buildings. Use non-sparking tools to open containers. Keep dry chemical or CO_2 extinguishers on hand in case of fire. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground and bond all containers and equipment during fluid transfer. For bulk storage rooms, install electrical equipment, Class I, Group D. **Administrative Controls:** Consider preplacement and periodic medical examinations with emphasis on the skin and respiratory tract. Also consider liver and kidney function tests and urinalysis.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Acetone	**Packaging Authorizations**	**Quantity Limitations**	**Vessel Storage Requirements**
DOT Hazard Class: 3	**a) Exceptions:** 173.150	**a) Passenger, Aircraft, or Railcar:** 5L	**Vessel Stowage:** B
ID No.: UN1090	**b) Non-bulk Packaging:** 173.202	**b) Cargo Aircraft Only:** 60L	**Other:** --
DOT Packaging Group: II	**c) Bulk Packaging:** 173.242		
DOT Label: Flammable Liquid			
Special Provisions (172.102): T8			

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 176, 180
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD

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Appendix C
Chemical Agent Identification Sets Information

Chemical Agent Identification Set (CAIS)

Information Package

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GA Simulant.....K

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INFORMATION PACKAGE ON CHEMICAL AGENT IDENTIFICATION SETS (CAIS)

1. PURPOSE: The purpose of this information package is to provide data on Chemical Agent Identifications Sets (CAIS) to military services, government contractors, and state and local authorities as required. This package is cleared for release to government agencies, to government contractors, and to the general public.

2. BACKGROUND: More than 100,000 CAIS were produced for use by all branches of the military between the 1930's and the 1960's. In the late 1970's and early 1980's, a program to destroy CAIS was successful at Rocky Mountain Arsenal. In this operation, 21,458 CAIS were destroyed. The remaining 80,000 sets are thought to have been primarily expended through training, although some were disposed of by the military. In the past, one of the standard and approved procedures for disposing of CAIS was burial.

Three major varieties including seventeen different types of CAIS were produced over the years. These sets were used by the military to train soldiers to identify chemical agents in the field.

One major variety of CAIS was an instructional "sniff set" that contained agent impregnated charcoal. It was intended for use indoors to instruct military personnel in recognizing the odors of chemical agent. This type of set contained only small amounts of chemical agent.

A second major variety, designed for use outdoors, consisted of agent (pure or in solution) in sealed pyrex tubes. The gas tubes would be detonated, creating an agent cloud. Soldiers would then try to identify the agent based on its odor and other characteristics. These typically contained more agent than the instructional "sniff sets" and could produce a much greater hazard.

A third major variety of CAIS were those containing bulk mustard. These CAIS were used in decontamination training by purposely contaminating the terrain or equipment with mustard, and then teaching the soldiers how to don the correct protective clothing and decontaminate the area or equipment. These CAIS contained relatively large quantities of pure mustard.

3. This package has been prepared by The U.S. Army Chemical Materiel Destruction Agency, Program Manager for Non-Stockpile Chemical Materiel, ATTN: SFIL-NSP, Aberdeen Proving Ground, Maryland 21010. For questions or comments about this package, please contact the U.S. Army Chemical Materiel Destruction Agency, Public Affairs Office at (410) 671-1411 or DSN: 584-1411.

References:

Chemical Agent Identification Set Training Package, Brankowitz, William T.

Gas Identification Sets: Ordnance Pamphlet 1447, Navy Department, Bureau of Ordnance, Washington DC, 14 June 1945.

Instructions for Using Gas Identification Sets; Pamphlet No. 4, Chemical Warfare School, Edgewood Arsenal, Maryland, January 1942.

OPLAN SETCON II: Disposal of Chemical Agent Identification Sets at Rocky Mountain Arsenal, Colorado; Headquarters, Department of the Army, U.S. Army Armament Materiel Readiness Command, Rock Island, IL, February 1978.

Technical Aspects of Chemical Operations: Handout FB 040.1, Department of the Army, U.S. Army Chemical Center and School, Fort McClellan, Alabama, November 1971.

Potential Military Chemical/Biological Agents and Compounds: FM 3-9, NAVFAC P-467, AFR 355-7, Headquarters, Departments of the Army, Navy, and Air Force, Washington DC, 12 December 1990.

Descriptions of

Chemical Agent Identification Sets

SET K941

TOXIC GAS SET, M1

OLD STOCK NUMBER: FSN 1365-219-8574

TIME FRAME OF USE: WWII - LATE 1950's

The K941 CAIS contains 24 glass bottles, each containing 3 1/2 ounces of Mustard (H) or Distilled Mustard (HD) for a total of 84 ounces (2.48 L) per set.

Bottles are round and have a small screw top. Heat resistant paint on the bottles indicates "H", "HS", or "HD", "TOXIC GAS SET, M1." Four bottles are packed in 1/2 inch layers of sawdust within a sealed metal can. The Cans are pressure sealed, 6 1/4" high, and have a sardine-type key on the bottom. Six of these metal cans are fitted into a steel shipping cylinder that is 6 5/8 inches in diameter, approximately 38 inches long, and 0.145 inches thick. The open end of this container is closed by a flanged end cover which is secured by eight bolts tightened over a 1/8 inch thick lead gasket (See Figure 1).

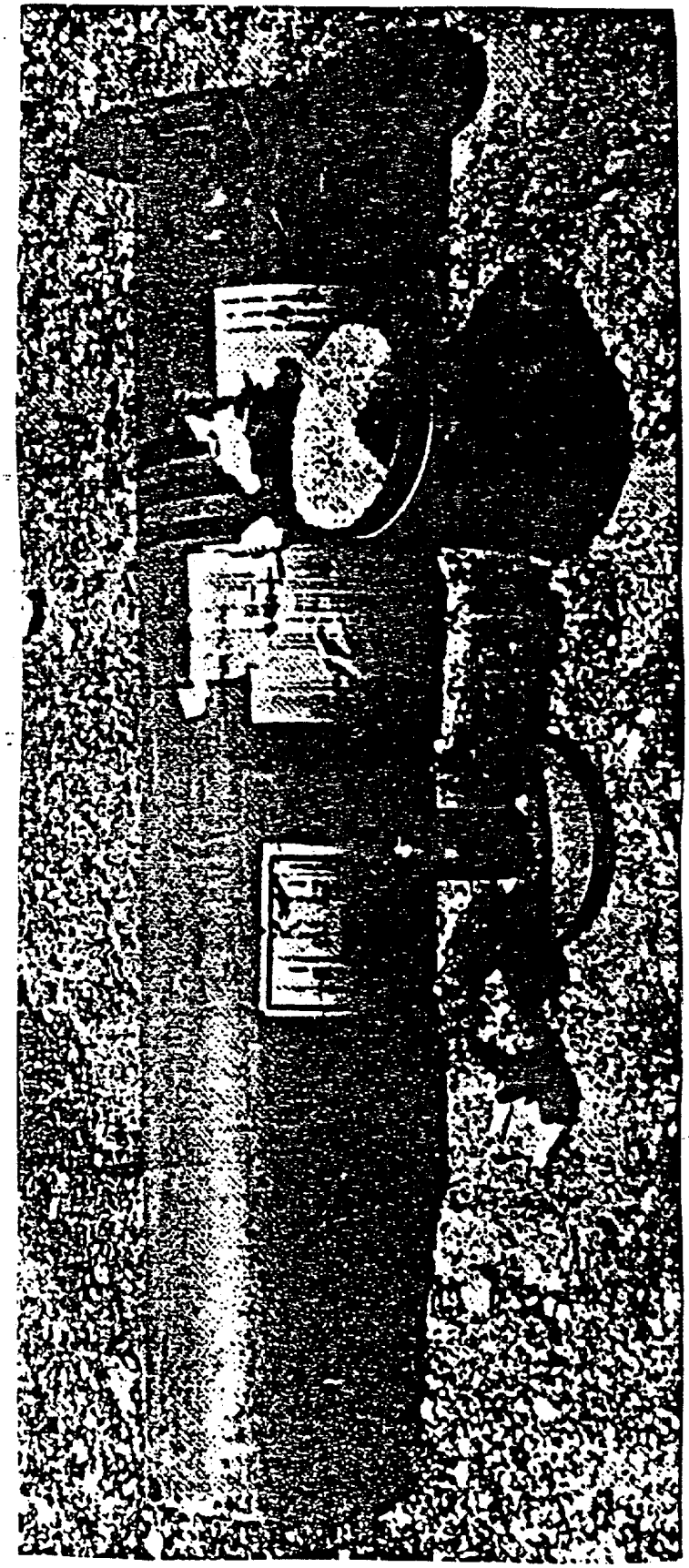


FIGURE 1: K941

SET K942

TOXIC GAS SET, M2

OLD STOCK NUMBER: FSN 1365-563-4146

TIME FRAME OF USE: KOREAN ERA

The K942 CAIS contains 28 heat-sealed ampules, each containing 3.8 ounces of Mustard (H, HD, or HS) for a total of 106.4 ounces (3.15 liters) per set.

Each ampule is 1 7/8 inches in diameter and 4 5/8 inches in length and packed in its own can. Twenty eight (28) cans are packed in a cold-rolled carbon steel drum 14 inches in diameter, 14 inches high and 0.0375 inches thick (20 gauge) in 2 layers (14 cans per layer). The cans are separated into individual compartments by a fiberboard packaging (See Figure 2).

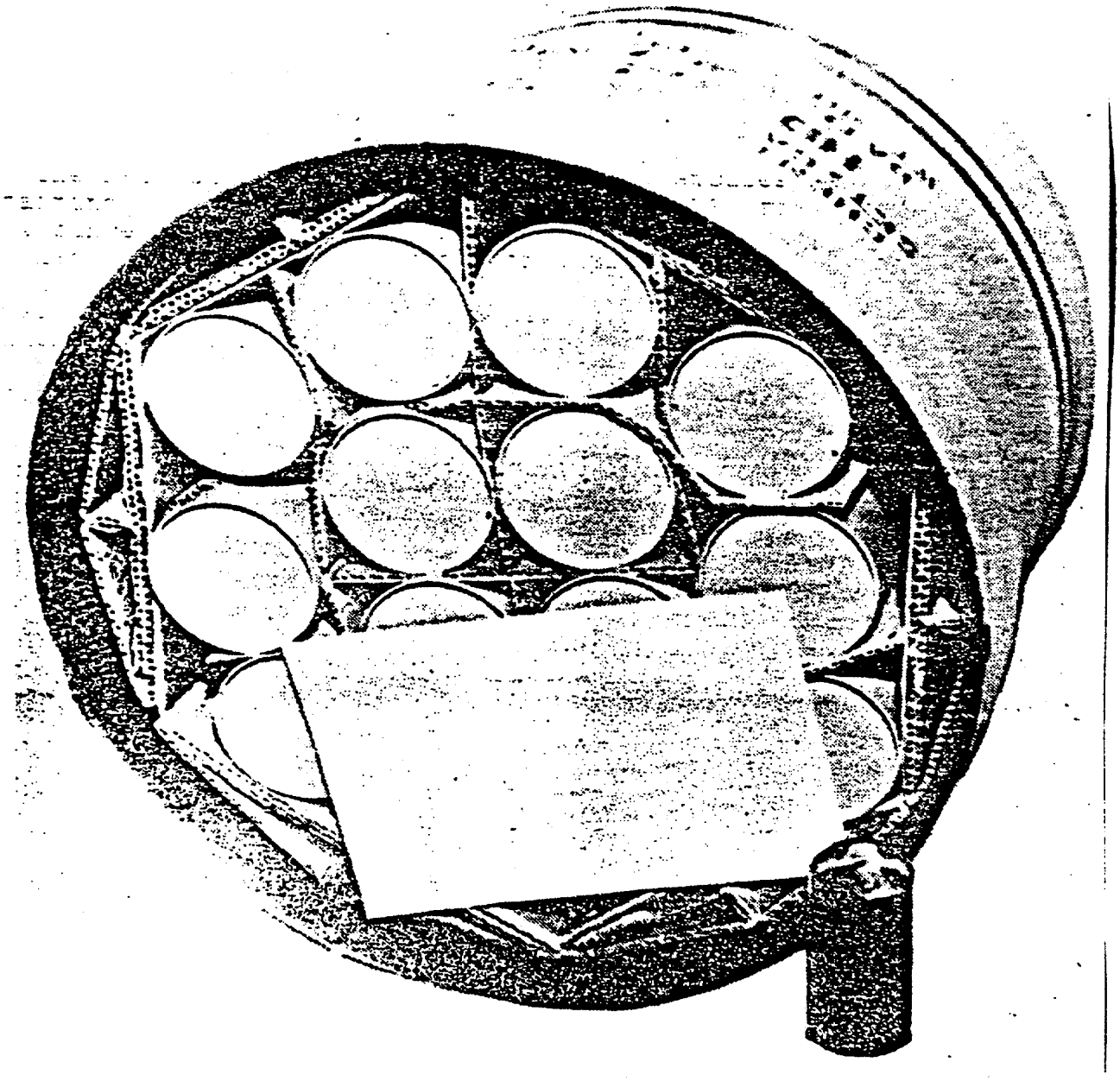


FIGURE 2: K942

SET K945

TRAINING SET, CHEMICAL AGENT IDENTIFICATION, M72

OLD STOCK NUMBER: FSN 1365-051-1807

TIME FRAME OF USE: LATE 1960's

The K945 CAIS contained four bottles of nerve agent, GB, one bottle of Lewisite (L), one bottle of Triphosgene (a simulant for Phosgene (CG)), one bottle of Potassium Cyanide (KCN), and one bottle of Mustard (H). Each K945 CAIS contains about 0.7 fluid ounces of agent absorbed in plastic pellets. These sets also contain three vials of simulants.

Eight square bottles and three small round bottles are inclosed in a plastic carrying case measuring 12 x 5 1/2 x 4 inches and weighing about three pounds. This case is described as "tackle box" type. The plastic case is sealed in two-layer laminated plastic bags that are packed in a fiberboard box which is in turn packed into a wooden box sealed with metal straps (See Figure 3).

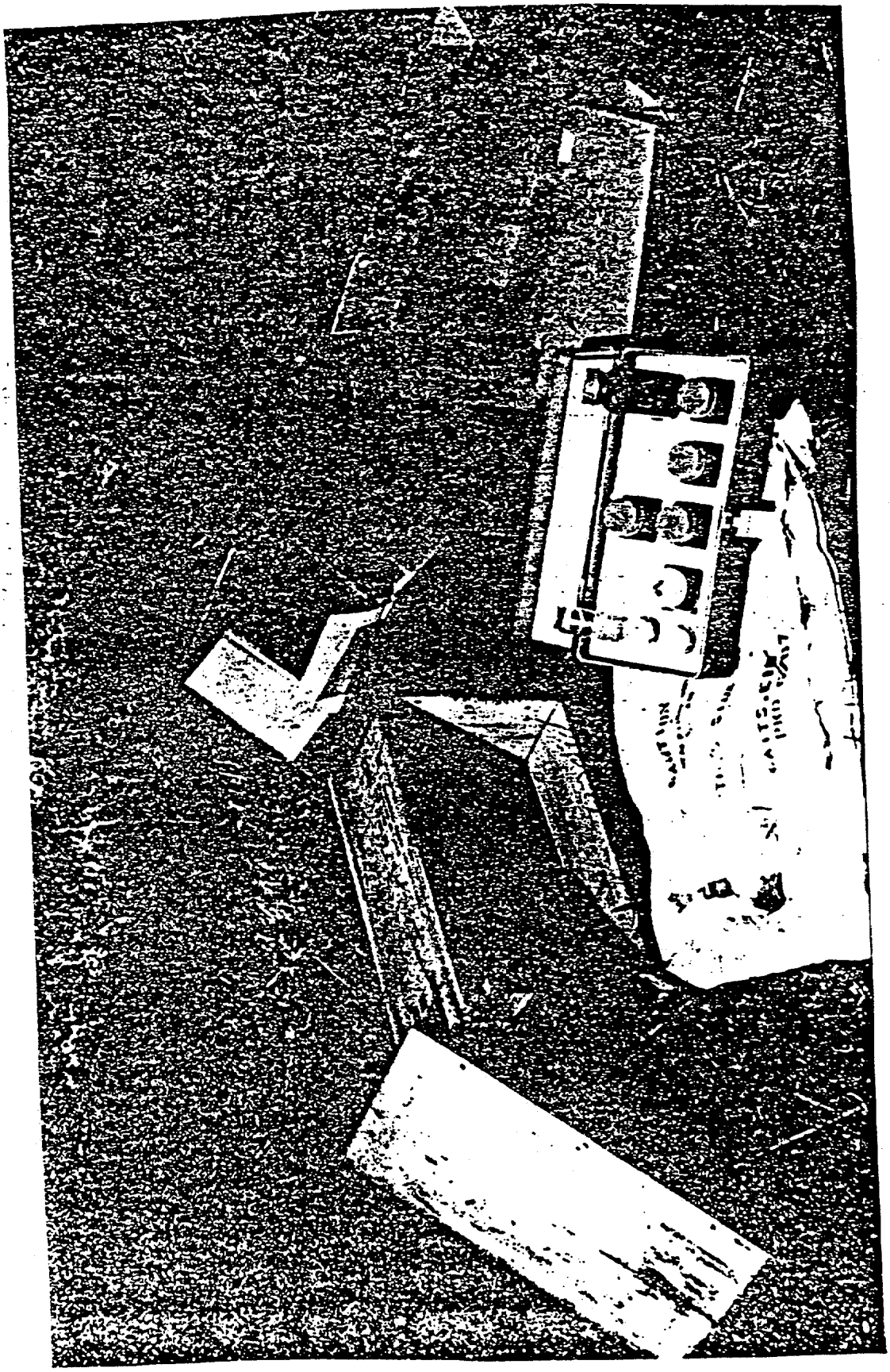


FIGURE 3: K945

SET K951/K952

WAR GAS IDENTIFICATION SET, INSTRUCTIONAI M1

SET GAS IDENTIFICATION, DETONATION M1

OLD STOCK NUMBER: FSN 1365-025-3273 (K951)
FSN 1365-025-3783 (K952)

TIME FRAME OF USE: EARLY 1930's to LATE 1950's

The K951/K952 CAIS contained 48 pyrex, flame sealed ampules, 12 each containing 1.4 ounce solution of Mustard (H, 5% in chloroform) Lewisite (L, 5% in chloroform), Chloropicrin (PS, 50% in Chloroform), and Phosgene (CG) for a total of 26 fluid ounces (0.768 liters) of agent, less the chloroform, per set.

Each ampoule is 1 inch in diameter and 7 1/2 inches long. Each ampoule is packed in a cardboard screw cap container (mailing tube-type) with agent type indicated by letters on the cardboard container. Twelve (12) cardboard containers each are packaged into 4 press fit metal cans which are 9 1/4 inches high. The cans are packed into a steel cylinder 6 5/8 inches in diameter, approximately 38 inches long and 0.145 inches thick. The open end of the cylinder is closed by a flanged end cover which is secured by eight bolts.

The only difference between the K951 and K952 is that the K951 was issued with blasting caps that were packed and shipped in a separate container (See Figure 4).

SET K953/K954

WAR GAS IDENTIFICATION SET, INSTRUCTIONAL, AN-M1A1

SET GAS IDENTIFICATION, DETONATION, AN-M1A1

OLD STOCK NUMBER: FSN 1365-323-7728 (K953)
FSN 1365-338-0735 (K954)

TIME FRAME OF USE: KOREAN ERA

The K953/954 are identical in configuration to the K951 and K952 except that they contain eight ampules each of Phosgene (CG), Lewisite (L, 5% in chloroform), Distilled Mustard (HD, 5% in chloroform), Cyanogen Chloride (CK), Nitrogen Mustard (HN-1, 10% in chloroform) and GA simulant (See Attachment K for information about the GA simulant) for a total of 23.8 fluid ounces (0.704 liters) of agent, less the chloroform, per set.

These sets are packed in containers identical to the K951 and K952.

The only difference between the K945 and K943 CAIS is that the K953 was issued with blasting caps (See Figure 4).

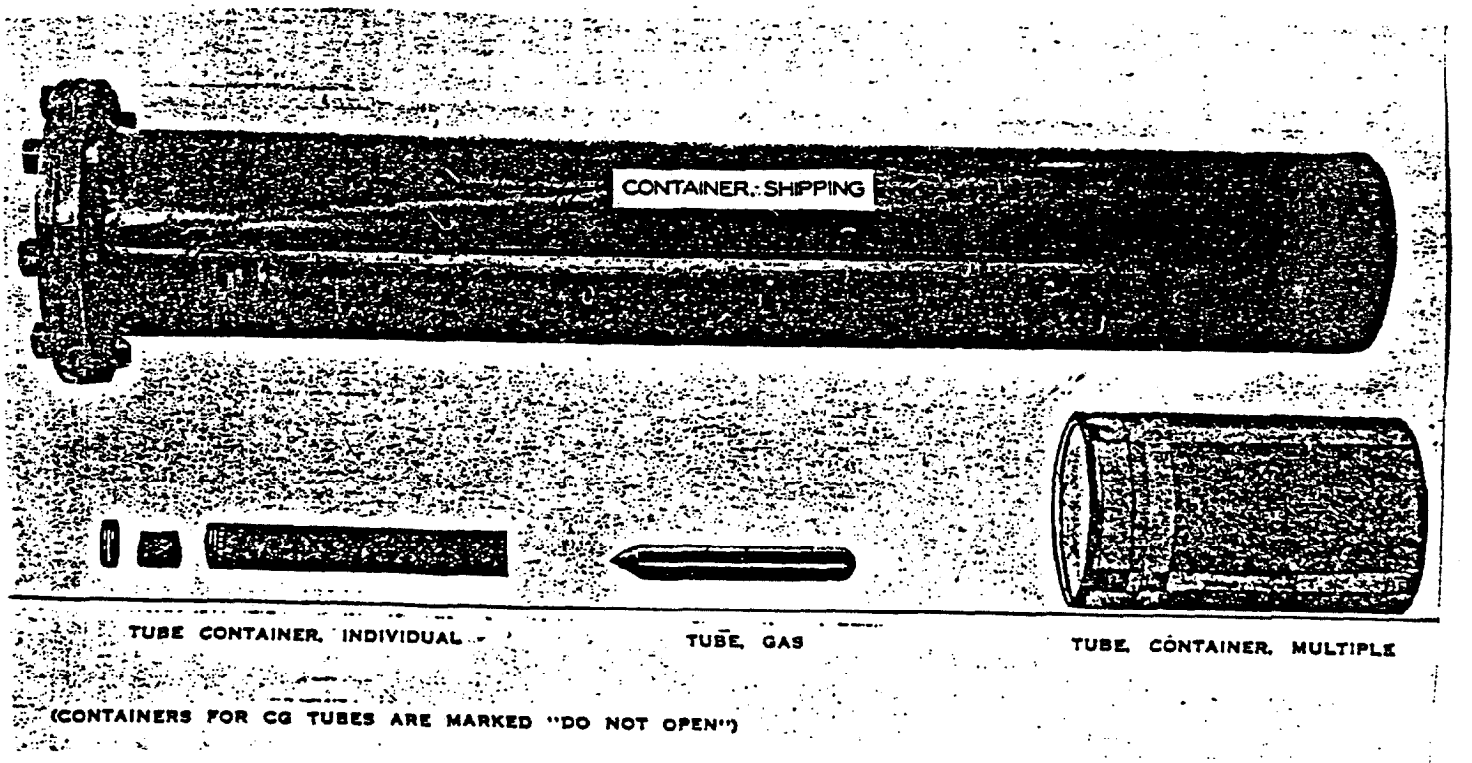


FIGURE 4: K951/K952/K953/K954

SET K955

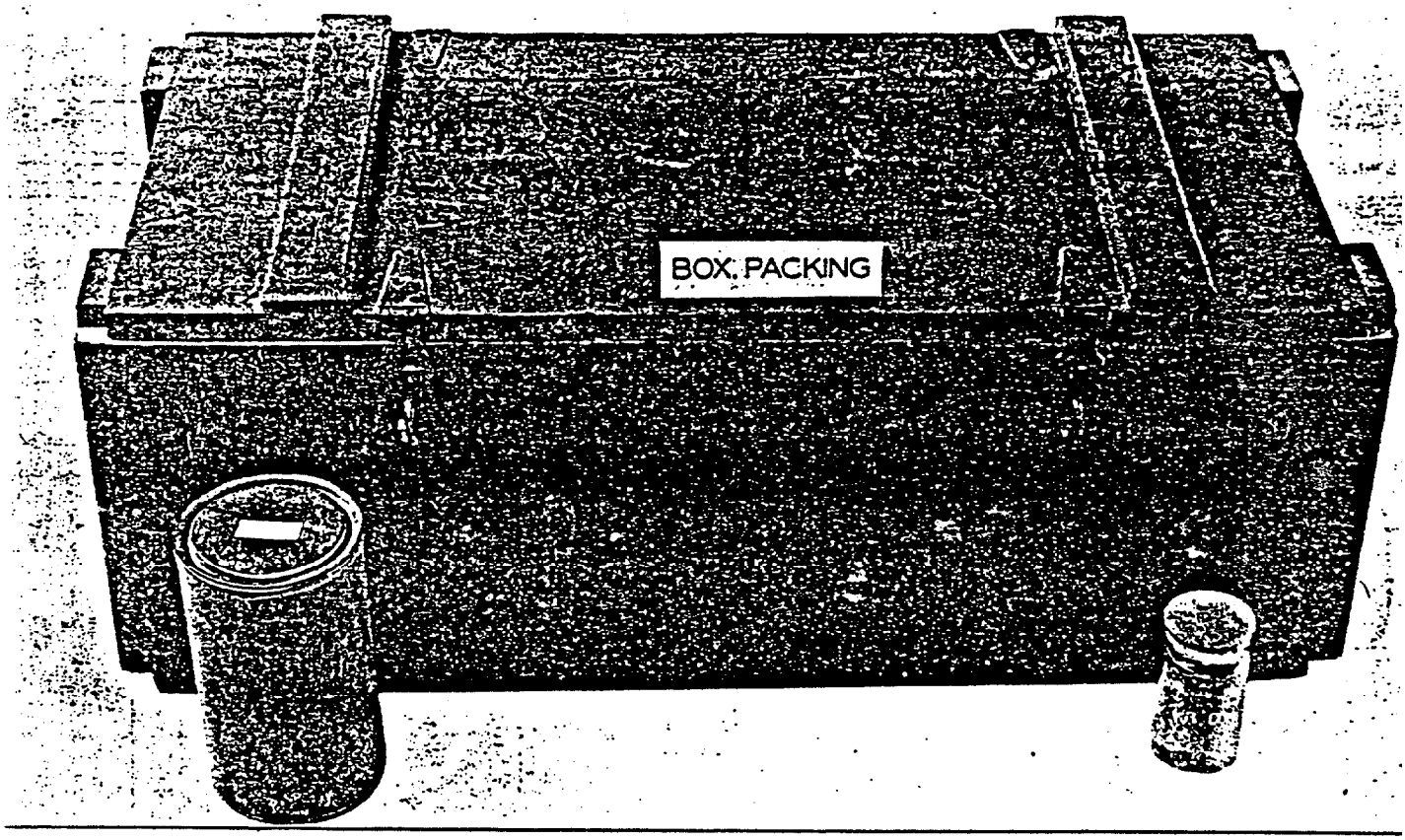
SET, GAS IDENTIFICATION, INSTRUCTIONAL, M1 (NAVY SET)

OLD STOCK NUMBER: FSN 1365-368-6154

TIME FRAME OF USE: LATE 1930's to WWII

Each K955 CAIS contains seven glass bottles with a total of 3.5 fluid ounces (0.103 liters) of agent per CAIS. Four of the bottles contain 3 ounces (90cc) of activated charcoal on which agent is absorbed. One bottle contains Lewisite (L), one Chloropicrin (PS), and two mustards (HS), one contains 6 grams of Triphosgene (a simulant for Phosgene (CG)), one 15 grams of Chloroacetophenone (CN) and one with 15 grams of Adamsite (DM).

These sets are packed in a hinged-covered wood box that resembles a foot locker and measures 30 3/8 inches wide, 15 1/2 inches long and 11 3/4 inches high. The inside of the box is divided into eight sections. Seven of the sections contain sealed metal cans in sawdust and the eighth has instructions. The cans are 4 inches in diameter and 7 inches high and have a paint can type lid. Inside each can is one round bottle with a large screw top or glass stopper which is usually wax coated. The bottles are frequently filled with charcoal (See Figure 5).



CONTAINER

BOTTLE, FOUR OUNCE

• COMPONENTS OF SET, GAS IDENTIFICATION, INSTRUCTIONAL, MI

FIGURE 5: K955

NAVY X SETS

REPLACEMENT SET, GAS IDENTIFICATION, INSTRUCTIONAL, (NAVY)

OLD STOCK NUMBER:	FSN 1365-038-5183	(X302)
	FSN 1365-608-5322	(X545)
	FSN 1365-608-5323	(X546)
	FSN 1365-608-5324	(X547)
	FSN 1365-608-5325	(X548)
	FSN 1365-608-5326	(X549)
	FSN 1365-608-5327	(X550)
	FSN 1365-608-5328	(X551)
	FSN 1365-608-5328	(X552)

TIME FRAME OF USE: WWII to KOREAN ERA

These include nine different types of replacement CAIS used by the Navy to replace components of the K955 CAIS.

The X302 contains 1.7 fluid ounces (0.050 liters of agent per set) including one bottle of 0.9 fluid ounces (0.025 liters) or Nitrogen Mustard (HN1), and one bottle of 0.9 fluid ounces (0.025 liters) of Nitrogen Mustard (HN3) absorbed in three ounces (90 cc) of activated charcoal.

The sample replacement sets X545 through X552 contain two bottles with either a total of 1.7 fluid ounces (0.05 liters) of liquid agent absorbed in activated charcoal or solid agent as outlined below. The contents of these sets are:

X545	Triphosgene, a simulant for Phosgene (CG) - 6 grams per set (no charcoal)
X546	Chloroacetophenone (CN) - 30 grams per set (no charcoal)
X547	Mustard (HS)
X548	Lewisite (L)
X549	Adamsite (DM) - 30 grams per set (no charcoal)
X550	Nitrogen Mustard (HN1)
X551	Nitrogen Mustard (HN3)
X552	Chloropicrin (PS)

Each of the X-sets are packaged in a wooden box, with a hinged cover, measuring 7 1/2 inches wide, 16 inches long, and 11 3/4 inches high. The box is divided into two sections. Each section contains a 4 x 7 inch can with a paint can-type top packed in sawdust. Each can contains one round bottle with a large screw top or glass stopper which is usually wax coated.

DESCRIPTION OF FIGURE 6 (PHOTOGRAPH):

Upper Left Corner: K941: Toxic Gas Set, M1.

Lower Left Corner: K945: Training Set, Chemical Agent Identification, M72

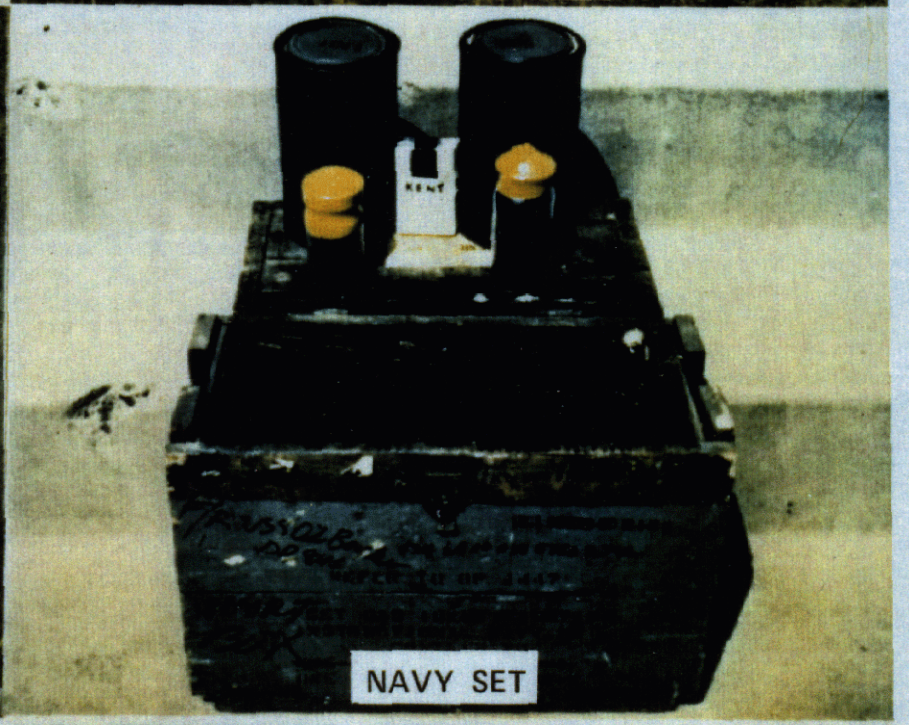
Upper Right Corner: K951/K952/K953/K954: War Gas Identification Set, Instructional M1/AN-M1A1

Lower Right Corner: X302/X545-X552: Replacement Set, Gas Identification, Instructional, Navy

TOXIC GAS SET

WAR GAS ID SET

CHEMICAL AGENT
IDENT & TRAINING SET
(CAITS)



NAVY SET

IDENTIFICATION AND TRAINING SETS

02318T04Y

AGENT INFORMATION

QUICK REFERENCE

BLISTER AGENTS

All of the Blister Agents are persistent. Blister agents damage any tissue that they contact. They affect the eyes and lungs and blister the skin. They damage the respiratory tract when inhaled and cause vomiting and diarrhea when absorbed.

Mustard - H, HS or HD (Sulfur Mustards)

Levinstein mustard (H) is the original mustard (gas) of WWI vintage. A WWII era abbreviation of H which was also used was HS signifying Sulfur Mustard, as opposed to HN or Nitrogen Mustard which had been stockpiled by Germany. It contains about 30% sulfur impurities, which give it a pronounced odor similar to garlic or horseradish. The impurities lessen the effectiveness of H and lower its freezing point 2-5°. Other properties of H are essentially the same as those for distilled mustard, which is discussed next.

Distilled Mustard (HD) - HD is a purified form of H and is a colorless to amber colored liquid with a garlic-like odor. The effects of HD are usually delayed 4-6 hours, but latent periods have been observed for up to 24 hours. The higher the concentration, the shorter the interval of time from exposure to the first symptoms. Mustard acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. Early symptoms include inflammation of the eyes; inflammation of the nose, throat, trachea, bronchi, and lung tissue; and redness of the skin; blistering or ulceration may follow. Effects may include a more "at ease" attitude, vomiting, and fever, beginning about the same time as skin reddening.

Nitrogen Mustard - HN1 or HN3

HN-1 is a oily, colorless to pale yellow with an fishy or musty odor. HN-3 is an oily liquid with no odor.

HN-1/HN-3 irritate the eyes in dosages which do not significantly damage the skin or respiratory tract, insofar as single exposures are concerned. Eye irritation appears in a shorter time than that from HD. Mild vapor exposure may result in no skin lesions. After severe vapor or liquid exposure irritation, itching and reddening of the skin may occur. Later blisters may form on the affected areas. Effects on the respiratory tract include irritation of the nose and throat, hoarseness progressing to loss of voice, and persistent cough. Fever, labored respiration, and most rales (abnormal sounds) may develop. Bronchopneumonia may appear after the first 24 hours. Following ingestion or systemic absorption, the agent causes inhibition of cell division, resulting in depression of the blood-forming mechanism and injury to other tissues. Severe diarrhea, which may be accompanied by bleeding, occurs.

Lewisite - L (Arsenical)

The arsenical vesicants are a group of blister agents in which arsenic is the central atom.

Lewisite is a liquid with an odor similar to geraniums and very little odor when pure. L warns of its presence by irritating the eyes and skin and has a rapid rate of action. Liquid L causes immediate burning sensation in the eyes and permanent loss of sight if not decontaminated within one minute with large amounts of water. It has about the same blistering action on the skin as does the Mustard (HD), even though the lethal dosage for L is much higher. Skin exposure to L produces an immediate and strong stinging sensation; reddening of the skin starts within 30 minutes. Blistering does not appear until after about 13 hours.

VOMITING AGENTS

Vomiting agents produce strong, pepperlike irritation in the upper respiratory tract, with irritation of the eyes and tearing. They cause violent, uncontrollable sneezing; cough; nausea; vomiting; and a general feeling of bodily discomfort. The vomiting compounds are normally solids that vaporize when heated then condense to form aerosols. The produce their effects by inhalation or by direct action on the eyes.

Chloropicrin - PS

PS is a pungent, colorless, oily liquid. The odor of PS is described as stinging and pungent.

PS is a powerful irritant whose vapors cause nose and throat irritation, coughing and vomiting. As an eye irritant, it produces immediate burning, pain and tearing. Even in very limited concentrations PS causes the eyelids to close. In high concentration PS damages the lungs, causing pulmonary edema. As a liquid, it causes severe burns on the skin that generally result in blisters and lesions.

Due to its eye irritating effects, chloropicrin is also classed as a tear agent.

Adamsite - DM

The physical state of DM is a light yellow to green crystalline solid. It has no pronounced odor, but it is irritating. DM as a solid forms no appreciable vapor; for tactical operations DM was disseminated as an aerosol.

Symptoms are irritation of the eyes and mucous membranes, viscous discharge from the nose similar to that caused by a cold, sneezing and coughing, severe headache, acute pain and tightness in the chest, nausea, and vomiting. DM has no irritant effect on the skin. The effects of DM for moderate concentrations last about 30 minutes after exposure. At high concentrations the effects may last up to one hour.

CHOKING AGENT

PHOSGENE - CG

Phosgene is a colorless gas with an odor similar to new-mown hay, grass, or green corn.

Phosgene, an industrial chemical, also know as Carbonyl Chloride, is a volatile gas which produces irritant and inflammatory effects on the eyes, nose, upper airways and lungs. Following the inhalation of high concentrations of phosgene, within 10 minutes to 2 hours later, the individual may experience tearing of the eyes, burning of the nose and upper airways, as well as coughing and chest tightness. Following exposure to as little as 1-2 parts per million (ppm), the individual can experience eye irritation and tearing, burning of the nose, coughing and chest tightness within 10 minutes to 2 hours. The mildness of the early signs and symptoms can be misleading, with the individual later developing severe cough, shortness of breath, and inflammation so severe that the lungs fill up with fluid.

TEAR AGENT

Tear compounds cause a flow of tears and irritation of the skin. Because tear compounds produce only transient effects, they are widely used for training and riot control.

Chloroacetophenone - CN

The physical state of CN is a solid powder. CN is described as having an odor similar to apple blossoms.

CN identifies the riot control agent popularly known as tear gas or mace. CN quickly irritates the eyes and upper respiratory passages. In higher concentrations it causes copious tearing; a tingling sensation, irritation, burning and pain of the nose and throat; and burning and itching on tender areas of the skin, especially areas wet by perspiration. High concentrations can cause blisters. The effects are similar to those of a sunburn and disappear in a few hours.

NERVE AGENT

SARIN - GB

GB is a volatile liquid at room temperature. It is odorless and colorless.

GB is a volatile, rapid acting, lethal nerve agent. It is an inhibitor of the enzyme acetylcholinesterase (AChE), which is required for the function of many nerves and muscles in nearly every multicellular animal. Normally, AChE prevents the accumulation of acetylcholine after its release in the nervous system. Acetylcholine plays a vital role in stimulation voluntary muscles and nerve endings of the autonomic nervous system and many structures within the central nervous system. Thus, this type of nerve agent permits acetylcholine to accumulate at those sites, mimicking the effects of a massive release of acetylcholine. The major effects will be on skeletal muscles, parasympathetic end organs, and the central nervous system.

Accidental skin contact with liquid agent or inhalation of agent aerosol or vapor are the most likely causes of exposure. The agent absorption rate is accelerated through cuts and abrasions in the skin.

The number and severity of the symptoms depend on the quantity and route of entry of the nerve agent into the body. The agent is quick acting, and within 15 minutes the exposed person can experience symptoms.

Mild symptoms of nerve agent exposure include:

- Pinpoint eye pupils (myosis) and dimness of vision.
- Runny nose.
- Chest tightness and difficulty breathing.
- Localized muscle twitching.

Symptoms of severe nerve agent poisoning include:

- Nausea and vomiting.
- Cramps and involuntary defecation or urination.
- Convulsions.
- Coma.
- Cessation of respiration and death.

BLOOD AGENT

Blood agents are cyanide containing compounds that are absorbed into the body primarily by inhalation. They are highly volatile and therefore are nonpersistent.

Cyanogen Chloride - CK

CK is a colorless, highly volatile liquid with a pungent, biting odor that will go unnoticed because of the agent's tearing and irritating properties.

CK interferes with oxygen use by all cells in the body, particularly the heart and central nervous system. Inhalation of high concentrations may produce immediate shortness of breath, tearing of the eyes, burning pain in the nose and upper airways, with chest tightness, coughing and wheezing. Soon after, the person may become dizzy and increasingly short of breath, followed by loss of consciousness, convulsions, cessation of respiration, and death. If recovery is complete and the central nervous system has not been deprived of oxygen, no long term health effects are likely to occur.

CK also has an irritant effect on the eyes, upper airways, and lungs, and therefore it is classed as both a choking and blood agent.

ATTACHMENTS:

AGENT TOXICITY DATA

DATE: 3 Dec 1990
HCSDS NO: 20058A

POISON GAS

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

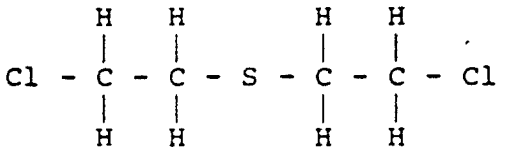
TRADE NAME AND SYNONYMS:

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

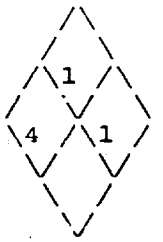
CHEMICAL FAMILY: chlorinated sulfur compound

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)
Sulfur Mustard	C4(H8)Cl2(S)	100	0.003 mg/m3 (8 hr-TWA)

SECTION III - PHYSICAL DATA

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

SECTION IV - FIRE AND EXPLOSION DATA

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).

SECTION V - HEALTH HAZARD DATA

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/m3 at 90 DEG F (dry environment)
ICt50 (eyes) = 200 mg-min/m3
ICt50 (inhalation) = 1500 mg-min/m3 (Ct unchanged with time)
LD50 (oral) = 0.7 mg/kg

Maximum safe Ct for skin and eyes are 5 and 2 mg-min/m3, 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.

SECTION VI - REACTIVITY DATA

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.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

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 monitor ing 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.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Concentration mg/m3	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/m3 level of detection. (b) M9, M17 or M40 mask is available and donned if ceiling concentrations exceed 0.003 mg/m3. (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 respiratiors. (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 that 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).

SECTION IX - SPECIAL PRECAUTIONS

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 transfering 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 USAFHA Technical Guide No.173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT".

SECTION X - TRANSPORTATION DATA

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 form 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.

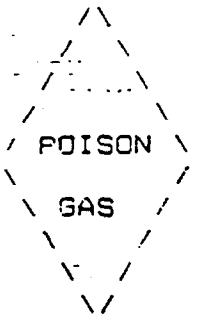
NOTE: Surfaces contaminated with THD or HD and then rinse-decontaminated may evolve sufficient mustard vapor to produce a physiological response.

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: January 12, 1990



US ARMY CHEMICAL
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

Emergency Telephone #s:
CRDEC Safety Office
301-671-4411, 0800-1630
EST. After normal duty
hours: 301-278-5201
Ask for CRDEC Staff
Duty Officer

HN1 MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

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

CAS REGISTRY NUMBER: 538-07-8

CHEMICAL NAME: 2,2'-Dichlorotriethylamine

Alternate Chemical Names:

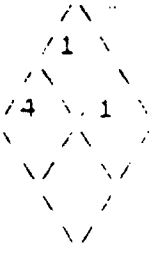
Ethylbis(beta-chloroethyl)amine
Ethylbis(2-chloroethyl)amine
2-Chloro-N-(2-chloroethyl)-N-ethylethanamine

TRADE NAME AND SYNONYMS: Ethyl-S
HN1
TL 329
TL 1149

CHEMICAL FAMILY: Chloroamino hydrocarbon

FORMULA/CHEMICAL STRUCTURE: $(Cl\ CH_2\ CH_2)_2\ NC_2\ H_5$

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



SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	TLV
Nitrogen Mustard 1	(Cl CH2 CH2)2 N C2 H5	100%	*

*None established/available

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): 150.8 (66) at 3 torr
185.9 (88.5) at 12 torr
381.2 (194) at 760 torr (Calculated)
Decomposes before boiling at 760 torr.

VAPOR PRESSURE (mm Hg): 0.0773 at 10 DEG C
0.25 at 25 DEG C
0.744 at 40 DEG C

VAPOR DENSITY (AIR=1): 5.9

LIQUID DENSITY (g/cc): 1.09 at 25 DED C (77 DEG F)

SOLUBILITY IN WATER: Miscible with many organic solvents and oils.
Very slightly soluble in water.

SPECIFIC GRAVITY (H2O=1): 1.0861 at 23 DEG C
1.09 at 25 DEG C

FREEZING (MELTING) POINT: -34 DEG C

AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available

VISCOSITY (CENTISTOKES): Data not available

VOLATILITY: 127 mg/m3 at -10 DEG C
308 mg/m3 at 0 DEG C
744 mg/m3 at 10 DEG C
1520 mg/m3 at 20 DEG C
2290 mg/m3 at 25 DEG C
3100 mg/m3 at 30 DEG C
6290 mg/m3 at 40 DEG C

EVAPORATION RATE: Data not available

APPEARANCE AND ODOR: Pale amber to yellow oily liquid
Faint "fishy or musty" odor

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT: No immediate danger of fire or explosion

FLAMMABILITY LIMITS (% BY VOLUME): Data not available

EXTINGUISHING MEDIA: Water, fog, foam, CO_2. Avoid use of extinguishing methods that will splash or spread HN1.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Vapors of unburned agent will exhibit toxic effects.

SPECIAL FIRE FIGHTING PROCEDURES: Full protective clothing (see Section VIII) and full respiratory protection must be worn when fighting fires inside buildings and areas where HN1 is stored. Full protective clothing and canister or filter type masks can be worn where oxygen deficiency is not a problem. All persons not engaged in extinguishing the fire should be evacuated. Skin contact and inhalation of HN1 and its vapors must be avoided at all times. Although the fire may destroy most of the HN1, care must be taken to assure that the HN1 does not contaminate uncontrolled areas and that the fire fighters are adequately protected from physical contact with the agent and agent fumes. Contact may be fatal.

SECTION V - HEALTH HAZARD DATA

RECOMMENDED EXPOSURE LIMITS (REL): An REL is not available for HN1. No individual should be exposed to any direct skin or eye contact or any detectable airborne concentrations. Nitrogen mustards are classified as carcinogens by the International Agency for Research on Cancer (IARC).

EFFECTS OF OVEREXPOSURE: The vapors are irritating to the eyes and nasal membranes even in low concentration. HN1 is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues. HN1 is not naturally detoxified by the body, therefore repeated exposure produces a cumulative effect.

Median lethal dosages of HN1 in man are the following:

LCt50 (man, inhalation) = 1500 mg-min/m^3

LCt50 (man, percutaneous vapor) = 20,000 mg-min/m^3

Median incapacitating dosages of HN1 in man are the following:

ICt50 (man, eye contact) = 200 mg-min/m^3

ICt50 (man, percutaneous) = 9000 mg-min/m^3

--- Vesicancy doses in man are the following:
Liquid:

43.6 microliters produced 28 percent erythema
218 microliters produced 72 percent erythema
218 microliters produced 20 percent blisters (4 mm. av. diameter.)

ACUTE PHYSIOLOGICAL ACTION OF HN1 IS LOCAL AND SYSTEMIC.

Locally, HN1 affects both the eyes and the skin. Skin damage occurs after percutaneous resorption. Skin penetration is rapid and skin irritation is noted very shortly after contact with the agent. Redoening (erythema) of the skin may occur within 30 minutes to 1 hour following the exposure, depending on degree of exposure and individual sensitivity. Blistering may not occur for more than 12 hours following exposure. Tender skin, mucous membrane and perspiration covered skin are more sensitive to the effects of HN1. Local action on the eyes is extremely rapid, and produces severe neurotic damage and loss of eyesight. Exposure of eyes to HN1 vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea. Greatest immediate effect on HN-1 is on the eyes.

Systemic actions occur primarily through inhalation and ingestion. When inhaled, the lesions caused by nitrogen mustards are similar to those caused by mustards. They decrease in severity down the respiratory tract from the point of entry. The upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, hoarseness progressing to loss of voice, and persistent cough. Fever and moist rails develop followed by loss of appetite, diarrhea, and apathy. Broncho pneumonia may appear after the first twenty four hours. Exposure to near lethal doses of HN1 can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count. and results in increased susceptibility to local and systemic infections. Ingestion of HN1 will produce severe stomach pains, vomiting, and bloody stools.

Chronic exposure to HN1 can cause sensitization and chronic lung impairment (cough, shortness of breath, chest pain). In mild vapor exposures there may be no skin lesions. After severe exposure or after exposure to liquid nitrogen mustard, reddening may appear earlier than in mustard contamination. There may be irritation and itching as with mustard; blisters may appear later. However, blisters may not occur for more than 12 hours following exposure. Skin lesions are similar to those caused by mustard.

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: immediately flush eyes with water for 10-15 minutes, pulling eyelids apart with fingers and pouring water into eyes. Do not cover eyes with bandages. After flushing eyes with water, protect eyes with dark or opaque goggles. Seek medical attention immediately.

Skin Contact: Don respiratory protective mask and gloves: remove victim from source immediately and remove contaminated clothing. immediately decontaminate skin by flushing with a 5% solution of liquid household bleach. After 3-4 minutes, wash off with soap and water to remove decon agent and protect against erythema. Seek medical attention immediately.

The rate of absorption of liquid nitrogen mustards through the skin is slower than that of mustard. Therefore, to prevent systemic toxicity, decontamination should be done as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction. Further cleansing may be done with soap and water.

Ingestion: Do not induce vomiting. Give victim milk to drink. Seek medical attention immediately.

SECTION VI - REACTIVITY DATA

STABILITY: Polymerizes slowly

RATE OF HYDROLYSIS: Slow

HYDROLYSIS PRODUCTS: Hydroxyl derivatives and condensation products.

INCOMPATIBILITY: Corrosive to ferrous alloys beginning at 65 DEG C (149 DEG F)

HAZARDOUS DECOMPOSITION: Toxic intermediate products are produced during hydrolysis. Approximate half-life in water at 25 DEG C in 1.3 minutes. Decomposition comes through slow change into quaternary ammonium salts. Decomposition point is below 194 DEG C (381.2 DEG F)

HAZARDOUS POLYMERIZATION: Slowly

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing will be allowed in an area where HN1 is spilled. HN1 should be contained using vermiculite,

diatomaceous earth, clay or fine sand and neutralized as soon as possible. A minimum of 65 grams of decon solution (5.25% Sodium Hypochloritite solution) is required for each gram of HN1. HN1 must be added to the decon solution and NOT DECON SOLUTION TO HN1. Decontamination/agent 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 to 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% sulfuric acid:water and swirl. IMMEDIATE iodine color indicates the presence of active chlorine. If negative, add additional 5.25% 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 % HTH mixture may be substituted for sodium hypochlorite. Use 65 grams of decon per gram of HN1 and continue the test as described for sodium hypochlorite.

Do not use dry STB or HTH as they react violently with some chemicals. Scoop up all contaminated material and place in approved DOT containers. Pour in STB slurry or HTH solution. Decontaminate the outside of containers and label in accordance with federal, state and local regulations and hold for disposal.

NOTE: Surfaces contaminated with HN1 and then rinsed with water may evolve sufficient HN1 vapor to produce a physiological response.

WASTE DISPOSAL METHOD: All decontaminated material should be collected, contained, and chemically decontaminated, then thermally decomposed in an approved incinerator for HN1, 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. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the Department of Army issue point. Decontamination of waste or excess material shall be accomplished in accordance with the following proceoure:

(a) HN1 on laboratory glassware may be oxidized reacting it with strong bleaches, alkalies, or other oxidizers.

(b) Chemical decontamination of HN1 should be accomplished as described above. HN1 has poor solubility in water.

Decontaminated waste and/or HN1 shall be transported according to local SOP (in accordance with AR 55-355). Final disposition will be controlled according to AMCR 385-131 and APG 200-2 and RCRA state regulations which take precedence (NOTE: Some states

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

SECTION VIII - SPECIAL PROTECTION INFORMATION

(U)RESPIRATORY PROTECTION:

HN1 Concentration	Respiratory Protective Equipment
Less than or equal to 0.003 mg/m3 as an 8-hr TWA	Protective mask not required provided that: (a) Continous real-time monitoring (with alarm capability) is conducted in the work area at the 0.003 mg/m3 level of detection. (b) M9, M17 or M40 mask is available and donned if concentrations exceed 0.003 mg/m3. (c) Exposure has been limited to the extent practicable by engineering control (remote operations, ventilations, and process isolation) or work practices. If those 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 M17 or M40 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: Local Exhaust: Mandatory must be filtered or scrubbed to limit exit concentration to 0.003 mg/m3 averaged over 8 hr/day. Filtration must be adequate to maintain stack concentration below 0.03 mg/m3 as a 1 hour TWA. These values are based on structural similarity to HD.

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 inclosure's ability to contain agent HN1.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through 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, or glove set).

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, underwear, M9 series mask and coveralls (if desired), STEPOI or the DPE. For general lab work, gloves and lab coat shall be worn with M9, M17, or M40 Mask readily available.

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

SECTION IX - SPECIAL PRECAUTIONS

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 by a detector kit), and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HN1 must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and at the end of the workday. No smoking, eating, or drinking is permitted at the work site.

smoking, eating, or drinking is permitted at the work site. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HN1 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.

SECTION X - TRANSPORTATION DATA

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

DOT HAZARD CLASSIFICATION: Poison A

DOT LABEL: Poison Gas

DOT MARKING: Poison Liquid, n.o.s. (2,2'-Dichlorotriethylamine) NA 1955

DOT PLACARD: POISON GAS

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placecarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. All shipments will be handled per local SOP. (AR 55-355)

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.

LIST OF REFERENCES FOR MSDS FOR HN1

1. Compton, James A.F., Military Chemical and Biological Agents, The Telford Press, Caldwell, NJ, 1987.

2. Field Manual 8-9, NATO Handbook on the Medical Aspects of NBC Defensive Operations, Department of the Army, the Navy, and the Air Force, Washington, D.C., August 1973.

3. Summary Technical Report of Division 9, NDRC, Volume I. Chemical Warfare Agents and Related Chemical Problems, Parts I-II, "Chapter 6: Nitrogen Mustards", by Arthur C. Cope, Marshall Gates, and Birdsey Renshaw, Washington, DC, 1946.

4. Summary Technical Report of Division 9, NDRC, Volume I. Chemical Warfare Agents and Related Chemical Problems, Parts III-VI, "Chapter 22: Systemic Pharmacology and Pathology of Sulfur and Nitrogen Mustards", by William P. Anslow and C. Riley Houck, Washington, DC, 1946.

5. Field Manual 3-9, Military Chemistry and Chemical Compounds, Department of the Army and the Air Force, Washington, DC, 30 October 1975.

6. TM 8-285, Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries, Department of the Army, the Navy, and the Air Force, Washington, DC, May 1974.

7. The Merck Index, 10th ed., Merck and Co., Inc., Rahway, NJ, USA, 1983.

8. RTECS, Registry of Toxic Effects of Chemical Substances, US Department of Health and Human Services, Washington, DC, 1987.

9. CWS Field Lab Memo 1-4-5, Medical Division Status Summaries, Information Division, CWS Technical Command, Chemical Warfare Center, Edgewood Arsenal, MD, August 1944.

10. AMC-R 385-131, Safety Regulation for Chemical Agents H, HD, HT, GB, and VX, Department of the Army, Headquarters, United States Army Material Command, Alexandria, VA, 9 October 1987.

11. AR 385-64, Ammunition and Explosives Safety Standards, Headquarters, Department of the Army, Washington, DC, 22 May 1987.

12. CRDECR 385-1, Chemical, Explosive, and Occupational Safety and Health Program, Department of the Army, US Army Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD, 15 August 1986.

ADDENDUM A

Equipment Description

M-9 Mask	----	Mask, Chemical Biological Special Purpose M9, M9A1.
M-40 Mask	----	Mask, Protective
M-17 Mask	----	(M-17, M-17A1, M17-A2) - Biological/Chemical Field Protective Mask.
M-3 Tap	----	Toxicological Agent Protective Ensemble
M-3 Hood	----	Toxicological Agent Protective
M-2A1 Boots	----	Butyl-Safety Toe-TAP-Toxicological Agent Protective
M3	----	M3 Gloves Toxicological Protective
M4	----	M4 Gloves Toxicological Protective
Gloves	----	Gloves-Norton-Toxicological Protective

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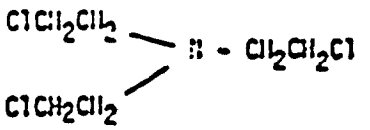
1. Chemical Code or EA Number: HN-3

2. Chemical Name: 2, 2', 2" - Trichlorotriethylamine, Nitrogen Mustard -3.

3. Chemical Formulae:

   a. Empirical. $C_6H_{12}Cl_3N$

   b. Structural.



4. Biological Type Compound: Lethal agent.

5. Principal Pharmacological Action:

HN-3 is a vesicant, and similar to HD, produces eye injury, damage to the respiratory tract and, after absorption into the body, produces cytotoxic actions in a variety of tissues. The hematopoietic and lymphoid tissues are especially sensitive. These cytotoxic effects follow absorption through the intact skin, respiratory or gastrointestinal tracts.

6. Characteristic Odor: None when pure.

7. Effective Routes of Administration: Ocular, percutaneous, inhalation, ingestion, injection.

8. Median Lethal Dosage, Man:

   a. Total Exposure (Head and Body Unprotected). LCt_{50}, 1500 mg min/m^3.

Since HN-3 is not detoxified and the effects are cumulative, this Ct is not significantly changed with variations in time of exposure within reasonable limits.

   b. Percutaneous.

      Vapor, LCt_{50}, masked personnel. 10,000 mg min/m^3.

      Liquid, approximate LD_{50}. Estimated to be 0.7 g/70 kg man.

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9. Median Lethal Dosage, Animal:

a. Total Exposure (Head and Body Unprotected).

(Temperatures given when known).

Species	LCt_{50}*	t	Remarks
	(mg min/m^3)	(min)	
House	165	10	Vapor, wind tunnel, 5.5 mph, 95° F
	345	10	Aerosol (2 μ), wind tunnel, 5.5 mph, 80° F
	500-600	10	Aerosol-free vapor
	590	10	Low-flow chamber
	300	10	High flow chamber, aerosol present
Rat	ca 300	0.25-2	Fine aerosol
	1700 (H)**	10	Low-flow chamber
	670	10-100	Vapor, 90° F, 85% R.H.
Guinea Pig	2300 (H)**	10	Low-flow chamber
	1000	30	Static chamber, 80° F
Rabbit	ca 585	3-15	Vapor, wind tunnel, 5.5 mph, 95° F
	330	10-50	Low-flow, 72° F
	500	10-18	Low-flow chamber, vapor only, 100° F
	635	10-100	Vapor, 90° F, 85% R.H.
Cat	400-1000	10	Low-flow chamber
Dog	400-1500	10	Low-flow chamber
Goat	500-1000	30	Static chamber, 85° F

* Analytical concentration unless otherwise stated
** Nominal concentration

b. Inhalation (Head Exposed, Body Protected).

Species	LCt_{50} (mg min/m^3)	t (min)	Remarks
Mouse	1100	10	Low flow
	1200	10	High flow
Rabbit	650	10	Vapor, wind tunnel, 5.5 mph, 95° F
	1000	10	Vapor, low flow, 72° F
	600-800	10	Vapor, low flow, 100° F

c. Percutaneous.

(1) Vapor (body exposed, head protected).

The percutaneous toxicities of HN-3 vapor for all animal species except the mouse were found to be insignificant when compared with total exposure toxicities. In the mouse, HN-3 was more toxic by body exposure than by inhalation.

Mouse LCt_{50}'s (mg min/m^3), t = 10 min

Types of Exposures			Flow
Body (PC)	Inhalation	Total	
1000	1100	590	Low
370	1200	300	High

(2) Liquid, LD_{50}'s in mg/kg.

Mouse - 7.0 (base)
Rat - 4.9 (base)
Rabbit - 19.0 (base)
Dog - 10.0 (base)
Goat - 20.0 (base)

d. Intravenous, LD_{50}'s in mg/kg.

Mouse	1-2
Rat	0.7 (HCl)
Rabbit	2.5 (HCl)
Dog	1.0

e. Subcutaneous, LD_{50}'s in mg/kg.

Mouse	2.0 (HCl)
Rat	2.0 (HCl)
Guinea Pig	7-10
Rabbit	2.0 (base)
Goat	20-30 (base)

f. Intragastric, LD_{50}'s in mg/kg.

Rat 2.5 mg/kg (HN-3 in corn oil)

10. Median Incapacitating Dosage, Man (ICt_{50}'s):

a. Inhalation. No data.

b. Percutaneous (Masked Personnel). 2500 mg min/m^3.

c. Eye Injury. 200 mg min/m^3.

11. Threshold Limit Value. No data.

12. Minimum Effective Dosage: No data on minimum effective dosage. Effects of low dosages for man are given below.

a. Eyes. Although exposure to an HN-3 vapor dosage of 20 mg min/m^3 (t unknown) produced no subjective symptoms among four volunteers, all showed moderate conjunctival infection. Grossly, their corneas seemed normal, but slit-lamp examination revealed moderate to marked epithelial edema. Three volunteers exposed to 42 mg min/m^3 (t = 7 min) developed lacrimation, photophobia, and a gritty feeling in the eye. Grossly, their corneas were normal and did not stain with fluorescein, but slip-lamp examination revealed epithelial edema and slight infiltration of the anterior stroma. One developed moderate edema of the lids. On the fourth day after exposure, all were improving both subjectively and objectively.

b. Skin. Median threshold blistering dosage, ca. 70 mg.

13. & 14. Acute Physiological Effects and Onset Time of Symptoms:

a. Eyes.

In single exposures, nitrogen mustards irritate the eye in doses which do not significantly damage the skin or respiratory tract. This irritation appears sooner than that from mustard.

Mild or moderate exposure causes slight smarting and lacrimation within 20 minutes. Thereafter, symptoms may wax and wane until they become persistent about 2-1/2 hours later and reach their maximum in 8 to 10 hours. Mild exposure produces erythema and edema of the palpebral and bulbar conjunctivae and superficial, steamy haziness of the cornea. Irritation, lacrimation, deep eye pain, miosis, and photophobia are usually present.

After more severe exposure, symptoms begin immediately and progress for 24 hours or longer. These symptoms are followed by spotty hemorrhagic discolorations of the iris. The corneal epithelium shows a roughened, lusterless surface, with areas of punctate staining (fluorescein). Severe exposure may cause the corneal epithelium to exfoliate. Slit lamp examinations will reveal clouding and edema of the corneal substance extending deep below the Bowman's membrane. Local necrosis of the cornea may rupture the globe.

b. Skin.

In mild vapor exposures, there may be no skin lesions. After severe vapor exposure or after exposure to liquid nitrogen mustard, erythema may appear earlier than in mustard contamination. There may be irritation and itching as with mustard. Later, blisters may appear in the erythematous areas. The skin lesions are similar to those caused by mustard.

c. Respiratory Tract.

The symptoms are the same as those caused by mustard, namely, delay in appearance, irritation of the nose and throat, hoarseness progressing to aphonia, and a persistent cough. Fever, dyspnea, and moist rales may develop. Bronchopneumonia may appear after the first 24 hours.

Mild tracheitis may result in a persistent cough. Low grade fever may persist a week or longer. The prognosis is grave if there is a severe respiratory tract involvement. Late deaths due to pneumonia may occur.

d. Gastrointestinal Tract.

Following oral administration or systemic absorption, the nitrogen mustards injure the intestinal tract. In animals severe diarrhea, which may be hemorrhagic, occurs. Lesions are most marked in the small intestine and consist of degenerative changes and necrosis in the mucosa. In man the ingestion of 2 to 6 milligrams causes nausea and vomiting.

e. Systemic Effects.

The most specific effects of the nitrogen mustards are on the hematopoietic and lymphoid tissues. These effects follow absorption from the intact skin, respiratory or gastrointestinal tract. In bone marrow the degenerative changes can be detected within 12 hours and may progress to severe aplasia. The thymus, spleen, and lymph nodes involute rapidly, with necrosis and phagocytosis of their lymphocytes. This injury is demonstrable in the blood as a transient leucocytosis of a few hours duration, followed by severe lymphopenia, granulocytopenia, thrombocytopenia, and a moderate anemia. The blood picture may show little change other than lymphopenia for 5 to 10 days after exposure, when the white count may fall to 500 cells/mm^3 or lower. The various nitrogen mustards differ in ability to produce these changes.

15. Chronic Physiological Effects:

In severe cases scarring of the cornea may be expected and the iris is frequently left discolored and atrophied. Repeated skin burns may lead to hypersensitivity of the skin, manifested in the same manner as sensitivity to HD (q.v.).

16. Self Aid and First Aid: Same as for HD (q.v.).

17. Tolerable Environmental Concentrations to Uncontrolled Population:

No data.

18. Molecular Height: 204.5.

19. Purity Range (average):

a. Laboratory Sample. 96 to 99 wt%.

b. Plant Sample.

20. Physical Appearance: Dark to bright yellow liquid.

21. Vapor Density, Relative to Air: 7.1.

22. Liquid Density: 1.24 g/ml @ 25° C.

23. Solid Density:

a. Bulk Density. NA

b. Crystal Density. NA

24. Normal Freezing Point or Melting Point: -3.7° C.

25. Boiling Point: 256° C (calculated); decomposes at 150° C.

26. Vapor Pressure: 0.011 mm Hg @ 25° C.

27. Volatility: 120 mg/m^3 @ 25° C.

28. Viscosity: 5.9 centistokes @ 25° C.

29. Flash Point: High enough not to interfere with military use of the agent.

30. Autoignition Temperature: Decomposes at 150° C; may become explosive. (Properties of War Gases - Vol IV, E1F100/41).

31. Latent Heat of Vaporization: 74 cal/g.

32. Latent Heat of Fusion: Unknown.

33. Vapor-Air Explosive Hazard Range: Unknown.

34. Relative Persistency:

a. Soil. Persistent.

b. Surface (Wood, Metal, Masonry, Rubber, Paint). Persistent.

c. Water. Not completely hydrolyzed by water after standing for days.

35. Solubility (g/100 g solvent):

a. Water (distilled). 0.003 g/100 g solvent.

b. Other. Soluble in ether, benzene, and most organic solvents.

c. Best Solvent. Organic solvents.

Nitrogen Mustard

36. Thermal Decomposition Rate: Decomposes at 150° C. Process may become explosive. Unstable at room temperature in glass.

37. Heat of Combustion: Unknown.

38. Products of Combustion: CO_2, HCl, Cl_2, H_2O, N_2 estimated for furnace incinerator.

39. Rate of Hydrolysis:

a. Acidic (pH). Very slow.

b. Basic (pH). Hydrolysis is more rapid under basic conditions.

40. Hydrolysis Products: $N(CH_2CH_2OH)_3$ in dilute solutions; dimer formation in higher concentrations.

41. Corrosive Properties: Does not attack iron in the absence of water. Penetrates steel at the rate of 1×10^{-5} to 5×10^{-5} inches/month at 65° C.

42. Detection Methods and Equipment: DB-3 Test, Spotted Disk (SD) Test, Dragendorff Test; otherwise, same as H.

43. Decontaminants:

a. Personnel. M13 kit (liquid on skin, clothing, or equipment). M5 ointment.

b. Equipment. Bleach, DANC solution. DS2.

c. Areas (Terrain). Fire, earth moving equipment; STB slurry sprayed from M9 or M12A1 decontaminating apparatus.

44. DOT Classification: Poison A.

45. Stabilizer Utilized:

a. Laboratory Sample. Rate of polymerization decreases with addition of CS_2 & ϕ_3COH (carbon disulfide, triphenyl carbinol).

b. Production Sample. Same.

46. Types of Containers Required for Storage:

a. RDT&E Quantities. Glass with stabilizer.

b. Stockpile Quantities. Stable in high carbon steel at 25° for 40-50 weeks or low carbon steel with stabilizer. Polymerizes when stored at 65° C.

47. Q-D Classification: 8
Compatibility Group: A
Chemical Group: A

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DATE: 7 January 1991

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LEWISITE

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

MATERIAL SAFETY DATA SHEET

Emergency Telephone #s:
Cml Rsch Dev & Engr Cen
301-671-4411 0700-1700
EST After normal duty
hours: 301-278-5201
Ask for CRDEC Staff
Duty Officer

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Chemical Research, Development and Engineering Center

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

CAS REGISTRY NUMBER: 541-25-3

CHEMICAL NAME AND SYNONYMS:

Arsine, (2-chlorovinyl) dichloro-
Arsonous dichloride, (2-chloroethenyl)-
Chlorovinylarsine dichloride
2-Chlorovinyldichloroarsine
beta-Chlorovinyldichloroarsine
Dichloro (2-chlorovinyl) arsine

TRADE NAME AND SYNONYMS: Lewisite, L, EA 1034

CHEMICAL FAMILY: Arsenical (vesicant)

FORMULA/CHEMICAL STRUCTURE:

C2H2AsC13

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          H
C1        |      C1
   >C=C- As<
H              C1
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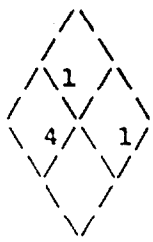
NFPA 704 SIGNAL: Health - 4
Flammability- 1
Reactivity- 1



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SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
Lewisite	C2H2AsC13	100	* 0.003 mg/m3

* This is a ceiling value

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): 374 (190)

VAPOR PRESSURE (mm Hg): 0.35 @ 25 DEG C
0.22 @ 20 DEG C

VAPOR DENSITY (AIR=1): 7.2

SOLUBILITY: Negligible in water, completely soluble in Et20, CHC13, all common organic solvents, mustard, oils, and alcohol.

SPECIFIC GRAVITY (H2O=1): 1.88 @ 25 Deg C

VOLATILITY (mg/m3): 3.9 x (10)3 @ 25 DEG C
2.5 x (10)3 @ 20 DEG C

MOLECULAR WEIGHT: 207.32

APPEARANCE AND ODOR: Pure L is a colorless oily liquid. "War gas" is an amber to dark brown liquid; characteristic odor is usually geranium-like; very little odor when pure.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT (Method Used): does not flash.

FLAMMABILITY LIMITS: N/A.

EXTINGUISHING MEDIA: N/A.

SPECIAL FIRE FIGHTING PROCEDURES: Full protective clothing (See Section 8) and full respiratory protection must be worn when fighting fires inside buildings and areas where L is stored. Full protective clothing and canister or filter type mask can be worn where oxygen deficiency is not a problem. All persons not engaged in extinguishing the fire should be evacuated. Skin contact and inhalation of L and its vapors must be avoided at all times. Although the fire may destroy most of the L, care must be taken to assure that the L does not contaminate uncontrolled areas and that the fire-fighters are adequately protected from physical contact with the agent and agent fumes.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMIT (AEL): The AEL for Lewisite is 0.003 mg/m3 as a ceiling value. A ceiling value may not be exceeded at any time. Practically, it may be an average value over the minimum time required to detect the specified concentration. The ceiling value for Lewisite is based upon the present technologically feasible detection limit of 0.003 mg/m3. The ceiling value may be lowered as detection technology improves. The AEL for Lewisite is proposed by AR 385-64, Change 2 to DoD 6055.9-Std (Appendix A). To date, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure limit (PEL) for Lewisite.

EFFECTS OF OVEREXPOSURE: L is a vesicant (blister agent), also, it acts as a systemic poison, causing pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure. In order of severity and appearance of symptoms, it is: a blister agent, a toxic lung irritant, and absorbed in tissues, a systemic poison. When inhaled in high concentrations, may be fatal in as short a time as 10 minutes. L is not detoxified by the body. Common routes of entry into the body include occular, percutaneous, and inhalation.

LCt50 (inhalation, man) = 1200 - 1500 mg min/m3
LCt50 (skin vapor exposure, man) = 100,000 mg min/m3
LDLO (skin, human) = 20 mg/kg
LCt50 (skin, man): >1500 mg/min3. L irritates eyes and skin and gives warning of its presence. Minimum effective dose (ED min) = 200 mg/m3 (30 min).
ICt50 (eyes, man): <300 mg min/m3.

ANIMAL TOXICOLOGICAL DATA:

LD50 (oral, rat) = 50 mg/kg
LD50 (subcutaneous, rat) = 1 mg/kg
LCtLO (inhalation, mouse) = 150 mg/m3 10m
LD50 (skin, dog = 15 mg/kg RTECS) or 38 mg/kg (CRDEC chemical agent data sheets)
LD50 (skin, rabbit) = 6 mg/kg
LD50 (subcutaneous, rabbit) = 2 mg/kg
LD50 (intravenous, rabbit) = 500 mg/kg
LD50 (skin, guineapig) = 12 mg/kg
LD50 (subcutaneous, guinea pig) = 1 mg/kg
LD50 (skin, domestic farm animals) = 15 mg/kg
LCt50 (inhalation, rat) = 1500 mg min/m3 (9 min)
LCt50 (vapor skin, rat) = 20,000 mg min m 25 min)
LCD50 (skin, rat) = 15 - 24 mg/kg
LD50 (ip, dog) = 2 mg/kg
EDmin (skin, dog) = 50 mg/m3 (30 min)
EDmin (eye, dog) = 20 mg/m3 (30 min)
EDmin (skin, rabbit) = 25 mg/m3 (30 min)
EDmin (eye, rabbit) = 1 mg/m3 (30 min)

a. Acute Exposure:

(1) Eyes. Severe damage. Instant pain, conjunctivitis and blepharospasm leading to closure of eyelids, followed by corneal scarring and iritis. Mild exposure produces reversible eye damage if decontaminated instantly, otherwise more permanent injury or blindness is possible within 1 minute of exposure.

(2) Skin. Immediate stinging pain increasing in severity with

time. Erythema (skin reddening) appears within 30 minutes after exposure accompained by pain with itching and irritation for 24 hours. Blisters appear within 12 hours after exposure with more pain which diminished after 2-3 days. Skin burns are much deeper than with HD. Tender and moist skin (mucous membrane; perspiration covered;...), absorbs more L, therefore is more sensitive than the skin. This, however, is counteracted by L's hydrolysis by moisture, producing less vesicant, higher vapor pressure product.

(3) Respiratory Tract. Irritating to nasal passages and produces a burning sensation followed by a profuse nasal secretion and violent sneezing. Prolonged exposure causes coughing and production of large quantities of froth mucus. In experimental animals, injury to respiratory tract, due to vapor exposure is similar to mustard's; however, edema of the lung is more marked and frequently accompanied by pleural fluid.

(4) Systemic Effects. L on the skin, as well as inhaled vapor, are absorbed and may cause systemic poisoning. A manifestation of this is a change in capillary permeability, which permits loss of sufficient fluid from the bloodstream to cause hemoconcentration, shock and death. In non-fatal cases, hemolysis of erythrocytes has occurred with a resultant hemolytic anemia. The excretion of oxidized products into the bile by the liver produces focal necrosis of that organ, necrosis of the mucosa of the biliary passages with periobiliary hemorrhages, and some injury to the intestinal mucosa. Acute systematic poisoning from large skin burns causes pulmonary edema, diarrhea, restlessness weakness, subnormal temperature, and low blood pressure in animals.

b. Chronic Exposure. L can cause sensitization and chronic lung impairement. Also, by comparison to agent mustard and arsenical compounds, it can be considered as a suspected human carcinogen.

EMERGENCY AND FIRST AID PROCEDURES: Always don your own protective mask and gloves before administering first aid.

INHALATION: Remove from the source immediately. If breathing has stopped give artifical 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 for 10-15 minutes by tilting the head to the side, pulling eyelids apart with 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. See medical attention IMMEDIATELY.

SKIN CONTACT: Remove victim from source immediately and remove contaminated clothing. Immediately decon affected areas by flushing with 10 percent sodium carbonate solution. After 3-4 minutes, wash off with soap and water to protect against erythema. Seek medical attention immediately.

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

SECTION VI - REACTIVITY DATA

INCOMPATIBILITY: Corrosive to steel at a rate of 1 x 10 -5 to 5 x 10-5 in/month at 65 DEG C.

HAZARDOUS DECOMPOSITION PRODUCTS:
Stability: Reasonably stable; however, in presence of moisture, it hydrolyses rapidly, losing its vesicant property. It also hydrolyses in acidic medium to form HCl and non-volatile (solid) chlorovinylarsenious oxide, which is less vesicant than Lewisite. Hydrolysis in alkaline medium, as in decontamination with alcoholic caustic or carbonate solution or DS2, produces acetylene and trisodium arsenate (Na3 AS 04). Therefore, decontaminated solution would contain toxic arsenic.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

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

RECOMMENDED FIELD PROCEDURES: The L should be contained using vermiculite, diatomaceous earth, clay, or fine sand and neutralized as soon as possible using copious amounts of alcoholic caustic, carbonate, or DS2. Caution must be exercised when using these decontaminates since acetylene will be given off. Household bleach can also be used if accompanied by stirring to allow contact. Scoop up all contaminated material and place in approved DOT containers. Cover with additional decontaminant. Decontaminate the outside of the container, label IAW DOT and EPA requirements, and dispose of as specified below. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

RECOMMENDED LABORATORY PROCEDURES: A 10 wt percent alcoholic Sodium Hydroxide solution is prepared by adding 100 grams of denatured ethanol to 900 grams of 10 wt percent NaOH in water. A minimum of 200 grams of decon is required for each gram of L. The decon/agent solution is agitated for a minimum of one (1) hour. At the end of one hour the resulting pH should be checked and adjusted to above 11.5 using additional NaOH, if required.

It is permitted to substitute 10 wt percent alcoholic sodium carbonate made and used in the same ratio as the NaOH listed above. Reaction time should be increased to 3 hours with agitation for the first hour. Final pH should be adjusted to above 10.

It is permitted to substitute 5.25 percent sodium hypochlorite for the 10 percent alcoholic sodium hydroxide solution above. Allow one hour with agitation for the reaction. Adjustment of the pH is not required.

Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Section 8).

WASTE DISPOSAL METHOD:
All neutralized material should be collected and contained for disposal IAW land ban RCRA regulations or thermally decomposed in an EPA permitted incinerator equipped with a scrubber which will scrub out the chlorides and be equipped with an electrostatic precipitator or other filter device to remove arsenic. Collect all the arsenic dust from the electrostatic precipitator or other filter device and containerize and label IAW DOT and EPA regulations. The arsenic will be disposed of IAW land ban RCRA regulations. Any contaminated materials or protective clothing should be decontaminated using alcoholic caustic, carbonate, or bleach 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.

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

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Concentration (mg/m3)	Respiratory Protection/Ensemble Required
*0.003 (unmasked agent worker)	A full facepiece, chemical canister, air-purifying, protective mask shall be on hand for escape (the M9, M17 and M40 series protective masks are acceptable for this use).
Greater than *0.003 and less than or equal to **0.003 (masked personnel in routine operations)	A. A full facepiece, chemical canister, air-purifying protective mask (M9, M17 and M40 series protective masks and NIOSH approved, air-supplied escape devices are acceptable for this use). B. A NIOSH-MSHA-approved pressure demand or continuous flow, full facepiece air-supplied respirator. C. A NIOSH-MSHA-approved pressure-demand full facepiece SCBA.
Greater than *0.003 or unknown	A. NIOSH-MSHA-approved, full face-piece pressure-demand respirator suitable for use in atmospheres immediately dangerous to life and health. Respirator and protective suit must be approved by the AMC Field Safety Activity prior to use. B. For field operations or emergencies only, use full face-piece, chemical canister, air-purifying protective mask with hood (only the M9 series protective mask with M11 canister and M40 mask are acceptable for this use).

* This represents the ceiling value determined by continuous real time monitoring (with alarm) at the 0.003 mg/m3 level of detection.

** Based on an 8-hr TWA measurement. The stated or permissible TWA is the concentration to which nearly all workers may be repeatedly exposed, for a normal 8-hr workday, day after day, without adverse effect. TWAs permit excursions above the limit provided they are compensated by equivalent excursions below the limit during the workday.

VENTILATION: Local exhaust - Mandatory, must be filtered or scrubbed to limit exit concentration to non-detectable level.

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (1fpm) = 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 inclosure's ability to contain Lewisite.

Other: Recirculation of exhaust air form 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. Procedures should be developed for disposal of contaminated filters.

PROTECTIVE GLOVES: Norton, Chemical Protective Glove Set
M3 Butyl Rubber

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

OTHER PROTECTIVE EQUIPMENT: Full protective clothing (Level A) 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 30 mil Demilitarization Protective Ensemble (DPE) if available or NIOSH approved equivalent. For general lab work, gloves and lab coat shall be worn with M9, M17 or M40 mask readily available.

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

MONITORING: Available monitoring equipment for agent L is the M18A2 (yellow band), Automatic Chemical Agent Detector Alarm (ACADA), bubblers (arsenic and GC method) and the M256A2 Kit.

SECTION IX - SPECIAL PRECAUTIONS

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. Stringent control over all personnel handling L must be exercised. 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. The storage or consumption of food or beverages; the storage or application of cosmetics; the smoking or storage of smoking materials, tobacco products or other products for chewing; or the chewing of such product in all laboratory areas, is prohibited. Laboratory glasswear will not be used to prepare or consume food or beverages. Decontaminating equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. L 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 or during transportation.

SECTION X - TRANSPORTATION DATA

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

DOT HAZARD CLASSIFICATION: Poison A

DOT LABEL: Poison Gas

DOT MARKING: Poisonous liquid, n.o.s. (Chlorovinylarsine dichloride)
NA 1955

DOT PLACARD: POISON GAS

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

PRECAUTTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given fullo 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 and Development 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 and Development 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.

Occupational Health Guideline for Chloropicrin

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: CCl_3NO_2
- Synonyms: Nitrotrichloromethane; trichloronitromethane; nitrochloroform
- Appearance and odor: Colorless, oily liquid with a sharp, penetrating odor that causes tears.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for chloropicrin is 0.1 part of chloropicrin per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.7 milligram of chloropicrin per cubic meter of air (mg/m³).

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Chloropicrin 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: Chloropicrin causes eye irritation and tearing. It also causes cough, nausea, and vomiting, and severe irritation of the skin. Breathing chloropicrin vapors may also cause delayed severe breathing difficulties and which may cause death.

2. Long-term Exposure: Overexposure to chloropicrin may cause increased susceptibility to future overexposure.

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 chloropicrin.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to chloropicrin 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 respiratory system should be stressed. The skin should be examined for evidence of chronic disorders.

—FVC and FEV (1 sec): Chloropicrin is a severe respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure.

—14" x 17" chest roentgenogram: Chloropicrin may cause respiratory impairment. Persons with pre-existing pulmonary disease may be at increased risk.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Chloropicrin vapor is a severe irritant of the eyes, skin, and respiratory tract. A lethal exposure for humans is stated to be 119 ppm for 30 minutes, with death usually resulting from pulmonary edema; particular injury occurs in the medium and small bronchi. In addition to pulmonary irritation, human exposure results in lacrimation, cough, nausea, vomiting, and skin irritation; individuals injured by inhalation of chloropicrin vapor are said to be more susceptible to subsequent exposures. A concentration of 15 ppm could not be tolerated longer than 1 minute, even by persons acclimated to chloropicrin; exposure to 4 ppm for a few seconds is temporarily disabling, due to the irritant effects. Concentrations of 0.3 to 0.37 ppm resulted in painful eye irritation in 3 to 30 seconds. Chloropicrin is a severe skin irritant.

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

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

CHEMICAL AND PHYSICAL PROPERTIES

- Physical data

1. Molecular weight: 164.4
2. Boiling point (760 mm Hg): 112 C (234 F)
3. Specific gravity (water = 1): 1.635
4. Vapor density (air = 1 at boiling point of chloropicrin): 5.7
5. Melting point: −64 C (−83 F)
6. Vapor pressure at 20 C (68 F): 20 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.18
8. Evaporation rate (butyl acetate = 1): Data not available

- Reactivity

1. Conditions contributing to instability: High temperatures or severe shock, particularly when involving containers of greater than 30 gallons capacity.
2. Incompatibilities: Contact with strong oxidizers may cause fires or explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen, phosgene, nitrosyl chloride, chlorine, and carbon monoxide) may be released when chloropicrin decomposes.
4. Special precautions: Liquid chloropicrin will attack some forms of plastics, rubber, and coatings.

- Flammability

1. Not combustible, but with strong initiation, heated material under confinement will detonate.
2. Fires involving chloropicrin should be fought from an explosion-resistant location.

- Warning properties

1. Odor Threshold: Stern reports an odor threshold of 0.0073 mg/l (1.1 ppm)
2. Eye Irritation Level: The *Documentation of TLV's* states that "according to Flury and Zernik, chloropicrin in concentrations of from 0.3 to 0.37 ppm resulted in painful irritation to the eyes in 3 to 30 seconds." Patty, however, reports that 1.3 ppm is the lowest irritant concentration, but that 0.3 to 3.7 ppm for 3 to 30 seconds causes "closing of the eyelids according to individual sensitivity."
3. Evaluation of Warning Properties: Through its irritant effects on the eyes, chloropicrin can be detected within three times the permissible exposure limit, according to the *Documentation of TLV's*. For the purposes of this guideline, therefore, it is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- General

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).

- Method

At the time of publication of this guideline, no measurement method for chloropicrin had been published by NIOSH.

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 any possibility of skin contact with liquid chloropicrin.
- Clothing contaminated with chloropicrin should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of chloropicrin from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the chloropicrin, the person performing the operation should be informed of chloropicrin's hazardous properties.
- Where there is any possibility of exposure of an employee's body to liquid chloropicrin, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with chloropicrin should be removed immediately and not reworn until the chloropicrin is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid chloropicrin contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to liquid chloropicrin, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with chloropicrin should be immediately washed or showered with soap or mild detergent and water to remove any chloropicrin.
- Eating and smoking should not be permitted in areas where liquid chloropicrin is handled, processed, or stored.
- Employees who handle liquid chloropicrin 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 chloropicrin may occur and control methods which may be effective in each case:

Operation	Controls
Use as a soil fumigant, disinfectant, and sterilizer for control of fungi, nematodes, and other injurious organisms; liberation as a fumigant for stored grains, cereals, and fruits	Process enclosure; general dilution ventilation; personal protective equipment
Use as a rodenticide and insecticide for rats and insects	Process enclosure; general dilution ventilation; personal protective equipment
Use as a chemical intermediate in organic synthesis in dyes and as an oxidizing agent	Process enclosure; general dilution ventilation; personal protective equipment
Use as a warning agent in illuminating gas; use as a lacrimator, and as a nauseant in chemical warfare	General dilution ventilation; personal protective equipment
Use as a chemical sterilant without high temperature	General dilution ventilation; process enclosure; 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 liquid chloropicrin or high concentrations of chloropicrin vapor get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If liquid chloropicrin gets on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If liquid chloropicrin soaks through the clothing, remove the clothing immediately 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 chloropicrin, 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 liquid chloropicrin has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **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 liquid chloropicrin 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:

Chloropicrin may be disposed of by absorbing in vermiculite, dry sand, earth, or a similar material and disposing in sealed containers in a secured sanitary landfill.

REFERENCES

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RESPIRATORY PROTECTION FOR CHLOROPICRIN

Condition	Minimum Respiratory Protection* Required Above 0.1 ppm
Vapor Concentration	
4 ppm or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 4 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 with a full facepiece providing protection against organic vapors. Any escape self-contained breathing apparatus with a full facepiece.

*Only NIOSH-approved or MSHA-approved equipment should be used.

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of chloropicrin; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 4 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

CHLOROPICRIN

CPL

Common Synonyms		
Trichloronitromethane Nitrochloroform Picfume Nitrotrichloromethane	Oily liquid. Colorless. Extremely irritating odor. Strike in water. Poisonous vapor is produced.	

AVOID CONTACT WITH LIQUID AND VAPOR. KEEP PEOPLE AWAY.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
POISONOUS GASES ARE PRODUCED IN FIRE.
Containers may explode in fire.
Wear chemical protective suit with self-contained breathing apparatus.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
POISONOUS IF INHALED.
Irritating to eyes, nose and throat.
Move victim to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
Will burn skin and eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-assess, water contaminant, air contaminant
Restrict access; evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Poison
2.2 Class: 6

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: CCl_3NO_2
3.3 IMO/UN Designation: 6.1/1580
3.4 DOT ID No.: 1580
3.5 CAS Registry No.: 76-06-2

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Intensely irritating, lachrymator; intense and penetrating odor which causes a pronounced secretion of tears.

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Self contained breathing apparatus, rubber gloves, protective clothing
5.2 Symptoms Following Exposure: Inhalation causes nausea, eye watering, vomiting, bronchitis, and pulmonary edema. Vapor is a powerful tear gas. Liquid irritates and burns skin and causes severe burns of eyes. Ingestion causes severe erosion of mouth and stomach.
5.3 Treatment of Exposure: Get medical attention following all exposures to this compound. INHALATION: remove from exposure, support respiration. EYES: flush with copious quantities of water for at least 15 min. SKIN: wash with water for 15 min. INGESTION: do NOT induce vomiting; give large amounts of water.
5.4 Threshold Limit Value: 0.1 ppm
5.5 Short Term Inhalation Limits: 0.3 ppm
5.6 Toxicity by Ingestion: Grade 3, oral LD_{50} = 250 mg/kg (rat)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause severe irritation of eyes and throat and can cause eye or lung injury. They cannot be tolerated even at low concentrations.
5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second-and third-degree burns on short contact and is very injurious to the eyes.
5.10 Odor Threshold: 1.1 ppm
5.11 IDLH Value: 4 ppm

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Cool exposed containers with water
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Compound forms a powerful tear gas when heated. Heated material may decompose under fire conditions.
6.7 Ignition Temperature: Not pertinent
6.8 Electrical Hazards: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: 99%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Poison B
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	0
Health	
Vapor Irritant	4
Liquid or Solid Irritant	4
Poisons	4
Water Pollution	
Human Toxicity	4
Aquatic Toxicity	3
Aesthetic Effect	4
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classifications

Category	Classification
Health Hazard (Blue)	4
Flammability (Red)	0
Reactivity (Yellow)	3

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 16°C and 1 atm: Liquid
12.2 Molecular Weight: 164.4
12.3 Boiling Point at 1 atm: 231°F = 112°C = 385°K
12.4 Freezing Point: −63°F = −64°C = 209°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.64 at 25°C (liquid)
12.8 Liquid Surface Tension: 32.3 dynes/cm = 0.0323 N/m at 19°C
12.9 Liquid Water Interfacial Tension: (est.) 20 dynes/cm = 0.02 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 5.7
12.11 Ratio of Specific Heats of Vapor (Gas): 1.0991
12.12 Latent Heat of Vaporization: 103 Btu/lb = 57.3 cal/g = 2.4×10^5 J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 46.18 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

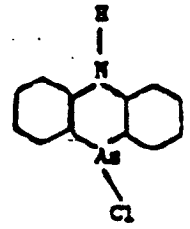
1. Chemical Code or EA Number: DM

2. Chemical Name: 10 chloro- 5, 10 dihydrophenarsazine, Adamsite.

3. Chemical Formulae:

   a. Empirical. $C_{12}H_9AsClN$

   b. Structural.



4. Biological Type Compound: Incapacitating sternutator.

5. Principal Pharmacological Action:

DM produces strong pepper-like local inflammation of the upper respiratory tract, the nasal accessory sinuses, with irritation of the eyes and lacrimation. It causes violent uncontrollable sneezing, coughing, nausea, vomiting, and a general feeling of malaise.

6. Characteristic Odor: No pronounced odor; irritates nasal passages similar to pepper.

7. Effective Routes of Administration: Inhalation, percutaneous, injection, oral.

8. Median Lethal Dosage, Man (LCt_{50}'s):

   a. Inhalation. (Single exposures of 4 hours or less.)

   11,000 mg min/m^3 - pure DM dispersed by laboratory methods (as a dry dust, form solvent sprays or by volatilization-condensation).

   35,000 mg min/m^3 - dispersed from Federal Laboratories No. 113 Speedheat Grenade.

   44,000 mg min/m^3 - dispersed from M6A1 military grenade.

Adamsite

9. Median lethal Dosage, Animal:

a. Inhalation (LCt_{50}'s).

Species	Pure DM	M5A1 Grenade	No. 112 Grenade
		mg min/m^3	
Monkey	17,837	19,569	22,814
Dog	7,828	28,193	28,428
Swine	56,364	36,011	35,888
Goat	12,135	8,076	11,723
Rabbit	2,903	41,159	46,959
Rat	10,224	66,856	48,217
Guinea Pig	4,623	12,591	29,888
Mouse	46,245* (1918-1965)		
All rodents	10,951	83,380	37,980
Nonrodents	10,233	24,462	30,063
All species	12,306	43,208	34,683
No. of animals	407	473	656

*These animals are not included in the total number of animals listed below for pure DM.

b. Intraperitoneal. Dog. 10 mg/kg body weight kills a dog.

10. Median Incapacitating Dosage, Man.

a. Inhalation, ICt_{50}: 370 mg min/m^3 (nausea and vomiting).

11. Threshold Limit Value: No data.

12. Minimum Effective Dosage, Man:

Lowest intolerable concentration.

Concentration	Time of Exposure
mg min/m^3	minute
22	1
3.6	5
3.45	15
8.40	60

The lowest concentrations (sprayed from alcoholic solutions) that are irritating to the throat and lower respiratory tract are 0.38 and 0.5 mg/m^3, respectively. The lowest concentration causing cough is 0.75 mg/m^3.

13. Acute Physiological Effects:

a. Single Exposures.

DM produces a feeling of pain and a sense of fullness in the nose and sinuses, accompanied by a severe headache, intense burning in the throat, and tightness and pain in the chest. Irritation of the eyes and lacrimation are produced. Coughing is uncontrollable, sneezing violent and persistent. Nasal secretion is greatly increased, and quantities of ropy saliva flow from the mouth. Nausea and vomiting are prominent. Mental depression may occur during progression of symptoms.

Mild symptoms, caused by exposure to very low concentrations, resemble those of a severe cold. The onset of symptoms may be delayed for several minutes after initial exposure, and effective exposure may, therefore, occur before the presence of the smoke is suspected.

If the mask is then put on, symptoms will increase for several minutes in spite of adequate protection. As a consequence, the victim may believe his mask is ineffective and by removing it cause himself to be further exposed.

Symptoms of exposure to field concentrations usually disappear in 20 minutes to 2 hours, leaving no residual injury. A few instances of severe pulmonary injury and death have occurred due to accidental exposures to high concentrations in confined spaces.

b. Repeated Exposures.

Monkeys, dogs, and guinea pigs were exposed to DM aerosols (No. 113 grenade) on 10 consecutive days. The daily doses were approximately at the LCt_5 level. A similar group of animals was exposed to approximately the LCt_{20} to 25 level on each of 10 days. In both cases, the accumulated doses would be expected to kill all animals if the total dose were given in a single exposure.

The lower dose level killed five out of eight monkeys. This is more than would be expected from any one of the exposures alone, but less than would be expected from the total accumulated dose. The deaths among the dogs and guinea pigs at the low dose level were less than would have been expected from any of the single exposures and far less than would be expected from the accumulated dose.

The deaths in monkeys and guinea pigs at the high dosage level are slightly greater than that which would have been expected for the greatest single dose. The deaths in dogs were less than would have been expected of the greatest single dose. There was little indication of cumulative toxicity due to the repeated exposures.

14. Chronic Physiological Effects:

a. A survey was made at Edgewood Arsenal of 39 women exposed to various concentrations.

Thirty-one workers who had been subjected to DM dust from 4 to 6 weeks were studied. Most of these workers had become entirely free of the initial eye and nose symptoms. This hardening process took several days to a week and the tolerance was readily lost within several days away from DM. Exposure to a much heavier concentration usually led to a return of symptoms. Epistaxis was observed in two workers after heavy exposures. Chronic hoarseness was present in one-quarter of the patients, burning of the skin in one-third, and hyperpigmentation of the skin in one-third of the subjects studied. Acute dermatitis was present in one-quarter of the patients.

Eight patients with moderately heavy chronic exposure had become tolerant to the action on the respiratory tract except for slight chronic conjunctivitis and persistent hoarseness in a few cases. Posterior cervical lymph node enlargement was noted in two cases and enlargement of the parotid gland in one. The vital capacity was reduced between 40 and 80% of normal in 70%. X-ray of the lungs showed no change attributable to DM exposure.

b. Dermatitis.

By far the most disturbing result of prolonged exposure to DM is the dermatitis which appears in a quarter of the workers so exposed.

(1) Individual variations in tolerance are very large and undoubtedly play a part in the development of dermatitis.

(2) The effect of concentration of DM. Dermatitis may develop in workers exposed to only a very light concentration. Heavy concentrations certainly play a part in the precipitation of frank dermatitis in certain workers.

(3) Effect of moisture and heat. These factors probably increase the sensitivity of the skin and certainly precipitate dermatitis.

(4) Incubation period. Almost every case of dermatitis began three weeks after the beginning of exposure.

(5) Avoidance of DM after dermatitis developed did not result in improvement in the severe cases. In a very mild early case, avoidance of DM was sometimes followed by remission.

(6) Effect of prolonged exposure. Many subjects continued to work with a severe dermatitis. In some of these the dermatitis improved despite continued exposure. In most of the cases the dermatitis persiste

15. Onset Time of Symptoms: See Items 13 and 14.

16. Self Aid and First Aid:

Put on mask and wear it in spite of coughing, sneezing, salivation, and nausea. Lift the mask from the face briefly if necessary to permit vomiting or to drain saliva from the facepiece. Carry on duties as vigorously as possible; this will help to lessen and shorten the sympto Combat duties usually can be performed in spite of the effects of sternutators.

Adamsite

17. Tolerable Environmental Concentrations to Uncontrolled Population: No data.

18. Molecular Weight: 277.57

19. Purity Range:

    a. Laboratory Sample. 95 to 99%.

    b. Plant Sample.

20. Physical Appearance: Light yellow to dark yellow-green solid, depending on crystal phase.

21. Vapor Density, Relative to Air: 9.6. Does not vaporize at ordinary temperatures; must be dispersed as an aerosol through application of heat.

22. Liquid Density: Not applicable.

23. Solid Density:

    a. Bulk Density. Less than 1 g/cm^3.

    b. Crystal Density. 1.65 g/cm^3 @ 20° C.

24. Normal Freezing Point or Melting Point: 195° C.

25. Boiling Point: 410° C with decomposition.

26. Vapor Pressure: 4.5×10^{-11} mm Hg @ 25° C.

27. Volatility: Not of practical significance.

28. Viscosity: NA

29. Flash Point: Does not flash.

30. Autoignition Temperature: Unknown.

31. Latent Heat of Sublimation: 134 cal/g @ 170° to 195° C.

    Latent Heat of Vaporization: 80 cal/g @ 200° to 250° C.

32. Latent Heat of Fusion:

33. Vapor-Air Explosive Hazard Range: Not available.

34. Relative Persistency:

a. Soil. Persistent.

b. Surface (Wood, Metal, Masonry, Rubber, Paint). Persistent.

c. Water. Persistent. When material is covered with water, an insoluble film forms which prevents further hydrolysis.

35. Solubility (g/100 g solvent):

a. Water (distilled). 0.0004 at room temperature.

b. Other.

Tetrachlorethane	1.16 @ 17° C
Chlorobenzene	1.06 @ 16° C
Benzene	2.3 @ 15° C

c. Best Solvent.

Acetone	13.03 @ 15° C

36. Thermal Decomposition Rate (half-life): Not available.

250° C, 0.15% per minute.

37. Heat of Combustion: Unknown.

38. Products of Combustion: Unknown.

39. Rate of Hydrolysis:

a. Acidic (pH). 0.5% HCl; prevents hydrolysis at room temperature. 0.0% HCl; prevents hydrolysis at 70°C.

b. Basic (pH). Slowly hydrolyzes in water; see Item 34.

40. Hydrolysis Products: $[NH(C_6H_4)_2AS]_2O$ & HCl.

41. Corrosive Properties:

Titanium	71° C, 6 months, appeared good.
Stainless Steel	43° C, 30 days, slight discoloration.
Common Steel	43° C, 30 days, covered with rust.
Aluminum Anodized	43° C, 30 days, minor corrosion & pitting.
Aluminum	43° C, 30 days, severe corrosion.

42. Detection Methods and Equipment: For vapor or solid, M19 kit, DPT test.

43. Decontaminants:

a. Personnel. Soap and water.

b. Equipment. Slurry or DS2. Bleaching Powder or DS2 in confined spaces. Aeration is sufficient in the field.

c. Areas.

Terrain: Earth moving equipment. STB slurry applied by M9 or M12A1 Decontaminating Apparatus.

44. DOT Classification: Irritating Material.

45. Stabilizer Utilized: None.

46. Types of Containers Required for Storage: Heresite, Teflon, Kynar — unaffected, 3 months at 71° F.

Stable in steel when pure. After 3 months, caused extensive corrosion of aluminum, anodized aluminum, and stainless steel. Will corrode iron, bronze, and brass when moist.

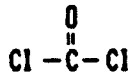
47. Q-D Classification: B
Compatibility Group: A
Chemical Group: B

MATERIAL SAFETY DATA SHEET

Sigma-Aldrich Corporation
1001 West Saint Paul Ave, Milwaukee, WI 53233 USA

Version January 1991

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



29,562-8

---------- IDENTIFICATION ----------

PRODUCT #: 29562-0 NAME: PHOSGENE
CAS #: 75-44-5
MF: CCL2O

SYNONYMS

CARBON DICHLORIDE OXIDE * CARBONE (OXYCHLORURE DE) (FRENCH) * CARBONIC CHLORIDE * CARBONIO (OSSICLORURO DI) (ITALIAN) * CARBON OXYCHLORIDE * CARBONYLCHLORID (GERMAN) * CARBONYL CHLORIDE * CARBONYL CHLORIDE (DOT,OSHA) * CARBONYL DICHLORIDE * CG * CHLOROFORMYL CHLORIDE * FOSGEEN (DUTCH) * FOSGEN (POLISH) * FOSGENE (ITALIAN) * KOOLSTOFOXYCHLORIDE (DUTCH) * NCI-C60219 * PHOSGEN (GERMAN) * PHOSGENE (ACGIH,DOT,OSHA) * RCRA WASTE NUMBER P095 * UN 1076 (DOT) *

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

RTECS NO: SY5600000
PHOSGENE

TOXICITY DATA

IHL-HMN LCLO:50 PPM/5M	TABIA2 3,231,33
IHL-HMN LC50:3300 MG/M3	SCJUAD 3(4),33,67
IHL-MAN LCLO:360 MG/M3/30M	85GMAT -,99,82
IHL-RAT LC50:1400 MG/M3/30M	NTIS** PB158-508
IHL-MUS LC50:1800 MG/M3/30M	NTIS** PB158-508
IHL-DOG LC50:4200 MG/M3/20M	NTIS** PB158-508

IHL-MKY LC50:600 MG/M3/1M NTIS** PB158-508
IHL-RBT LC50:1 GM/M3/30M NTIS** PB158-508
IHL-GPG LC50:1500 MG/M3/30M NTIS** PB158-508
IHL-DOM LC50:4600 MG/M3/2M NTIS** PB158-508
IHL-HOR LC50:10 GM/M3/10M NTIS** PB158-508

REVIEWS, STANDARDS, AND REGULATIONS

ACGIH TLV-TWA 0.1 PPM 85INA8 5,481,86
MSHA STANDARD-AIR:TWA 0.1 PPM (0.4 MG/M3) DTLVS* 3,208,71
OSHA PEL:8H TWA 0.1 PPM (0.4 MG/M3) FEREAC 54,2923,89
OSHA PEL FINAL:8H TWA 0.1 PPM (0.4 MG/M3) FEREAC 54,2923,89
NIOSH REL TO PHOSGENE-AIR:10H TWA 0.1 PPM;CL 0.2 PPM/15M MMWR** 37(S-7),23,88
NOHS 1974: HZD 57710; NIS 10; TNF 408; NOS 11; TNF 5729
NOES 1983: HZD 57710; NIS 5: TNF 57; NOS 10; TNE 2358; TFE 282
EPA TSCA CHEMICAL INVENTORY, 1989
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0278-0076 P;8EHQ-0278-0079 P
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, APRIL 1990
OSHA ANALYTICAL METHOD #ID-01

TARGET ORGAN DATA

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.

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

ACUTE EFFECTS

MAY BE FATAL IF INHALED.
CAUSES BURNS.
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.

FIRST AID

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.
DISCARD CONTAMINATED CLOTHING AND SHOES.

SECTION 3 FOOTNOTES

CAUSES SEVERE DESTRUCTION OF THE ALVEOLAE OF THE LUNGS RESULTING IN PULMONARY EDEMA, SUFFOCATION AND POSSIBLE DEATH. THE ONSET OF THE PULMONARY EDEMA IS DELAYED DUE TO THE SLOW HYDROLYSIS OF THE MATERIAL. LONG TERM EFFECTS ARE EMPHYSEMA, FIBROSIS, COUGHING, BLOODY SPUTUM AND GENERAL MALAISE. THESE SYMPTOMS MAY LAST SEVERAL MONTHS.

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

VAPOR PRESSURE: 1180 MM @ 20 C

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

EXTINGUISHING MEDIA

USE WATER SPRAY OR FOG NOZZLE TO KEEP CYLINDER COOL. MOVE CYLINDER AWAY FROM FIRE IF THERE IS NO RISK.

SPECIAL FIREFIGHTING PROCEDURES

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

DANGER: POISONOUS AND CORROSIVE NONFLAMMABLE LIQUID AND GAS UNDER PRESSURE.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

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

INCOMPATIBILITIES

WATER
AMINES
AMMONIA
ALCOHOLS
SODIUM
POTASSIUM

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

CARBON MONOXIDE, CARBON DIOXIDE
HYDROGEN CHLORIDE GAS

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

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

EVACUATE AREA AND KEEP PERSONNEL UPWIND.
WEAR FULL PROTECTIVE EQUIPMENT SUCH AS, A BUTYL RUBBER CHEMICAL-PROOF AIR SUIT, WITH BREATHING AIR SUPPLIED.
SHUT OFF LEAK IF THERE IS NO RISK.

WASTE DISPOSAL METHOD

CAUTION: NO-RETURN CYLINDER. DO NOT REUSE. EMPTY CYLINDER WILL CONTAIN HAZARDOUS RESIDUE. FOLLOW PROPER DISPOSAL TECHNIQUES.
OBSERVE ALL FEDERAL, STATE, AND LOCAL LAWS.

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

CHEMICAL SAFETY GOGGLES.
RUBBER GLOVES.
USE ONLY IN A CHEMICAL FUME HOOD.
NIOSH/MSHA-APPROVED RESPIRATOR IN NONVENTILLATED AREAS AND/OR FOR EXPOSURE ABOVE THE ACGIH TLV.
SAFETY SHOWER AND EYE BATH.
AVOID CONTACT AND INHALATION.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
CORROSIVE.
HIGHLY TOXIC.
SEVERE LACHRYMATOR.
COMPRESSED GAS.
CYLINDER TEMPERATURE SHOULD NOT EXCEED 125 F(52 C).
USE WITH EQUIPMENT RATED FOR CYLINDER PRESSURE, AND OF COMPATIBLE MATERIALS OF CONSTRUCTION. CLOSE VALVE WHEN NOT IN USE AND WHEN EMPTY.
MAKE SURE CYLINDER IS PROPERLY SECURED WHEN IN USE OR STORED.
MOISTURE SENSITIVE
WARNING: SUCK-BACK INTO CYLINDER MAY CAUSE RUPTURE.
USE BACK-FLOW-PREVENTIVE DEVICE IN PIPING.

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 SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE

1. Chemical Code or EA Number: CG

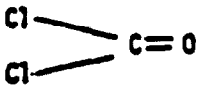
2. Chemical Name: Carbonyl Chloride, or Phosgene.

3. Chemical Formulae:

   a. Empirical.

   CCl_2O

   b. Structural.



4. Biological Type Compound: Lethal agent.

5. Principal Pharmacological Action:

   Phosgene is a lung irritant. The characteristic feature of phosgene poisoning is massive pulmonary edema. The edema results from the passage of fluid into the alveoli from capillaries whose permeability has been affected by the corrosive action of the compound. Hemoconcentration results from loss of plasma into the alveoli. The edema interferes with the interchange of oxygen and carbon dioxide and the capillary blood. Death results from anoxemia and may occur in less than 5 hours.

6. Characteristic Odor: New-mown hay or grass; green corn.

7. Effective Routes of Administration: Inhalation.

8. Median Lethal Dosage, Man (LCt_{50}'s):

   a. Inhalation 3,200 mg min/m^3.

   Since the effects of CG are cumulative, the above Ct is not significantly changed with variations in time of exposure within reasonable limits.

   b. Percutaneous. No data.

   c. Other. No data.

9. Median Lethal Dosage, Animals:

Phosgene

a. Inhalation.

Species	t	LCt_{50}
	min	mg min/m^3
House	2	4,700
	3	1,950
	10	3,800
	30	3,400
Rat	1	6,500
	30	1,400
Guinea Pig	1	2,800
	30	1,300-2,200
Rabbit	30	1,000
Monkey	1	600-1,000
	5	625
	10	750
	30	1,000
Dog	0.5	8,100
	1	8,400
	1	7,000
	3	4,500
	5	4,250
	20	4,200
Goat	2	4,600-6,500
Horse	ca 10	10,000

10. Median Incapacitating Dosage, Man: 1,600 mg min/m^3

During and immediately after exposure, symptoms include coughing, choking, a feel g of tightness in the chest, nausea, and occasionally ting, headache, and lacrimation. Some patients with severe . . . . fail to develop serious lung injury, while others with no signs of early respiratory tract irritation incur fatal pulmonary edema.

11. Threshold Limit Value:

0.4 mg/m^3 (0.1 ppm) is the TLV adopted by the American Conference of Governmental Industrial Hygienists (1972).

0.8 mg/m^3 (0.02 ppm) is the proposed ceiling level for a daily 8-hour exposure of workers. SMUEA-BL, 1972.

12. Minimum Effective Dose, Man: No data.

13. Acute Physiological Effects:

a. Initial Symptoms.

Mild conjunctivitis
Coughing
Tightness in chest
Nausea
Occasional vomiting
Headache

Following the above discomfort, there may be a delay in which the patient has few symptoms, not even abnormal chest signs.

b. Severe Symptoms.

After the delay mentioned above, signs and symptoms of pulmonary edema may occur rapidly, e.g., rapid shallow breathing, painful cough, and marked cyanosis. As the edema progresses, discomfort, apprehension, and dyspnea increase, and frothy, often blood-tinged sputum is raised. Rales and rhonchi are audible in the chest. The patient may go into shock and die.

14. Chronic Physiological Effects:

a. Acute Exposure.

Casualties from acute exposures who survive more than 48 hours usually recover without sequelae. Rarely do bronchitis and bronchiectasis result. However, residual pulmonary deficit may be expected. Neurasthenic symptoms have been the most disabling features observed after recovery from the initial severe symptoms.

b. Chronic Exposure.

Five industrial workers who had been chronically exposed to low concentrations of CG exhibited disturbances in lung function. All of the patients developed the following signs and symptoms over a period of several months with varying degrees of severity: cough, shortness of breath on exertion, and pain or tightness in the chest. Two of the patients also expectorated small amounts of glairy, mucoid sputum. Residual pulmonary deficit may be expected from chronic exposure to CG.

15. Onset Time of Symptoms

a. Initial Symptoms begin during and immediately after exposure. Symptom-free period may last 30 minutes to 24 hours.

b. Severe symptoms may occur rapidly after the symptom-free period above. Death usually occurs within the first 24-48 hours post exposure. Exposure to extremely high concentrations may cause death in 5 hours or less.

16. Self Aid and First Aid:

a. The protective mask should be put on immediately upon detection of the odor of phosgene (like green corn or grass), irritation of the eyes, or change in the taste of a cigarette (smoking may become tasteless or offensive in taste). The individual should hold his breath while masking.

b. If some phosgene has been inhaled, normal combat duties should be continued unless there is difficulty in breathing, nausea, and vomiting, or more than the usual shortness of breath on exertion.

c. If any of the above symptoms occur, the casualty should rest quietly until evacuated by the Medical Service.

17. Tolerable Environmental Concentrations to Uncontrolled Populations:

0.0025 mg/m^3 is the proposed ceiling level for general population.

18. Molecular Weight: 98.9

19. Purity Range:

a. Laboratory Sample. 99+%

b. Plant Sample. MIL SPEC 192-21-3B required 98.0% minimum purity.

20. Physical Appearance: Colorless gas at room temperature.

21. Vapor Density, Relative to Air: 3.4

22. Liquid Density (g/ml): 1.37 g/ml @ 20° C.

23. Solid Density:

a. Bulk Density. Not applicable.

b. Crystal Density. Not applicable.

24. Normal Freezing Point or Melting Point: -128° C.

25. Boiling Point: 7.6° C.

26. Vapor Pressure: 1400 mm Hg @ 25° C.

27. Volatility: 4.3×10^6 mg/m^3 @ 7.6° C.

28. Viscosity: 0.27 centistokes @ 0° C.

29. Flash Point: Does not flash.

30. Autoignition Temperature: Unknown.

31. Latent Heat of Vaporization: 59 cal/g.

32. Latent Heat of Fusion: Not available.

33. Vapor-Air Explosive Hazard Range: Not available.

34. Relative Persistency: Nonpersistent.

35. Solubility (g/100 g solvent @ 25° C):

a. Water (distilled). Very slight, with decomposition.

b. Other. Very soluble with almost all organic solvents, i.e., benzene, toluene. Unstable in some.

c. Best Solvent. Organic Solvents.

Phosgene

36. Thermal Decomposition Rate (half-life): Decomposes at 800° C.

37. Heat of Combustion: -41.8 kcal/mole (estimated).

38. Products of Combustion: CO_2 & Cl_2

39. Rate of Hydrolysis (specify half-life): 0.25 second @ 13° C. No pH given.

40. Hydrolysis Products:

    a. Acidic (pH). HCl and CO_2.

    b. Basic (pH). NaCl and Na_2CO_3.

41. Corrosive Properties: No appreciable corrosion in steel after 1 year at 20° C. Not corrosive when dry.

42. Detection Methods and Equipment: M18A2, M19 Kits. (PDB Test - Green band detector tube), M8 alarm.

43. Decontaminants:

    a. Personnel. If liquid, M13 Kit and M5 ointment.

    b. Equipment. Water, followed by DS2 or by 10% solution of caustic soda or sodium carbonate. Caustic soda is not recommended for fabrics, canvas, and leather.

    c. Areas. Aeration in closed area. Decontamination not required in the field.
    Terrain - Plain water, followed by 5% sodium hydroxide sprayed from M9 or M12A1 decontaminating apparatus.

44. DOT Classification: Poison A.

45. Stabilizer Utilized:

    a. Laboratory Sample. Stable when dry.

    b. Production Sample. Same as a.

46. Types of Container Required for Storage: Reaction with metal depends on purity. When dry, no reaction; when wet, vigorous corrosion. Requires refrigeration for filling shell. Stored in steel cylinders and special 1-ton containers.

47. Q-D Classification: B
Compatibility Group: A
Chemical Group: 8

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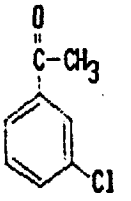
MATERIAL SAFETY DATA SHEET

Sigma-Aldrich Corporation
1001 West Saint Paul Ave, Milwaukee, WI 53233 USA
Version January 1991

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



28,879-9

---------- IDENTIFICATION ----------

PRODUCT #: 28879-9 NAME: 3'-CHLOROACETOPHENONE, 98%
CAS #: 99-02-5
MF: C8H7CLO

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

DATA NOT AVAILABLE

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

ACUTE EFFECTS

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

FIRST AID

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.
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.

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

BOILING PT: 227 C TO 229 C
SPECIFIC GRAVITY: 1.191

APPEARANCE AND ODOR
YELLOW LIQUID

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

FLASHPOINT: 221 F BY:

EXTINGUISHING MEDIA
WATER SPRAY.
CARBON DIOXIDE, DRY CHEMICAL POWDER, ALCOHOL OR POLYMER 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.

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

INCOMPATIBILITIES
STRONG OXIDIZING AGENTS
STRONG BASES

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
TOXIC FUMES OF:
CARBON MONOXIDE, CARBON DIOXIDE
HYDROGEN CHLORIDE 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.
LACHRYMATOR.
IRRITANT.
KEEP TIGHTLY CLOSED.
STORE IN A COOL DRY PLACE.

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 SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE

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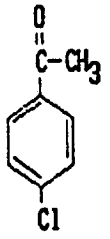

C1,978-8

---------- IDENTIFICATION ----------

PRODUCT #: C1970-8 NAME: 4'-CHLOROACETOPHENONE, 98%
CAS #: 99-91-2
MF: C8H7CLO

SYNONYMS
ACETOPHENONE, 4'-CHLORO- * P-CHLOROACETOPHENONE * 4-CHLOROACETOPHENONE * USAF DO-1 *

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

RTECS NO: KM5600000
ETHANONE, 1-(4-CHLOROPHENYL)-

TOXICITY DATA
ORL-MUS LD50:1207 MG/KG PHARAT 31,317,76
IPR-MUS LD50:100 MG/KG NTIS** AD277-689

REVIEWS, STANDARDS, AND REGULATIONS
NOES 1983: HZD X7067; NIS 1; TNF 7; NOS 1; TNE 28
EPA TSCA CHEMICAL INVENTORY, 1989

TARGET ORGAN DATA
PERIPHERAL NERVE AND SENSATION (FLACCID PARALYSIS WITHOUT ANESTHESIA)
BEHAVIORAL (MUSCLE WEAKNESS)
LUNGS, THORAX OR RESPIRATION (RESPIRATORY DEPRESSION)
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 ----------

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.
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.
WASH CONTAMINATED CLOTHING BEFORE REUSE.

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

BOILING PT: 232 C
MELTING PT: 20 C
SPECIFIC GRAVITY: 1.192
VAPOR PRESSURE: 8 MM @ 90 C

APPEARANCE AND ODOR

COLORLESS LIQUID

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

FLASHPOINT: 194 F BY:

EXTINGUISHING MEDIA

WATER SPRAY.
CARBON DIOXIDE, DRY CHEMICAL POWDER, ALCOHOL OR POLYMER 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.

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

INCOMPATIBILITIES

STRONG OXIDIZING AGENTS
STRONG BASES

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:
CARBON MONOXIDE, CARBON DIOXIDE
HYDROGEN CHLORIDE GAS

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

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

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 ---

CHEMICAL SAFETY GOGGLES.
RUBBER GLOVES.
NIOSH/MSHA-APPROVED RESPIRATOR.
SAFETY SHOWER AND EYE BATH.
MECHANICAL EXHAUST REQUIRED.
AVOID CONTACT AND INHALATION.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
WASH THOROUGHLY AFTER HANDLING.
IRRITANT.
LACHRYMATOR.
KEEP TIGHTLY CLOSED.
KEEP AWAY FROM HEAT AND OPEN FLAME.
STORE IN A COOL DRY PLACE.

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Occupational Health Guideline for alpha-Chloroacetophenone

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: $C_6H_5COCH_2Cl$
- Synonyms: Phenyacyl chloride; omega=chloroacetophenone; chloroacetophenone; chloromethyl phenyl ketone; phenyl chloromethyl ketone; "tear gas"; CN
- Appearance and odor: Colorless to gray solid with a sharp, irritating odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for alpha-chloroacetophenone is 0.05 part of alpha-chloroacetophenone per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.3 milligram of alpha-chloroacetophenone per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- **Routes of exposure**

alpha-Chloroacetophenone can cause irritation of the eyes and skin upon contact and irritation of the lungs if it is inhaled. It can also cause difficulty if it is swallowed.

- **Effects of overexposure**

alpha-Chloroacetophenone vapors may cause a tingling or runny nose, burning and/or pain of the eyes, blurred vision, and tears. Burning in the chest, difficult breathing, and nausea may occur. Skin irritation, rash, or burns may occur.

- **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 alpha-chloroacetophenone.

- **Recommended medical surveillance**

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

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from alpha-chloroacetophenone exposure.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of alpha-chloroacetophenone might cause exacerbation of symptoms due to its irritant properties or psychic reflex bronchospasm.

—Skin disease: alpha-Chloroacetophenone is irritating to the skin, especially if moist. Persons with pre-existing skin diseases may be more susceptible to the effects of alpha-chloroacetophenone.

—Eye disease: alpha-Chloroacetophenone is a potent lacrimator and eye irritant and may cause corneal damage. Persons with pre-existing eye diseases may be at increased risk from exposure.

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

- **Summary of toxicology**

alpha-Chloroacetophenone is a highly irritating substance. Exposure to low concentrations produces lacrimation and irritation of the eyes and upper respiratory tract. Exposure to high concentrations produces marked conjunctivitis and may cause corneal damage. Pulmonary edema may occur, often delayed for some 12 hours after exposure. No chronic effects are reported.

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.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

September 1978

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
  1. Molecular weight: 155
  2. Boiling point (760 mm Hg): 247 C (477 F)
  3. Specific gravity (water = 1): 1.32
  4. Vapor density (air = 1 at boiling point of alpha-chloroacetophenone): 5.2
  5. Melting point: 59 C (138 F)
  6. Vapor pressure at 20 C (68 F): 0.012 mm Hg
  7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
  8. Evaporation rate (butyl acetate = 1): Very much less than 1
- **Reactivity**
  1. Conditions contributing to instability: Heat
  2. Incompatibilities: Water or steam
  3. Hazardous decomposition products: Toxic and corrosive vapors are produced when combined with steam or water.
  4. Special precautions: None
- **Flammability**
  1. Flash point: 118 C (244 F)
  2. Autoignition temperature: Data not available
  3. Flammable limits in air, % by volume: Not applicable
  4. Extinguishant: Carbon dioxide or dry chemical
- **Warning properties**
  1. Odor Threshold: According to the *Documentation of TLV's*, the odor threshold is 0.1 mg/m³.
  2. Irritation Levels: According to the *Documentation of TLV's*, "irritation thresholds range from 0.15 to 0.4 mg/m³, lacrimation thresholds from 0.3 to 0.4 mg/m³. . . ."
  3. Evaluation of Warning Properties: Through its odor and irritant effects, alpha-chloroacetophenone can be detected below the permissible exposure limit; therefore, it is considered to have adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

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).

- **Method**

An analytical method for alpha-chloroacetophenone is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 5, 1979, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00349-1).

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 any possibility of skin contact with solid alpha-chloroacetophenone or liquids containing alpha-chloroacetophenone.
- If employees' clothing may have become contaminated with solid alpha-chloroacetophenone, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing contaminated with alpha-chloroacetophenone should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of alpha-chloroacetophenone from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the alpha-chloroacetophenone, the person performing the operation should be informed of alpha-chloroacetophenone's hazardous properties.
- Non-impervious clothing which becomes contaminated with alpha-chloroacetophenone should be removed immediately and not reworn until the alpha-chloroacetophenone is removed from the clothing.
- Where there is any possibility that employees' eyes may be exposed to alpha-chloroacetophenone, an eyewash fountain should be provided within the immediate work area for emergency use.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of solid alpha-chloroacetophenone or liquids containing alpha-chloroacetophenone contacting the eyes.

SANITATION

• Skin that becomes contaminated with alpha-chloroacetophenone should be immediately washed or showered with soap or mild detergent and water to remove any alpha-chloroacetophenone.

• Eating and smoking should not be permitted in areas where solid alpha-chloroacetophenone is handled, processed, or stored.

• Employees who handle solid alpha-chloroacetophenone or liquids containing alpha-chloroacetophenone 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 alpha-chloroacetophenone may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during loading of solutions for aerosols for law enforcement and civilian protective devices	General dilution ventilation; respiratory protective equipment
Liberation during manufacture	Process enclosure; general dilution ventilation
Liberation during denaturing of industrial alcohol	General dilution ventilation

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 alpha-chloroacetophenone gets into the eyes, wash eyes immediately with large amounts of water, 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

If alpha-chloroacetophenone gets on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If alpha-chloroacetophenone soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. When there are chemical burns or evidence of skin irritation, get medical attention.

• Breathing

If a person breathes in large amounts of alpha-chloroacetophenone, 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 alpha-chloroacetophenone 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 DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If alpha-chloroacetophenone is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. For small quantities, sweep onto paper or other suitable material, place in an appropriate container and burn in a safe place (such as a fume hood). Large quantities may be reclaimed; however, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

• Waste disposal methods:

alpha-Chloroacetophenone may be disposed of:

1. By making packages of alpha-chloroacetophenone in paper or other flammable material and burning in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
2. By dissolving alpha-chloroacetophenone in a flammable solvent (such as alcohol) and atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

REFERENCES

• American Conference of Governmental Industrial Hygienists: "alpha-Chloroacetophenone," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.

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• Macrae, W. G., Willensky, M. D., and Basu, P. K.: "Corneal Injury Caused by Aerosol Irritant Projectors," *Canadian Journal of Ophthalmology*, 5:1, pp. 3-11, 1970.

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• Rothberg, S.: "Skin Sensitization Potential of the Riot Control Agents," *Military Medicine*, 135:552-556, July 1970.

• Sax, N. I.: *Dangerous Properties of Industrial Materials* (3rd ed.), Van Nostrand Reinhold, New York, 1968.

RESPIRATORY PROTECTION FOR ALPHA-CHLOROACETOPHENONE

Condition	Minimum Respiratory Protection* Required Above 0.05 ppm
Particulate and Vapor Concentration	
15 mg/m³ (2.5 ppm) or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s) and high efficiency particulate filter(s). A gas mask with a chin-style or a front- or back-mounted organic vapor canister with a high efficiency particulate filter. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
100 mg/m³ (16 ppm) or less	A 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.
Greater than 100 mg/m³ (16 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 with a full facepiece providing protection against organic vapors and particulates. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

DATE: 3 Dec 1990

POISON GAS

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 (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
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

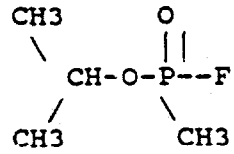
TRADE NAME AND SYNONYMS:

GB Sarin
Zarin

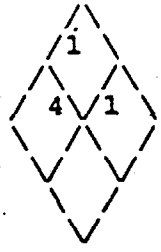
CHEMICAL FAMILY: Fluorinated organophosphorous compound

FORMULA/CHEMICAL STRUCTURE:

C4 H10 FO2 P



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



SECTION II - COMPOSITION

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

SECTION III - PHYSICAL DATA

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

SECTION IV - FIRE AND EXPLOSION DATA

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.

SECTION V - HEALTH HAZARD DATA

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 (2X10-5 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/m3 (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 airborn 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 MarkI 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 gastronintestinal. Immediately administer an intramuscular injection of the MARK I kit auto-injectors. SEEK MEDICAL ATTENTION IMMEDIATELY.

** See addendum B for detailed instructions. **

SECTION VI - REACTIVITY DATA

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.

SECTION VII - SPILL, LEAK AND DISPOSAL PROCEDURES

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 Supertropical 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.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Concentration	Respiratory Protective Equipment
< .0001 mg/m3	M9, M17, or M40 series mask shall be available this purpose.
.0001 to 0.2 mg/m3	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/m3 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/m3 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).

SECTION IX - SPECIAL PRECAUTIONS

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

SECTION X - TRANSPORTATION DATA

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 Sympotoms 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, jitter-iness, 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, depre-ssion 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 product 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/m3	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 collaspe so rapidly that the casualty cannont 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 exposoure; 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	Duration of 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, artifical 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 intramusclar 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.

1. Chemical Code or EA Number: CK

2. Chemical Name: Cyanogen Chloride.

3. Chemical Formulae:

   a. Empirical. CClN

   b. Structural. Cl-C≡N

4. Biological Type Compound: Lethal agent, rapid acting.

5. Principal Pharmacological Action:

   Systemic effects similar to those of hydrocyanic acid (AC), which disrupts the oxidative processes of the body by inhibiting the essential enzyme cytochrome oxidase. In addition, CK is a highly effective local irritant on the eyes, upper respiratory tract, and the lungs. Pulmonary edema may develop as a result of the irritant action on the lungs.

6. Characteristic Odor: Pungent odor detectable at 2.5 mg/m^3 (1 ppm).

7. Effective Routes of Administration: Inhalation; highly irritant to eyes and mucous membranes.

8. Median Lethal Dosage, Man (LCt_{50}'s):

   a. Inhalation. 11,000 mg min/m^3. Exposure time not stated in source material.

   b. Percutaneous. No data.

   c. Other. No data.

9. Median Lethal Dosage, Animals:

   a. Inhalation.

Species	t	LCt_{50}
	min	mg min/m^3
Mouse	0.5	3,000
	1.0	4,200
	3.0	4,200
	10.0	7,500

Cyanogen Chloride

Species	t	LCt_{50}
	min	mg min/m^3
Rat	2.0	9,400
	3.0	5,400
	30.0	9,000
Guinea pig	2.0	7,000
	7.5	9,000
	30.0	17,000
Rabbit	2.0	8,000
	7.5	6,000
	30.0	17,000
Dog	1.0	3,800 (nominal concn)
	3.0	4,200 (nominal concn)
	7.5	4,500
	10.0	5,000 (nominal concn)
	30.0	6,000 (nominal concn)
Monkey	1.0	4,400 (nominal concn)
Goat	1.0	4,500
	3.0	6,000
	10.0	7,500

b. Percutaneous. No data.

c. Other.

(1) Intravenous injection.

Species	$LD_{50} \pm$ (2 S. E.)
	mg/kg
Dog*	2.97±0.09
Goat*	3.43±0.006
Rabbit*	3.15±0.25
Rabbit**	3.30±0.36

* Anesthetized
** Unanesthetized

(2) Stomach Tube Administration. Rat, LD_{50}, approx. 6.0 mg/kg.

10. Median Incapacitating Dosage, Man:

a. Inhalation. ICt_{50}: 7,000 mg min/m^3. Exposure time not stated in source material.

b. Percutaneous. No data.

c. Other. No data.

11. Threshold Limit Value: $>$1.25 mg/m^3.

12. Minimum Effective Dose, Man: Minimal concentration detectable eye irritation by 27/27 human subjects within 3 minutes: 12.2 mg/m^3.

13. Acute Physiological Effects:

a. Initial. Intense irritation of nose, throat and eyes with coughing, tightness in chest and lacrimation.

b. Moderate. Dizziness, dyspnea, retching, and involuntary urination and defecation.

c. Severe. Convulsions, unconsciousness, and failing respiration.

If above effects are not fatal, signs and symptoms of pulmonary edema may develop.

14. Chronic Physiological Effects: Residual damage to the central nervous system may occur.

15. Onset Time of Symptoms:

a. Initial Symptoms. Immediately upon exposure.

b. & c. Moderate and Severe. At lethal doses, unconsciousness and death occur within a few minutes. Depending on the degree of exposure, the pulmonary effects may develop immediately or may be delayed until the systemic effects have subsided.

Death or recovery from cyanide effects within minutes. Recovery from lung irritant effects prolonged.

16. Self Aid and First Aid:

    a. Put on the mask immediately if any irritation of the eyes, nose, or throat is noticed.

    b. The first emergency therapeutic measure is the inhalation of amyl nitrate. If hydrocyanic acid or cyanogen chloride are no longer present in the atmosphere, two ampules of amyl nitrite should be crushed in the hollow of the hand and held close to the patient's nose. This may be repeated every few minutes until a total of eight ampules have been used. Artificial respiration should be given if respirations have ceased or are feeble. This will also facilitate the inhalation of the amyl nitrite. The artificial respiration must be continued until spontaneous breathing returns or until 10 minutes after the last sign of heart activity. If hydrocyanic acid or cyanogen chloride vapors are still present in the air, and the casualty is not already masked, he must have his mask put on for him. The crushed ampules of amyl nitrite, in the dosages given above, must then be inserted in the region of the eyelenses of the protective mask near the deflector tube openings; make certain after the insertion of amyl nitrite that the seal of the mask around the face is unbroken. Artificial respiration must be instituted on the patient if he is not breathing or if respiration is feeble.

17. Tolerable Environment Concentrations to Uncontrolled Population: No data.

18. Molecular Weight: 61.48.

19. Purity Range:

    a. Laboratory Sample. 95 - 99%.

    b. Plant Sample.

20. Physical Appearance: Colorless gas or liquid.

21. Vapor Density, Relative to Air: 2.0.

22. Liquid Density: 1.20 g/ml at 10° C.

23. Solid Density:

    a. Bulk Density. Not applicable.

    b. Crystal Density. Not applicable.

24. Normal Freezing Point or Melting Point: -6.9° C.

25. Boiling Point: 12.9° C.

26. Vapor Pressure: 1000 mm Hg @ 25° C.

27. Volatility: 2.6×10^6 mg/m^3 @ 12.9° C.

28. Viscosity: NA

29. Flash Point: Does not flash.

30. Autoignition Temperature: Nonflammable.

31. Latent Heat of Vaporization: 103 cal/g. This is sufficiently high to provide a satisfactory pancaking effect.

32. Latent Heat of Fusion: 41.8 cal/g.

33. Vapor-Air-Explosive Hazard Range: Not available.

34. Relative Persistency: Relatively nonpersistent.

35. Solubility (g, 100 g solvent):

    a. Water (distilled). 6.9 at 20° C.; will polymerize.

    b. Other. CK is completely miscible with almost all common organic solvents, i.e., alcohol, ether. Many of the resulting mixtures are unstable.

    c. Best Solvent: Organic solvents.

36. Thermal Decomposition Rate (half-life): Decomposes above 100° C. CK will stand for 30 days @ 65° C. without excessive decomposition; polymerizes between 40 and 60 days to form $(CNCl)_3$, a solid. May explode.

37. Heat of Combustion: Not available.

Cyanogen Chloride

38. Products of Combustion: Not available.

39. Rate of Hydrolysis:

a. Acidic (pH).

pH 6.6 - 7.06, t 1/2 1.6 hr @ 25° C; pH 4 - 6, t 1/2 58 hr @ 40° C.

b. Basic (pH).

pH 8, t 1/2 18 hr; at room temperature.
pH 7, t 1/2 180 hr (tap water) at room temperature.

40. Hydrolysis Products:

a. Acidic (pH). HCl and HOCH.

b. Basic (pH). NaCl and NaCHO.

41. Corrosive Properties: No action on metals when stabilized. Attacks many common metals when stored unstablized. Will polymerize, may explode.

42. Detection Methods and Equipment: M15A2A, M18A2, M19 kits (DB-3 Test, blue band dector tube), M3 Alarm.

43. Decontaminants:

a. Personnel. None effective.

b. Equipment. Aeration in closed spaces. Sodium hydroxide solution or DS2 on materiel.

c. Areas. Terrain: 5% sodium hydroxide solution sprayed from M9 or M12A1 decontaminating apparatus (PUDA).

44. DOT Classification: Poison A.

45. Stabilizer Utilized:

a. Laboratory Sample. 5% anhydrous, powdered sodium pyrophosphate; propylene oxide; arsenic trichloride.

b. Production Sample. Unknown.

46. Types of Containers Required for Storage: Stabilized CK can be stored in steel up to 100° C. without decomposition or corrosion.

47. Q-D Classification: 8
Compatibility Group: A
Chemical Group: B

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Analysis Of the GA Simulant:

A sample of the GA simulant from the CAIS was determined by a variety of analytical methods to contain three main and eleven minor or trace components for a total of at least 14 components. The analysis of the sample is outlined below:

COMPOUND	PERCENT
Benzonitrile	2.6%
Diethyl Malonate	25.7%
Acid as Heptanoic Acid	2.3%
Ethyl Caprate	17.8%
Ethyl Myristate	37.7%
Ethyl Heptanoate	2. %
Unidentified collectively, approximately	12. %

MATERIAL SAFETY DATA SHEET

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1001 West Saint Paul Ave., Milwaukee, WI 53233 USA

Version January 1991

	Sigma	Aldrich
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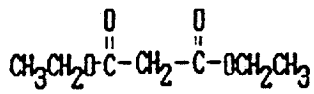

M5629

---------- IDENTIFICATION ----------

PRODUCT #: M5629 NAME: MALONIC ACID DIETHYL ESTER
CAS #: 105-53-3
MF: C7H12O4

SYNONYMS
CARBETHOXYACETIC ESTER * DICARBETHOXYMETHANE * DIETHYL MALONATE * DIETHYL PROPANEDIOATE * ETHYL MALONATE * MALONIC ESTER * METHANEDICARBOXYLIC ACID, DIETHYL ESTER * PROPANEDIOIC ACID, DIETHYL ESTER *

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

RTECS NO: 000700000
MALONIC ACID, DIETHYL ESTER

IRRITATION DATA
SKN-RBT 500 MG/24H MLD FCTXAV 14,745,76

TOXICITY DATA
ORL-RAT LD50:15 GM/KG AIHAAP 30,470,69
ORL-MUS LD50:6400 MG/KG BIJOAK 34,1196,40

REVIEWS, STANDARDS, AND REGULATIONS
NOES 1983: HZD X4574; NIS 3; TNF 78; NOS 7; TNE 5363; TFE 916
EPA TSCA CHEMICAL INVENTORY, 1989
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 ----------

ACUTE EFFECTS

MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION.
MAY CAUSE EYE IRRITATION.
MAY CAUSE SKIN IRRITATION.

FIRST AID

IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS AMOUNTS OF WATER.
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES.
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: 199 C
MELTING PT: -51 C TO -50 C
SPECIFIC GRAVITY: 1.055
VAPOR DENSITY: 5.52
VAPOR PRESSURE: 1 MM @ 40 C

APPEARANCE AND ODOR

COLORLESS LIQUID

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

FLASHPOINT: 212 F BY:

EXTINGUISHING MEDIA

CARBON DIOXIDE, DRY CHEMICAL POWDER, ALCOHOL OR POLYMER FOAM.

SPECIAL FIREFIGHTING PROCEDURES

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

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

INCOMPATIBILITIES

ACIDS
BASES
OXIDIZING AGENTS
REDUCING AGENTS

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:
CARBON MONOXIDE, CARBON DIOXIDE

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

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

WEAR RESPIRATOR, CHEMICAL SAFETY GOGGLES, 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.

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 ---

CHEMICAL SAFETY GOGGLES.
USE PROTECTIVE CLOTHING, GLOVES AND MASK.
SAFETY SHOWER AND EYE BATH.
MECHANICAL EXHAUST REQUIRED.

DO NOT BREATHE VAPOR.
AVOID CONTACT WITH EYES, SKIN AND CLOTHING.
WASH THOROUGHLY AFTER HANDLING.
KEEP TIGHTLY CLOSED.
STORE IN A COOL DRY PLACE.

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 SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE

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1001 West Saint Paul Ave, Milwaukee, WI 53233 USA

Version January 1991

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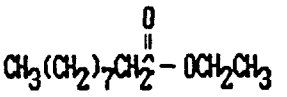
	Outside USA/Canada	314-771-5765	414-273-3850



C0760

---------- IDENTIFICATION ----------

PRODUCT #: C0760 NAME: CAPRIC ACID ETHYL ESTER
CAS #: 110-38-3
MF: C12H24O2

SYNONYMS
CAPRIC ACID ETHYL ESTER * ETHYL CAPRATE * ETHYL CAPRINATE * ETHYL DECANOATE * ETHYL DECYLATE *

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

RTECS NO: HD9420000
DECANOIC ACID, ETHYL ESTER

IRRITATION DATA
SKN-RBT 500 MG/24H MLD FCTXAV 16,733,78

REVIEWS, STANDARDS, AND REGULATIONS
NOES 1983: HZD X4666; NIS 1; TNF 7; NOS 1; TNE 28
EPA TSCA CHEMICAL INVENTORY, 1989
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 ----------

ACUTE EFFECTS
MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION.
MAY CAUSE IRRITATION.

FIRST AID

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

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

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: 245 C

SPECIFIC GRAVITY: 0.862

APPEARANCE AND ODOR

COLORLESS LIQUID

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

FLASHPOINT: 216 F BY:

EXTINGUISHING MEDIA

CARBON DIOXIDE, DRY CHEMICAL POWDER, ALCOHOL OR POLYMER FOAM.

SPECIAL FIREFIGHTING PROCEDURES

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

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

INCOMPATIBILITIES

ACIDS

BASES

OXIDIZING AGENTS

REDUCING AGENTS

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:

CARBON MONOXIDE, CARBON DIOXIDE

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

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

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.

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 ---

CHEMICAL SAFETY GOGGLES.

USE PROTECTIVE CLOTHING, GLOVES AND MASK.

SAFETY SHOWER AND EYE BATH.

MECHANICAL EXHAUST REQUIRED.

DO NOT BREATHE VAPOR.

AVOID CONTACT WITH EYES, SKIN AND CLOTHING.

WASH THOROUGHLY AFTER HANDLING.

KEEP TIGHTLY CLOSED.

STORE IN A COOL DRY PLACE.

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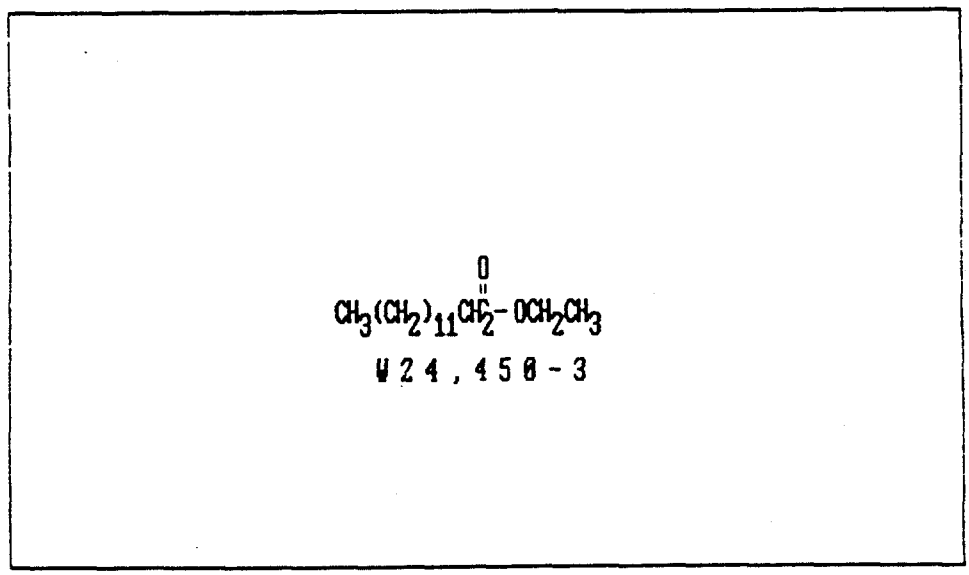

---------- IDENTIFICATION ----------

PRODUCT #: W24450-3 NAME: ETHYL MYRISTATE, 96+%, FCC
CAS #: 124-06-1
MF: C16H3202

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

DATA NOT AVAILABLE

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

ACUTE EFFECTS

MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION.
MAY CAUSE EYE IRRITATION.
MAY CAUSE SKIN IRRITATION.
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.

WASH CONTAMINATED CLOTHING BEFORE REUSE.

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

BOILING PT: 178 C TO 180 C/12MM.
MELTING PT: 11 C TO 12 C
SPECIFIC GRAVITY: 0.860

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, ALCOHOL OR POLYMER FOAM.

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

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

INCOMPATIBILITIES
STRONG OXIDIZING AGENTS

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
TOXIC FUMES OF:
CARBON MONOXIDE, CARBON DIOXIDE

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

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
WEAR RESPIRATOR, CHEMICAL SAFETY GOGGLES, 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.

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 ---

CHEMICAL SAFETY GOGGLES.
COMPATIBLE CHEMICAL-RESISTANT GLOVES.
NIOSH/MSHA-APPROVED RESPIRATOR.
SAFETY SHOWER AND EYE BATH.
MECHANICAL EXHAUST REQUIRED.
AVOID INHALATION.
AVOID CONTACT WITH EYES, SKIN AND CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
KEEP TIGHTLY CLOSED.
STORE IN A COOL DRY PLACE.
CAUTION: FOR MANUFACTURING, PROCESSING OR REPACKING.
THIS MATERIAL IS NOT STERILE AND HAS NOT BEEN PYROGEN-TESTED.

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 SHALL NOT B HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH TH ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE

MATERIAL SAFETY DATA SHEET

Sigma-Aldrich Corporation
1001 West Saint Paul Ave, Milwaukee, WI 53233 USA

Version January 1991

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

$CHCl_3$
13,295-0

---------- IDENTIFICATION ----------

PRODUCT #: 13295-0 NAME: CHLOROFORM
CAS #: 67-66-3
MF: CHCL3

SYNONYMS

CHLOROFORM (ACGIH,DOT,OSHA) * CHLOROFORME (FRENCH) * CLOROFORMIO (ITALIAN) * FORMYL TRICHLORIDE * METHANE TRICHLORIDE * METHANE, TRICHLORO- * METHENYL TRICHLORIDE * METHYL TRICHLORIDE * NCI-C02686 * R 20 * R 20 (REFRIGERANT) * RCRA WASTE NUMBER U044 * TCM * TRICHLOORMETHAAN (DUTCH) * TRICHLORMETHAN (CZECH) * TRICHLOROFORM * TRICHLOROMETHANE * TRICHLOROMETHANE (OSHA) * TRICLOROMETANO (ITALIAN) * UN 1888 (DOT) *

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

RTECS NO: FS9100000
CHLOROFORM

IRRITATION DATA

SKN-RBT 10 MG/24H OPEN MLD	AIHAAP 23,95,62
SKN-RBT 500 MG/24H MLD	85JCAE -,89,86
EYE-RBT 148 MG	AIHAAP 37,697,76
EYE-RBT 20 MG/24H MOD	85JCAE -,89,86

TOXICITY DATA

IHL-HMN LCLO:25000 PPM/5M	TABIA2 3,231,33

UNR-MAN LDLO:546 MG/KG	85DCAI	2,73,70
ORL-RAT LD50:908 MG/KG	JPFCD2	17,205,82
IHL-RAT LC50:47702 MG/M3/4H	ENVRAL	40,411,86
IPR-RAT LD50:894 MG/KG	ENVRAL	40,411,86
ORL-MUS LD50:36 MG/KG	ATSUDG	2,371,79
IPR-MUS LD50:623 MG/KG	AGGHAR	18,109,60
SCU-MUS LD50:704 MG/KG	JPETAB	123,224,58
IPR-DOG LD50:1000 MG/KG	TXAPA9	10,119,67
ORL-GPG LD50:820 MG/KG	GISAAA	48(3),10,83

REVIEWS, STANDARDS, AND REGULATIONS

ACGIH TLV-SUSPECTED CARCINOGEN 85INA8 5,130,86
ACGIH TLV-TWA 10 PPM 85INA8 5,130,86
IARC CANCER REVIEW:ANIMAL SUFFICIENT EVIDENCE IMEMDT 20,401,79
IARC CANCER REVIEW:HUMAN LIMITED EVIDENCE IMEMDT 20,401,79
IARC CANCER REVIEW:ANIMAL LIMITED EVIDENCE IMEMDT 1,61,72
IARC CANCER REVIEW:GROUP 2B IMSUDL 7,152,87
MSHA STANDARD:AIR-CL 50 PPM (240 MG/M3) DTLWS* 3,14,73
OSHA PEL:CL 50 PPM (240 MG/M3) FEREAC 54,2923,89
OSHA PEL FINAL:8H TWA 2 PPM(9.78 MG/M3) FEREAC 54,2923,89
NIOSH REL TO CHLOROFORM-AIR:CL 2 PPM/60M MMWR** 37(S-7),8,88
NIOSH REL TO WASTE ANESTHETIC GASES AND VAPORS-AIR:CL 2 PPM/1H MMWR** 37(S-7),28,88
NOHS 1974: HZD 18500; NIS 78; TNF 5120; NOS 66; TNE 96747
NOES 1983: HZD 18500; NIS 65; TNF 4890; NOS 55; TNE 95773; TFE 41397
ATSDR TOXICOLOGY PROFILE (NTIS** PB/89/160360/AS)
EPA GENETOX PROGRAM 1988, POSITIVE: CARCINOGENICITY-MOUSE/RAT; S CEREVISIAE GENE CONVERSION
EPA GENETOX PROGRAM 1988, POSITIVE: S CEREVISIAE-HOMOZYGOSIS; S CEREVISIAE-REVERSION
EPA GENETOX PROGRAM 1988, NEGATIVE: CELL TRANSFORM.-SA7/SHE; V79 CELL CULTURE-GENE MUTATION
EPA GENETOX PROGRAM 1988, INCONCLUSIVE: MAMMALIAN MICRONUCLEUS; SPERM MORPHOLOGY-MOUSE
EPA TSCA CHEMICAL INVENTORY, 1989
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0979-0310;8EHQ-0180-0324
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, APRIL 1990
NIOSH CURRENT INTELLIGENCE BULLETIN 9, 1976
NIOSH ANALYTICAL METHODS: SEE HYDROCARBONS, HALOGENATED, 1003
NCI CARCINOGENESIS BIOASSAY (GAVAGE);CLEAR EVIDENCE:MOUSE,RAT NCITR* NCI-TR,1976
NTP FIFTH ANNUAL REPORT ON CARCINOGENS, 1989 : ANTICIPATED TO BE CARCINOGEN
OSHA ANALYTICAL METHOD #05

TARGET ORGAN DATA

BEHAVIORAL (FOOD INTAKE)
LIVER (LIVER FUNCTION TESTS IMPAIRED)
BLOOD (OTHER CHANGES)
EFFECTS ON FERTILITY (FEMALE FERTILITY INDEX)
EFFECTS ON FERTILITY (POST-IMPLANTATION MORTALITY)
EFFECTS ON FERTILITY (OTHER MEASURES OF FERTILITY)
EFFECTS ON EMBRYO OR FETUS (FETOTOXICITY)
EFFECTS ON EMBRYO OR FETUS (FETAL DEATH)
SPECIFIC DEVELOPMENTAL ABNORMALITIES (CRANIOFACIAL)
SPECIFIC DEVELOPMENTAL ABNORMALITIES (MUSCULOSKELETAL SYSTEM)
SPECIFIC DEVELOPMENTAL ABNORMALITIES (GASTROINTESTINAL SYSTEM)
SPECIFIC DEVELOPMENTAL ABNORMALITIES (HOMEOSTASIS)

NUTRITIONAL AND GROSS METABOLIC (WEIGHT LOSS OR DECREASED WEIGHT GAIN)
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 ----------

ACUTE EFFECTS

MAY BE FATAL IF INHALED, SWALLOWED, 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, DIZZINESS AND HEADACHE
MAY CAUSE NERVOUS SYSTEM DISTURBANCES.

CHRONIC EFFECTS

CARCINOGEN.
DAMAGE TO THE LIVER
DAMAGE TO THE KIDNEYS
DAMAGE TO THE HEART
EXPOSURE TO AND/OR CONSUMPTION OF ALCOHOL
MAY INCREASE TOXIC EFFECTS.
MAY ALTER GENETIC MATERIAL.

FIRST AID

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.
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.
WASH CONTAMINATED CLOTHING BEFORE REUSE.

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

BOILING PT: 61 C
MELTING PT: -63 C
SPECIFIC GRAVITY: 1.492
VAPOR DENSITY: 4.1
VAPOR PRESSURE: 160 MM @ 20 C

APPEARANCE AND ODOR

COLORLESS LIQUID

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

FLASHPOINT: NONE BY:

EXTINGUISHING MEDIA

NONCOMBUSTIBLE.
USE EXTINGUISHING MEDIA APPROPRIATE TO SURROUNDING FIRE CONDITIONS.

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.

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

INCOMPATIBILITIES

BASES
ALUMINUM
SENSITIVE TO LIGHT

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:
HYDROGEN CHLORIDE GAS
PHOSGENE GAS
CARBON MONOXIDE, CARBON DIOXIDE

---------- 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.
ABSORB ON SAND OR VERMICULITE AND PLACE IN CLOSED CONTAINERS FOR DISPOSAL.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

WASTE DISPOSAL METHOD

THE MATERIAL SHOULD BE IGNITED IN THE PRESENCE OF SODIUM CARBONATE AND SLAKED LIME (CALCIUM HYDROXIDE). THE SUBSTANCE SHOULD BE MIXED WITH VERMICULITE AND THEN WITH THE DRY CAUSTICS, WRAPPED IN PAPER AND BURNED 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.
USE ONLY IN A CHEMICAL FUME HOOD.
SAFETY SHOWER AND EYE BATH..
DO NOT BREATHE VAPOR.
AVOID ALL CONTACT.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
WASH THOROUGHLY AFTER HANDLING.
HIGHLY TOXIC.
CARCINOGEN.
MUTAGEN.
IRRITANT.
KEEP TIGHTLY CLOSED.
PROTECT FROM LIGHT.
STORE IN A COOL DRY PLACE.

REGULATORY INFORMATION

THIS PRODUCT IS SUBJECT TO SARA SECTION 313 REPORTING REQUIREMENTS.

--------- ADDITIONAL PRECAUTIONS AND COMMENTS ---------

SECTION 9 FOOTNOTES

STABILIZED WITH APPROX. 0.75% ETHANOL.

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 SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE

Appendix D
Technical Escort Unit SOPs

Appendix D will be included during the site mobilization which is scheduled for January 3, 1994.

Appendix E
Emergency Procedures for Exposure to Hazardous Materials/Waste

APPENDIX E

EMERGENCY PROCEDURES FOR EXPOSURE TO HAZARDOUS MATERIALS/WASTE

1. Call ambulance or transport individual to hospital/clinic immediately. Don't forget to take the HASP with you; it contains information on the contaminants expected to be found on site and will assist the physician in his/her assessment of the exposure.

2. Fill in Potential Exposure Report, answering each of the questions to the best of your ability.

3. Contact our physician(s) at EMR as soon as possible. The procedure is as follows:

   a. **Call EMR at 1-800-229-3674!**

   b. Ask to speak with:

      Dr. David L. Barnes;
      Dr. Elaine Theriault; or
      Ms. T.J. Wolff, R.N.

Note: During nonbusiness hours (after 6 p.m.) call 1-800-229-3674 and follow directions for paging the aforementioned individuals.

4. Once in contact with any of these individuals, explain what has happen (they will review the information on the form with you and may ask you to fax the form to them, if possible), and allow either of them to speak with the attending physician.

5. When asked about payment (and they will ask), inform the Hospital/Clinic/Physician that this is a "work related injury" and have them contact the Benefits Coordinator at (412) 269-2744. Have invoices sent to:

   Michael Baker Jr. Inc.
   Attn: Benefits Coordinator
   Airport Office Park, Bldg. 3
   Coraopolis, PA 15108

6. Contact the Project Manager and the Project Health and Safety Officer as soon as it is feasible, but wait no longer than 24 hours.

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POTENTIAL EXPOSURE REPORT

Name: _____ Date of Exposure: _____

Social Security No.: _____ Age: _____ Sex: _____

I. Exposing Agent

Name of Product or Chemicals (if known) _____

_____

Characteristics (if the name is not known)

Solid Liquid Gas Fume Mist Vapor

II. Dose Determinants

What was individual doing? _____

How long did individual work in area before signs/symptoms developed?

_____

Was protective gear being used? If yes, what was the PPE?

_____

Was there skin contact? _____

Was the exposing agent inhaled? _____

Were other persons exposed? If yes, did they experience symptoms?

_____

III. Signs and Symptoms (check off appropriate symptoms)

Immediately with Exposure:

- ☐ Burning of eyes, nose, or throat
- ☐ Tearing
- ☐ Headache
- ☐ Cough
- ☐ Shortness of breath
- ☐ Delirium
- ☐ Chest tightness/pressure
- ☐ Nausea/vomiting
- ☐ Dizziness
- ☐ Weakness
- ☐ Heat flashes
- ☐ Other _____

Delayed Symptoms:

- ☐ Weakness
- ☐ Nausea/vomiting
- ☐ Shortness of breath
- ☐ Cough
- ☐ Loss of appetite
- ☐ Abdominal pain
- ☐ Headache
- ☐ Numbness/tingling
- ☐ Other _____

Baker

Baker Environmental, Inc

POTENTIAL EXPOSURE REPORT

IV. Present Status of Symptoms (check off appropriate symptoms)

- ☐ Burning of eyes, nose, or throat
- ☐ Tearing
- ☐ Headache
- ☐ Cough
- ☐ Shortness of breath
- ☐ Chest tightness/pressure
- ☐ Cyanosis (bluish skin color)
- ☐ Nausea/vomiting
- ☐ Dizziness
- ☐ Weakness
- ☐ Loss of appetite
- ☐ Abdominal pain
- ☐ Numbness/tingling
- ☐ Other _____

Have symptoms (please check off appropriate response and give duration of symptoms):

Improved _____ Worsened _____ Remain Unchanged _____

V. Treatment of Symptoms (check off appropriate response)

None _____ Self-medicated _____ Physician treated _____

VI. Name _____
(Attending physician)

VII. Hospital/Clinic _____

Source: EMR, Inc.