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FINAL

HEALTH AND SAFETY PLAN

SITES 1, 28, AND 30
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0160

Prepared For:

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

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared By:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

DECEMBER 15, 1993

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EXECUTIVE SUMMARY

Several potential chemical and physical hazards are associated with the tasks of this project at Sites 1, 28, and 30. The chemicals identified from analytical activities include volatile organic compounds (VOCs), pesticides, and metals. Some of the physical hazards associated with this project are from the use of heavy equipment (drill rig) and temperature stress. The environmental hazards include the various degrees of dangerous flora and fauna. Section 3.0 describes these hazards.

Air monitoring requirements consist of using a HNu with an 11.7 electron volt (eV) bulb and the availability of an oxygen/lower explosive meter, radiation meter, and dräger tubes. Section 5.0 describes the 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 and Modified Level D with potential for upgrades based on air monitoring results.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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 Engineer-in-Charge (EIC) when such changes to the plan are implemented.

The HASP is based on an outline developed by the U.S. Coast Guard (U.S.C.G.) for responding to hazardous chemical releases (U.S.C.G. Pollution Response COMDTINST-ML6456-30) and by National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), USCG, and Environmental Protection Agency's (EPA's) 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 plan has been designed as a Site-Specific HASP for field investigation and sampling activities at Marine Corps Base (MCB), Camp Lejeune, Jacksonville, North Carolina, for Sites 1, 28, and 30.

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 1991-1992.

- The Center for Labor Education and Research, Lori P. Andrews, P.E., Editor. Worker Protection During Hazardous Waste Remediation, Van Nostrand Reinhold, New York, New York. 1990.

- Lewis, Richard J., Sr. Hazardous Chemicals Desk Reference, 3rd Edition, Van Nostrand Reinhold, New York, New York. 1991.

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

- U.S.C.G. Policy for Response to Hazardous Chemical Releases. USCG Pollution Response COMDTINST-M16465.30.

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

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

1.3 Pre-Entry Requirements

During the site mobilization and prior to the investigation activities, 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.
- Review any other issues deemed necessary to address site safety and health.

The SHSO will then meet with site personnel (as identified in Section 2.0) to discuss:

- Data obtained from the previous site reconnaissance
- Provisions outlined in this HASP
- 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. Richard E. Bonelli

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 general 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 be consulted before changes to the HASP can be approved or implemented. The PHSO's responsibilities will include:

- Coordinating the development, 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 that all on-site personnel have received the required training and medical surveillance prior to entry onto the site.

SITE MANAGER: Mr. Thomas Trebilcock

The Site Manager is responsible for assuring that all day-to-day 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 to hazardous areas, including the documentation of personnel arriving/departing (by name, company, and time).

- Approving all on site activities.

- 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.

- Coordinating activities with Baker and subcontractor personnel.

SITE HEALTH AND SAFETY OFFICER: (To Be Named Prior To On-site Activities)

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

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

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

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

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

- Monitoring conditions during field activities to assure compliance with the HASP and evaluate if more stringent procedures or a higher level of PPE should be implemented, and informing the PHSO and Project Manager.

- 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 procedures for activities requiring Level C or higher protection levels.

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

- Implementing the Baker Hazard Communication Program.

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

- Suspending field activities because of unsafe conditions that can threaten life or health.

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 procedures 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.
- Complying with the contents of the HASP.
- Attending training sessions to review the HASP, and staying informed of 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 or enhance site safety.
- Conducting site activities in an orderly and appropriate manner.

- Reporting accidents/injuries 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 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:	(To Be Determined per Baker's Ordering Agreements)
Survey Operations:	(To Be Determined per Baker's Ordering Agreements)
Geophysical Operations:	(To Be Determined per Baker's Ordering Agreements)

NAVFACENGCOM REPRESENTATIVES:

Ms. Linda Berry, P.E. (EIC)	(804) 445-8637

ACTIVITY/BASE REPRESENTATIVES:

Mr. Neal Paul (CLEJ EMD)	(910) 451-5874
Mr. Thomas Morris	(910) 451-5872

FEDERAL/STATE/LOCAL REPRESENTATIVES:

Ms. Michelle Glenn (USEPA)	(404) 347-3016
Mr. Peter Burger (NC DEHNR)	(919) 733-2801

3.0 SITE CHARACTERIZATION

This section describes the site background, work tasks, and a hazard evaluation for Sites 1, 28, and 30 at MCB Camp Lejeune.

3.1 Site Background

The information contained in this section has been obtained from a September, 1990 ESE, Inc. document titled Final Site Summary Report.

3.1.1 Site 1 - French Creek Liquids Disposal Area

Site 1 is located on both the north and south sides of the Main Service Road and is bordered to the east by Daly Road and the Gun Park Area and Force Troops Complex to the west. The estimated total acreage for Site 1 is approximately 7 to 8 acres.

Site 1 has been used by different Marine organization over the past three decades. These organizations ranged from motor transport units, armored personnel carriers, tank battalions, and artillery units. These Marine organizations utilized the area since the late 1940s to the mid-1970s.

Liquid wastes generated from the maintenance of vehicles were routinely poured onto the ground. These wastes have been reported as petroleum, oil, and lubricants (POL). Also, used battery acid was reported as being poured onto the ground. Quantities of the wastes have been estimated to be 5,000 to 20,000 gallons of POL waste and 1,000 to 10,000 gallons of battery acid waste.

3.1.2 Site 28 - Hadnot Point Burn Dump

The Hadnot Point Burn Dump is located east of the Mainside Sewage Treatment Plant (STP) and is on both sides of Cogdels Creek. A variety of solid wastes including mixed industrial waste, trash, garbage, oil-based paint, and refuse was burned and subsequently covered with dirt on this 23-acre disposal area which was in operation from 1946 to 1971. Upon its closure in 1971, the surface was graded and grass was planted. The volume of fill is estimated at 185,000 to 379,000 cubic yards. Since the waste was burned, no approximation of the remaining amount of specific substances can reasonably be made. The site is currently used as a recreational area which includes a stocked fishing pond.

3.1.3 Site 30 - Sneads Ferry Road Fuel Tank Sludge Area

The Sneads Ferry Road Fuel Tank Sludge Area is located along a tank trail which intersects Sneads Ferry Road from the west, about 6,000 feet south of the intersection with Marines Road. The site is located approximately 1,500 feet east of French Creek. In 1970, sludge from fuel storage tanks storing leaded gasoline containing tetraethyl lead and related compounds, and tank washout waters were disposed of at the site by a private contractor. It is estimated that at a minimum, 600 gallons of sludge or tank bottom deposits were dumped at the site. The 600-gallon estimate is based on tank capacity below the tank outflow ports. Additional washout water may also have been present. Additional information suggests that the site had also been used for similar wastes from other tanks. Composition of the sludge and/or washout is unknown and may vary from containing substantial amounts of tetraethyl lead to containing mostly cleaning compounds.

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. The work tasks to be accomplished at each of the sites include:

- Survey
- Soil borings
- Well installation
- Well purging and sampling
- Surface water and sediment sampling
- Benthic macroinvertebrate sampling

The following section details physical hazard and potential chemical risks associated with the work tasks.

3.3 Hazard Evaluation

3.3.1 Task-Specific Hazards

Hazards at the site may be associated with several job tasks as detailed in the site work plan.

Listed below are summaries for the hazards associated with each of the site tasks.

Land Surveying

Chemical

- Ingestion of contaminated material from hand to mouth contact.

Physical/Environmental

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

Soil Boring-Sampling

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 or volatile fraction of semivolatile contaminants.

Physical/Environmental

- Heavy equipment operation hazards.
- Lifting hazards (muscle strain).
- 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.

Monitoring Well Installation

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 or volatile fraction of semivolatile contaminants.

Physical/Environmental

- Heavy equipment operation hazards.
- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- 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).

Monitoring Well Development

Chemical

- Potentially-contaminated water, etc., in eyes and on skin.
- Ingestion of hazardous materials from hand to mouth contact.
- Inhalation of volatile contaminants or volatile fraction of semivolatile contaminants.

Physical/Environmental

- Elevated noise levels from equipment operation.
- Slips/trips/falls - sloped, uneven terrain.
- Skin irritation from contact with insects and vegetation.
- Interaction with native and potentially hostile animal life.

Groundwater Sampling

Chemical

- Skin contact with potentially contaminated water.
- Eye contact from splashing water.
- Ingestion of hazardous materials from hand to mouth contact.
- Inhalation of volatile contaminants or volatile fraction of semivolatile contaminants emitting from the well opening.

Physical/Environmental

- 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.

Sediment/Surface Water Sampling and Benthic Macroinvertebrate Sampling

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

- Sampling operations that occur from boats. These operations must comply with Baker's Safety SOP for Safe Boat Operations. (Appendix A)
- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Contact with insects and vegetation.
- Interaction with native and potentially hostile animal life. Note that an alligator occasionally occupies the pond at Site 28.

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 1, 28, and 30 is expected to be minimal based on the levels of the chemicals detected during previous sampling investigations. Table 3-1 identifies the toxicological properties of the chemicals detected during preliminary sampling investigations. Symptoms caused from an exposure to these chemicals can be located on the respective Material Safety Data Sheets (MSDS) located in Appendix B. Procedures to follow in the event of a chemical exposure, are included as Appendix C.

TABLE 3-1

TOXICOLOGICAL PROPERTIES OF CHEMICALS
SITE 1

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:									
Benzene	2 3 0	75	No	Yes	1 ppm	5 ppm	-	3,000 ppm	9.25
1,1-Dichloroethane	2 3 0	230 mm @ 25° C	No	No	100 ppm	-	-	4,000 ppm	11.06
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
1,1,2,2-Tetrachloroethane	2 0 0	9 mm @ 30° C	Yes	Yes	1 ppm	-	-	150 ppm	11.10
Tetrachloroethylene	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
1,2,4-Trichlorobenzene	2 1 0	6	No	No	-	-	5 ppm	-	9.07
Trichloroethylene	2 2 0	58	Yes	Yes	50 ppm	200 ppm	-	1,000 ppm	9.45
SEMIVOLATILES:									
Phenol	3 2 0	0.35	Yes	No	5 ppm	-	-	250 ppm	8.5
METALS:									
Cadmium	3 1 0	NA	No	Yes	0.05 mg/m^3	-	-	-	NA
Chromium	NA	NA	No	Yes	0.5 mg/m^3	-	-	-	NA
Lead	NA	NA	No	Yes	0.05 mg/m^3	-	-	700 mg/m^3	NA

TABLE 3-1 (Continued)

TOXICOLOGICAL PROPERTIES OF CHEMICALS
SITE 28

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:									
1,2-Dichloroethene	2 3 2	180	No	No	200 ppm	-	-	-	9.65
Trichloroethylene	2 2 0	58	No	Yes	50 ppm	200 ppm	-	1,000 ppm	9.45
Vinyl Chloride	2 4 2	2530	No	Yes	1 ppm	5 ppm		-	9.99
PESTICIDES:									
DDD	NA	NA	Yes	Yes	1 mg/m^3	-	-	-	-
DDE	NA	NA	Yes	Yes	1 mg/m^3	-	-	-	-
METALS:									
Chromium	NA	NA	No	Yes	0.5 mg/m^3	-	-	-	NA
Lead	NA	NA	No	Yes	0.05 mg/m^3	-	-	700 mg/m^3	NA

TABLE 3-1 (Continued)

TOXICOLOGICAL PROPERTIES OF CHEMICALS
SITE 30

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:									
Benzene	2 3 0	75	No	Yes	1 ppm	5 ppm	-	3,000 ppm	9.25
Ethylbenzene	2 3 0	10	No	No	100 ppm	125 ppm	-	-	8.86
Toluene	2 3 0	22	No	No	100 ppm	150 ppm	-	2,000 ppm	8.82
Xylene	2 3 0	6.72 mm	No	No	100 ppm	150 ppm	-	1,000 ppm	8.56
SEMIVOLATILES:									
Tetraethyl Lead	3 2 3	0.2 mm Hg	Yes	No	0.075 mg/m^3	-	-	40 mg/m^3	11.10
METALS:									
Cadmium	3 1 0	NA	No	Yes	0.05 mg/m^3	-	-	-	NA
Chromium	NA	NA	No	Yes	0.5 mg/m^3	-	-	-	NA
Lead	NA	NA	No	Yes	0.05 mg/m^3	-	-	700 mg/m^3	NA

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 Rating - 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 1991-1992

(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 1991-1992 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 1990-1991

(8) Ceiling Limit - denotes the ceiling concentration that cannot be exceeded at any time -ACGIH 1990-1991

(9) IDLH - Immediately Dangerous to Life and Health

(10) Ionization Potential - expressed in electron volts (eV) from the NIOSH Pocket Guide To Chemical Hazards

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 1, 28, and 30. This clearance must come from the base representative for this project and the North Carolina Utilities Locating Company, Inc. (ULOCO). 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 and at least two weekdays for ULOCO. 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.

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.

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 must operate properly on the heavy equipment. Only operators trained, qualified, and authorized will be permitted to operate the heavy equipment.

The subcontracting drilling company's representative is to provide any other cautions that need to be observed when working around this equipment during the HASP briefing.

3.3.3.3 Thermal Stress

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

3.3.3.4 Explosion and Fire

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

- Explosion and fire resulting from:
    - Heavy equipment malfunction
    - Penetration into underground utility/service lines (gas, electric, fuel)
    - Ignition of trapped flammable vapors
    - Vehicular accidents

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 are typically 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. A confined space entry procedure will be required if there is a potential for employees to fall into a "confined space," or where a rescue operation involving a confined space may occur, according to OSHA Standard 1910.146, Permit-Required Confined Spaces.

Before any operation is to be performed in a confined space, the PHSO must be contacted.

3.3.4 Radiation Hazards

Although the potential for exposure to radiological wastes or radioisotopes at Sites 1, 28, and 30 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

Hazardous Flora

Incidence of contact by individuals to poisonous/thorny plants is high; 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.

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* *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 subsections define measures and procedures for maintaining site control. Site control is an essential component with 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 1, 28, and 30 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.

4.2 Site Conditions

- The prevailing wind conditions are to be determined daily.
- An on-site Command Post will be established. This location will be in the Support Zone and oriented upwind from the Work Zone.

4.3 Work Zones

Refer to Figure 4-1 for a general description of how the work zones will be arranged at each site. Exact location of the demarcated zones will be field determined during site mobilization.

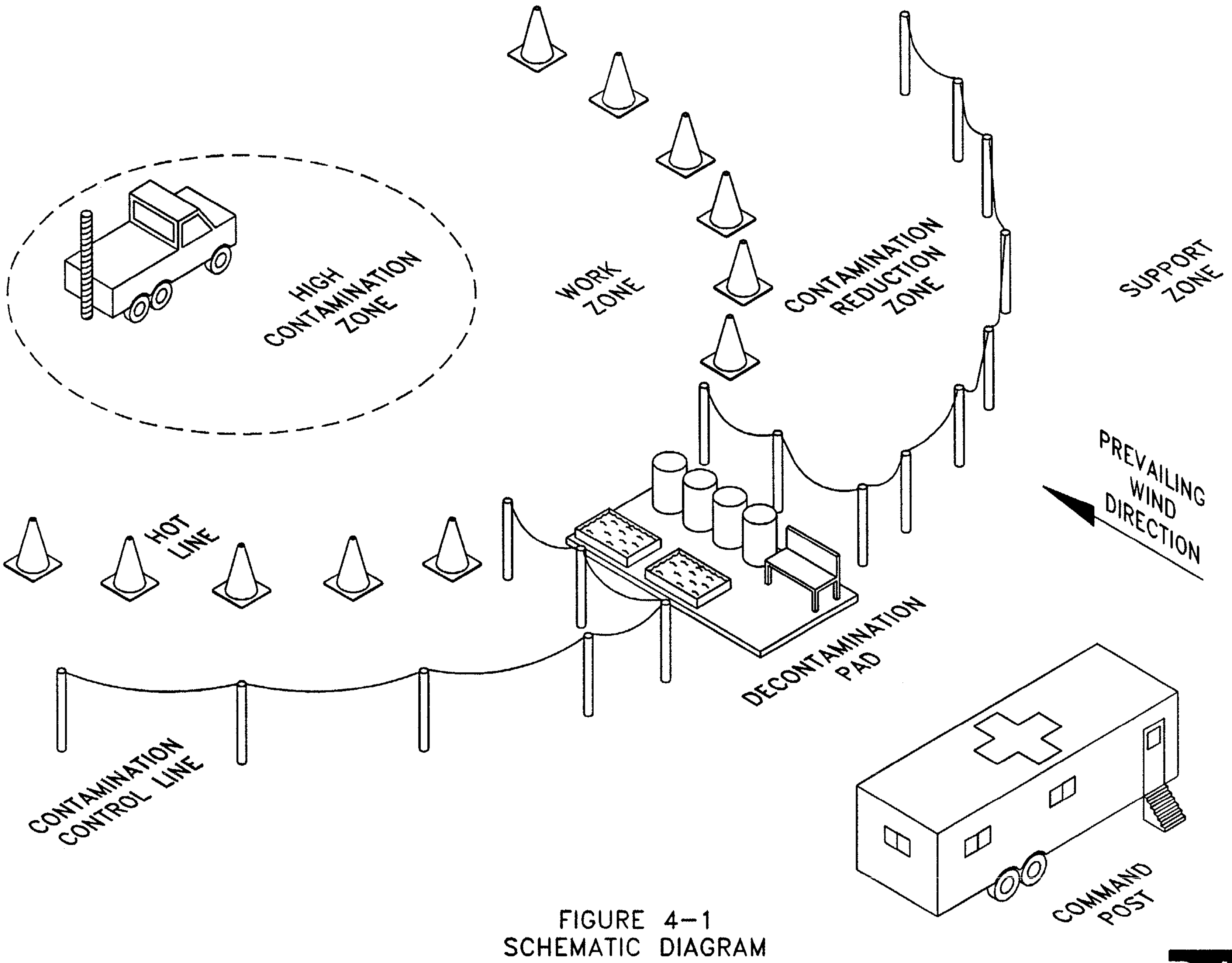

FIGURE 4-1
SCHEMATIC DIAGRAM
GENERAL CONTAMINATION
REDUCTION ZONE LAYOUT

Baker

Baker Environmental, Inc.

CONZONE2

Level C Activities

Although Level C protection level is not anticipated, boundaries between the Work Zone, the Contamination Reduction Zone (CRZ), and the Support Zone (Clean Zone) will be established if protection levels upgrade to Level C. These boundaries will be defined as follows:

- Work Zone - A radius of at least 25 feet (barring obstruction) from site investigative activities.
- 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.

Level D and D+ Activities

Populated Areas

Work Zones for activities conducted under Level D or D+ protection levels will 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.

Unpopulated/Secluded Areas

In unpopulated or secluded areas, the aforementioned materials may not be used due to the exclusive nature of the site, the short duration of the activity, and the low risk to outside populations. The SHSO and/or Field Team Leader is responsible for making this determination.

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 at 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, should 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.

- The subcontracting drilling company's supervisor is to provide other cautions to be observed when working around the drill rig during the HASP briefing.

- 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 digging (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 drill rig boom is to remain a minimum of 10 feet from power lines (see Section 3.3.3.1).

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

Air monitoring will be conducted at the personal breathing zones, point source, and around the site perimeter as necessary. Monitoring instrumentation to be available on site include a HNu (PID) with an 11.7 eV bulb, oxygen/combustible gas meter, and radiation survey meter.

5.1 Personal Monitoring

The following personal monitoring will be in effect on site:

Personal monitoring will be accomplished using real time environmental monitoring instrumentation directed at the breathing zone of work party personnel. Breathing Zone (BZ) monitoring will be performed each time a reading is taken at the point source. The guidelines below identify the protection levels required according to the concentration measured in the BZ.

PID(1)

- Background to 1 mu above background in the breathing, can remain in Level D
- >1 mu to 5 mu above background in the breathing zone for up to 5 continuous minutes = Level C or Stop Work plus Dräger Tubes
- >5 mu for up to 5 continuous minutes in the breathing zone = Stop Work and Consult PHSO

(1) PID with 11.7 eV ultraviolet lamp.

Dräger Tubes(1) (used to determine if Level C or D+ protection levels are adequate for highly volatile constituents when a PID response meets the level identified above).

- Benzene Dräger Tubes
  - Below limits of detection (BLD) to one-half of the TWA(2) = Level D
  - One-half of the TWA or greater = Level C
  - >5 times the TWA Stop Work and consult PHSO

If vinyl chloride is detected in the breathing zone with Dräger tubes, work will stop and the PHSO will be contacted.

(1) Dräger Tubes to be used include: Benzene (67 28561) and Vinyl Chloride (67 28061)
(2) Refer to Table 1, Section 3.0, for explanation.

5.2 Point Source Monitoring

Point source monitoring is defined by this HASP as monitoring performed at the source of the sampling/investigative activity. Instrumentation to be available will include a PID, oxygen/combustible gas meter, and radiation survey meter. The oxygen/combustible gas meter and radiation survey meter will be used at the discretion of the SHSO or Site Manager. The action levels for the oxygen/combustible gas meter and radiation meter are identified below.

Oxygen/Combustible Gas Meter*

Combustible Gas Meter

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

Oxygen Meter

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

*Used to evaluate physical safety in conjunction with the PID and/or Dräger Tubes.

Radiation Survey Meter - Ludlum Model 3-98 Survey Meter with Model 44-2 Gamma Scintillator Tube (external probe)

- Background = Continue work
- 2 times the background = Leave work area and consult PHSO

GM Pancake Probe (internal probe)

- Background = Continue work
- 2 times the background = Leave work area 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 (defined as monitoring performed at borders beyond the Support Zone and often at the "fence line") for each site will be performed 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 50 mu at the point source or 10 mu at the work area breathing zone.
- The Dräger Colorimetric Tubes will be used periodically 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 (i.e., when levels return to background), if a radiation level exceeding 2 times the background is established.

5.4 Equipment Maintenance and Calibration

Baker's procedures for the return of equipment to inventory and for maintenance of the equipment will be followed in order to assure that the optimum level of operation is maintained for the item. Equipment calibration under the direction of the SHSO will be conducted according to manufacturer's recommendations and calibration information entered into the equipment calibration log sheet. The log sheets will be maintained on site for the duration of the project with copies to be given to the Equipment Manager 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 area of the site, and specific location, such as, point source, breathing zone, or area. The log sheets will be placed in a binder and remain on site till the end of the field activities, whereby the log sheets will become part of the permanent file.

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.

Item No.	Personal Protective Equipment
1	Chemical-Resistant Clothing (Polyethylene-coated Tyvek®)
2	Chemical-Resistant Clothing (Saranex®)
3	Uncoated Tyvek®/Kleenguard® Coveralls
4	Normal Work Clothes or Coveralls
5	Air-Line Respirator (ALR) with 5-minute escape pack
6	Self-Contained Breathing Apparatus (SCBA) for rescue
7	NIOSH 5-minute Escape Pack (on standby)
8	Full-face Cartridge Respirator
9	Half-face Cartridge Respirator
10	Full-face Cartridge Respirator (on standby)
11	Half-face Cartridge Respirator (on standby)
12	Chemical-Resistant Gloves (Nitrile inner)
13	Chemical-Resistant Gloves (Latex inner)
14	Chemical-Resistant Gloves (Rubber/Neoprene outer)
15	Chemical-Resistant Gloves (Nitrile outer)
16	Work Gloves (outer)
17	Chemical-Resistant Overboots (with steel toe and shank)
18	Chemical-Resistant Overboots (w/o steel toe)
19	Steel Toe Boots
20	Safety Glasses
21	Safety Goggles
22	Face Shield
23	Hard Hat
24	Hearing Protection(1)

(1) At the discretion of the SHSO.

6.2 Site-Specific Levels of Protection

Based on an evaluation of potential hazards the levels of protection and corresponding personal protective equipment 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				Personal Protective Equipment (Item No.)
		C	D+	D	Other	
1, 28, and 30	Sediment/Surface Water Sampling and Benthic Sampling		X			15, 19, 20
	Land Surveying			X		4
	Monitoring Well Installation			X		16, 19, 20, 23, 24(1)
	Monitoring Well Development		X			15, 19, 20
	Groundwater Sampling		X			15, 19, 20
	Soil Boring - Sampling		X			16, 19, 20, 23, 24(1)

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) At the discretion of the SHSO

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 C

The "North" or "MSA" full-face/half-face NIOSH-certified negative pressure Air-Purifying Respirator (APR) with an organic vapor/acid gas/HEPA cartridge is the appropriate cartridge for use with the detected hazardous materials and the measured contaminant concentrations. Upgrades/downgrades in this level of respiratory protection will be based on measured "realtime" 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.

6.4 Care and Cleaning of Personal 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
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
3. Boot and glove wash*	3. Outer boot and glove rinse	3. Outer boot and glove rinse
4. Boot and glove rinse*	4. Tape Removal	4. Tape Removal
5. Tape Removal*	5. Outer boot and glove removal	5. Outer boot and glove removal
6. Boot removal*	6. Coverall removal/ disposal	6. Coverall removal/ disposal
7. Glove removal*	7. Inner glove removal/disposal	7. Respirator removal
8. Hand/Face wash	8. Hand/face wash	8. Inner glove removal/disposal
9. Equipment wipe down	9. Equipment cleaning	9. Hand/face wash
		10. Respirator cleaning/ sanitizing
		11. Equipment cleaning

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

The following decontamination equipment is required for Level C protection levels and recommended for Level D+ protection:

- Four small tubs (two sets of wash and rinse water)
- 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

*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

Pressure steam cleaning of the drill rig augers will be conducted by the subcontractor. A portable steam cleaning unit will be used for this 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 SOP on "Handling of Site Investigation Generated Wastes," located in the Standard Operating Procedures for Administrative, Field, and Technical Activities Manual.

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 various telephones located throughout the investigation areas.

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

Emergency telephone numbers will be place at strategic locations throughout the site. The list of emergency phone numbers is presented below.

Facility	Phone Number	Contact
Security (Police)	911 or (910) 451-4555	Response Operator
Fire	911	Response Operator
Ambulance (On-Base)	911	Response Operator
Ambulance (Off-Base)	(910) 455-9119	Response Operator
Hospital Emergency Room (On-Base)	911 or 910-451-4840 910-451-4841 910-451-4842	Response Operator
Onslow County Hospital (Off-Base)	(910) 577-2240	Response Operator
ULOCO	1-800-632-4949	Response Operator
Hazardous Waste Dispatcher	911	Response Operator
On-Scene Coordinator	911	Fire Chief
Public Works Department (Underground Utilities via EMD Contact)	(910) 451-5874	Mr. 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
EMD	(910) 451-5063	Mr. Neal Paul Mr. Tom Morris Mr. Walter Haven
Agency for Toxic Substances and Disease Registry	1-404-639-0615	Response Operated

8.4 Assembly Area

Personnel will be instructed before the start of operations the designated meeting point in the event of an emergency. 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 and base 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.

Directions to the Onslow County Memorial hospital (317 Western Boulevard) (Refer to Figure 8-1):

1. Leave base through the Main Gate (via Holcomb Boulevard).
2. Take Highway 24 West to Western Boulevard and turn right.
3. Continue on Western Boulevard to the fifth stop light and hospital will be on the left.
4. Follow directions to the emergency room entrance.

Directions to the Base Naval Hospital (Building NH 100) from Site 1 (Refer to Figure 8-1):

1. Travel east on Main Service Road to Sneads Ferry Road.

2. Turn left and travel north on Sneads Ferry Road to Holcomb Boulevard and bear right at yield sign.

3. Travel north on Holcomb Boulevard to traffic light and turn left on 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.

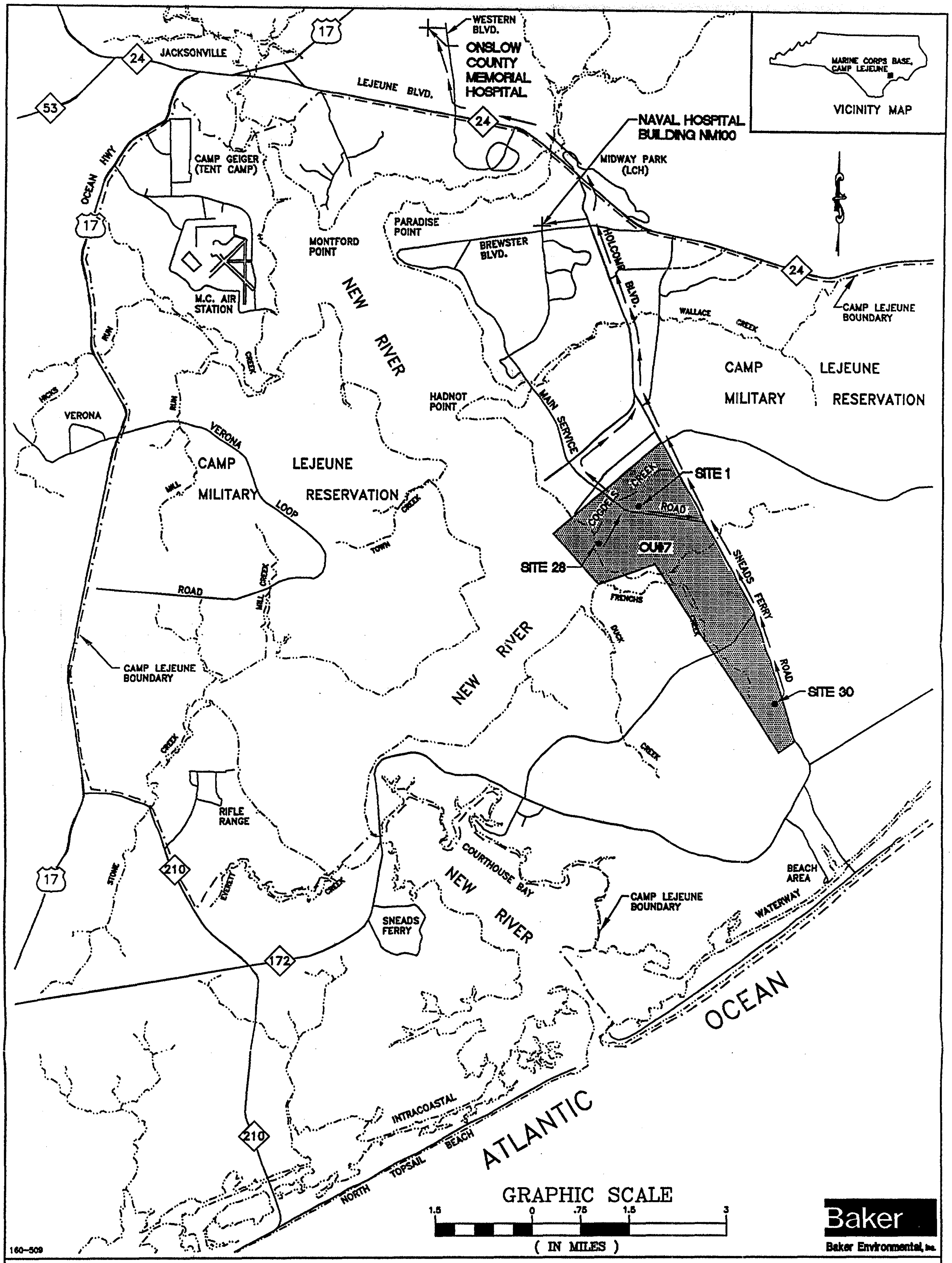

FIGURE 8-1
EMERGENCY HOSPITAL ROUTE
SITES 1, 28, AND 30

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Directions to Base Hospital (Building NH 100) from Site 28 (Refer to Figure 8-1):

1. Follow Exit Road to Julian C. Smith Road. Travel northwest on Julian C. Smith Road to "O" Street (first street on right) and make right turn.
2. Follow "O" Street to Main Service Road and turn left.
3. Travel north on Main Service Road to Circle, make a right on Circle and another right on Holcomb Boulevard.
4. Travel northeast then north on Holcomb Boulevard to third traffic light and turn left on Brewster Boulevard.
5. Continue on Brewster Boulevard until intersecting with driveway to Naval Hospital on right (approximately 0.75 miles).
6. Follow signs for emergency room entrance.

Directions to Base Hospital (Building NH 100) from Site 30 (Refer to Figure 8-1):

1. Follow tank trail to Sneads Ferry Road.
2. Turn left and travel north on Sneads Ferry Road to Holcomb Boulevard and bear right at yield sign.
3. Travel north on Holcomb Boulevard to traffic light and turn left on 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.

8.6 Emergency Medical Treatment

Emergency Services

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

Note: In instances of extreme emergency or for stable patient transfer to nearby public hospitals, personnel may be transported to Building NH 100 (Naval Hospital).

Local ambulance service is available from the Naval Ambulance Service at 911 and the City of Jacksonville at (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. A copy of Baker's Bloodborne Pathogen Program will be available in the site trailer.

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 Naval 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.

- 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. Obtain medical attention immediately.

- 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.

- Breathing - If a person has difficulty breathing, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.

The emergency procedures that are to be followed in the event of a site person or persons being exposed to hazardous materials are contained in Appendix C.

Snakebite Injury

In the event of a snakebite injury, the following procedures will be followed.

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.

Spider Bite Injury

There are two spiders commonly found in the United States whose bite can be serious: the black widow spider and the brown recluse spider. These bites may be serious, even life-threatening. Many other spiders will bite, but they do not produce serious complications. The black widow spider measures approximately 1 inch long with its legs extended. It is glossy black in color and has a distinctive yellow-orange marking in the shape of an hourglass on its belly. On its back, however, there is no marking, and unless you happen to turn the spider over, you cannot see this mark. The danger of the black widow spider bite lies in its systemic manifestations. The venom from this spider attacks the nervous system, resulting in severe muscle cramps with boardlike rigidity of the abdominal muscles, tightness in the chest, and difficulty in breathing. Sweating, nausea, and vomiting will also occur.

The emergency treatment for the black widow spider bite is basic life support. sometimes the individual is not even aware of having been bitten, or where. Apply cold to the site of the bite if it can be identified. There is a specific antivenin for this spider bite that must be administered by a physician. It is particularly important to identify the spider, and bring it in, if you can.

The brown recluse spider is a little bit smaller than the black widow spider and is dull brown in color. It has a violin-shaped mark on its back, which can be seen when you are looking at the spider from above. The spider gets its name because it tends to live in dark areas, corners, and old unused buildings. The bite from this animal produces local rather than systemic manifestations. The venom of the brown recluse spider causes severe local tissue damage and can lead to an ulcer and gangrene. The bitten area becomes red, swollen, and tender within a few hours after the bite. A small blister forms, and several days later, this may form a large scab, covering a deep ulcer. Death is rarely reported, but these bites need local surgical treatment, and these patients should be brought to the hospital. Again, if possible, identification of the spider should be carried out.

Decontamination

If on-site decontamination of injured employee(s) is not possible, the Emergency Coordinator will provide polyethylene sheeting (or equivalent) for a stretcher, and ambulance. If necessary, a site employee equipped with appropriate protective equipment and clothing will accompany the injured employee and will perform decontamination under the supervision of emergency medical personnel.

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

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.*

Level D	Level D+	Level C
• Equipment drop • Tape, boot, and glove removal • Coverall removal	• Equipment drop • Tape, outer boot, and glove removal • Coverall removal/ disposal • Inner glove removal/ disposal	• Equipment drop • Tape, outer boot, and glove removal • Coverall removal/ disposal • Respirator removal • Inner glove removal/ disposal

* 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:

- Polyvinyl chloride boots
- Saranex® suits
- Tyvek® suits, polyethylene coated and uncoated
- Nitrile gloves (inner and outer)
- Neoprene and Nitrile Gloves (outer)
- Face shields and 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 Vehicle
Emergency eye wash bottle: Baker Site Trailer and Baker Field Vehicle

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 a chemical release, fire, explosion, or severe weather conditions 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.

- Identify exposure and/or release pathways and the quantities of materials involved.

- Determine the potential effects of the exposure/release and appropriate safety precautions.

- Determine if release of materials meets EPA requirements for reportable quantities for spills under the RCRA or the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

- Inform appropriate personnel as identified in Section 8.9.

This assessment will 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 generated or the effects of any hazardous surface water runoff from water or chemical agents used to control fire and heat-induced explosions).

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).

- 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).

- 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

EPA 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:

- Absorbent pads
- Vermiculite
- Sheets of polyethylene
- Shovel

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. These are generally 5-day (40-hour) courses. 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.

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.

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.

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, pulmonary function test, 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.

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 $FEV_{1.0}$)

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* 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 1, 28, and 30.

Mr. Ronald Krivan, CSP	PHSO	Joseph E. Rozum for Ron Krivan
Name	Title	Signature
Mr. Richard E. Bonelli	Project Manager	
Name	Title	Signature
Mr. Joseph Rozum	QA/QC	Joseph E. Rozum
Name	Title	Signature

12.0 DECLARATION OF HASP REVIEW

All site personnel indicated below, have reviewed and are familiar with this Health and Safety Plan of Sites 1, 28, and 30 at MCB Camp Lejeune, North Carolina.

1.	(Name-Print)	(Company)
	(Name-Sign)	(Date)
2.	(Name-Print)	(Company)
	(Name-Sign)	(Date)
3.	(Name-Print)	(Company)
	(Name-Sign)	(Date)
4.	(Name-Print)	(Company)
	(Name-Sign)	(Date)
5.	(Name-Print)	(Company)
	(Name-Sign)	(Date)
6.	(Name-Print)	(Company)
	(Name-Sign)	(Date)

Appendix A
Baker Environmental, Inc.
Safety Standard Operating Procedures

APPENDIX A

BAKER ENVIRONMENTAL, INC.
SAFETY STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

*Not applicable, not included

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

Compressed and 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 as described in Compressed Gas Association Commodity Specification G-7.1-1966. Breathing air may be supplied to respirators from cylinders or air compressors. 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 shall be marked in accordance with American National Standard Method of marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1-1954; Federal Specification BB-A-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG-B-00675b, April 27, 1965, Breathing Apparatus, Self-Contained.

2.8 CLEANING AND MAINTENANCE

Respirator maintenance will be performed by each trained individual on a regular basis. The maintenance shall be carried out on a schedule which 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 on a schedule (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 Attachment 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.

Baker

Baker Environmental, Inc

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

RESPIRATOR FIT TEST RECORD

Baker Environmental, Inc

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	____________	Talking	____________
Deep Breathing	____________	Running	____________
Head, Side to Side	____________	Bending	____________
Head, Up and Down	____________	Rainbow Passage	____________

COMMENTS: ______________________________________

____

Signed: ______________________
(Test Subject)

Signed: ______________________
(Technician/Instructor)

Baker

Baker Environmental, Inc

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

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 C and 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. Dispose of according to site procedures.

3.2.4 Safety Shoes/Boots (Levels D through B)

- Examine daily for gauges, 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.

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.

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 not be allowed in areas where flammable materials are present.
- Hands and face must be thoroughly washed upon leaving the work area.
- 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.

- No contaminated work garments are 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 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 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 are prohibited on site.

- Personal radios, TVs, and tape players are prohibited on site.

- Firearms 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.

7.0 - SAFE BOAT OPERATIONS

7.1 OBJECTIVE

To provide safe operating procedures while performing sampling activities from a boat.

7.2 EQUIPMENT

Refer to Attachment A, "Federal Requirements for Recreational Boats," for a list of required equipment.

7.3 PRELIMINARY ACTIVITIES

Ensure that requirements governing the safe operation of a boat, published by the Department of Transportation, United States Coast Guard (Attachment A) are reviewed prior to placing the boat in the water.

7.4 OPERATING PROCEDURE

Operate the boat according to the Department of Transportation, United States Coast Guard Regulations (Attachment A), where applicable.

7.5 REFERENCES

U.S. Department of Transportation, United States Coast Guard. Federal Requirements for Recreational Boats. United States Coast Guard, Washington, D. C. 20593.*

* It is recognized that these requirements are directed towards recreational boating, but Baker Environmental, Inc. believes that the topics of discussion included in this reference are applicable to the size of boat, and activities to be performed during environmental sampling.

ATTACHMENT A

BE SAFE ON THE WATER

KNOW . . .

☐ The stability and handling of the boat you are using.

☐ How to use the equipment on the boat.

☐ The waters you will be using, tides, currents, sand bars, and other hazards.

☐ The weather conditions.

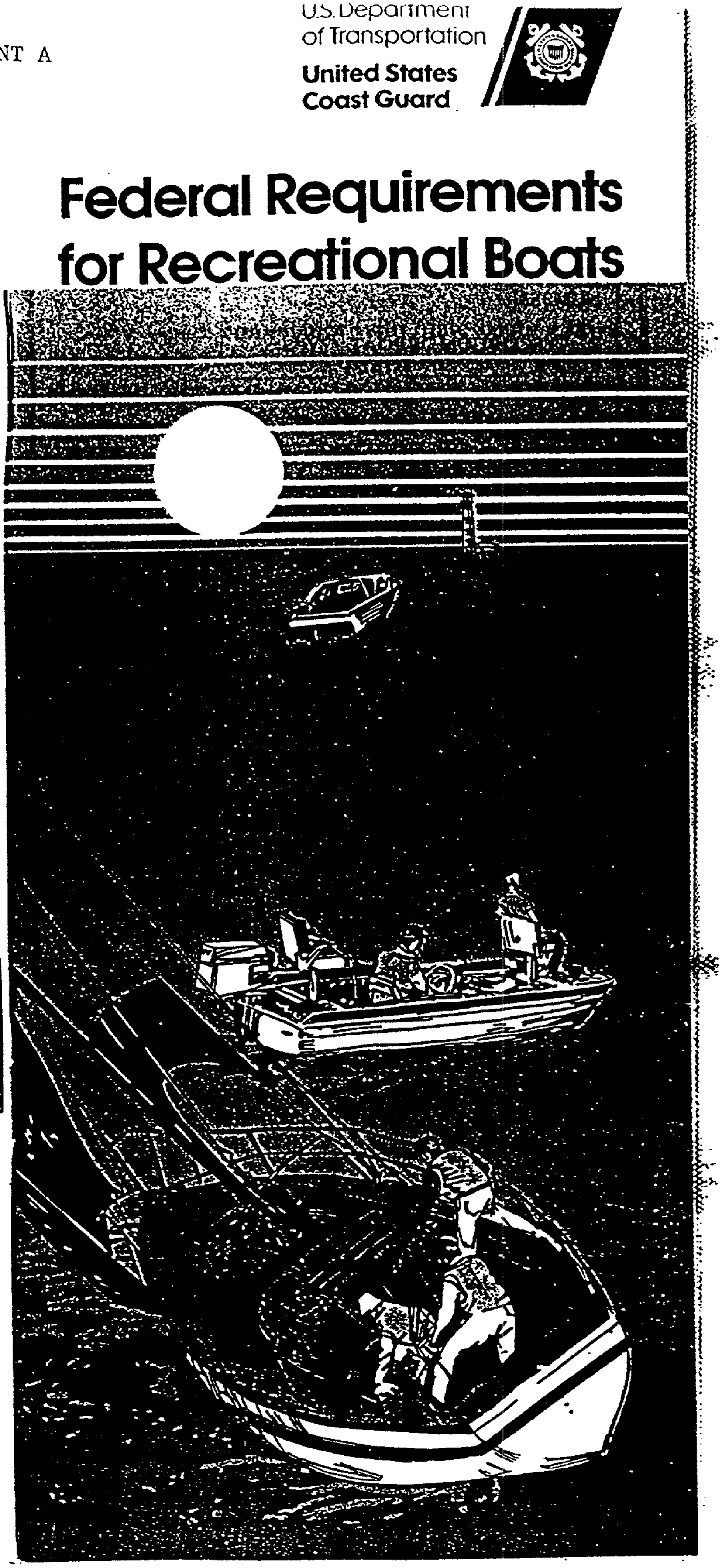
☐ The safety devices and emergency equipment
Make sure that life jackets fit properly.

☐ The navigation rules and observe the courtesies of safe boating.

☐ Your personal limitations and responsibilities.
Exposure to sun, wind, cold water, all affect your ability to react.

☐ That it is illegal to operate a vessel while intoxicated. If you add alcohol or drugs to boating, the results can be fatal.

. . . BEFORE YOU GO!



U.S. Department
of Transportation
United States
Coast Guard

Federal Requirements for Recreational Boats

FLOAT PLAN

Complete this page, before going boating and leave it with a reliable person who can be depended upon to notify the Coast Guard or other rescue organization, should you not return as scheduled. Do not file this plan with the Coast Guard.

1. NAME OF PERSON REPORTING AND TELEPHONE NUMBER.

2. DESCRIPTION OF BOAT. TYPE ____________
COLOR __________ TRIM ____________ REGISTRATION NO. ____________ LENGTH _____ NAME
____________ MAKE ____________
OTHER INFO. ____________

3. PERSONS ABOARD ____________

NAME	AGE	ADDRESS & TELEPHONE NO.

4. DO ANY OF THE PERSONS ABOARD HAVE A MEDICAL PROBLEM? ________ IF SO, WHAT? ____________

5. ENGINE TYPE ____________ H.P. ________
NO. OF ENGINES ______ FUEL CAPACITY ____________

6. SURVIVAL EQUIPMENT: (CHECK AS APPROPRIATE)
PFDs ________ FLARES ________ MIRROR ________
SMOKE SIGNALS __________ FLASHLIGHT ________
FOOD ______ PADDLES ________ WATER ________
OTHERS __________ ANCHOR ____________
RAFT OR DINGHY ________ EPIRB ________

7. RADIO YES/NO TYPE ____________
FREQS. ____________

8. TRIP EXPECTATIONS: LEAVE AT ____________
FROM ____________ GOING TO ____________
EXPECT TO RETURN BY ____________ (TIME) AND IN NO EVENT LATER THAN ____________

9. ANY OTHER PERTINENT INFO. ____________

10. AUTOMOBILE LICENSE ____________
TYPE ____________ TRAILER LICENSE ____________
COLOR AND MAKE OF AUTO ____________
WHERE PARKED ____________

11. IF NOT RETURNED BY ____________ (TIME)
CALL THE COAST GUARD, OR ____________ (LOCAL AUTHORITY)

12. TELEPHONE NUMBERS ____________
____
____
____

This pamphlet contains the Federal equipment carriage requirements for recreational vessels. The owner/operator may be required to comply with additional regulations specific to the State in which the vessel is registered or operated. State laws vary. A vessel in compliance with the laws of the State of registration, may not meet the requirements of another State where it may be operating.

To insure compliance with State boating laws, contact your State boating safety agency.

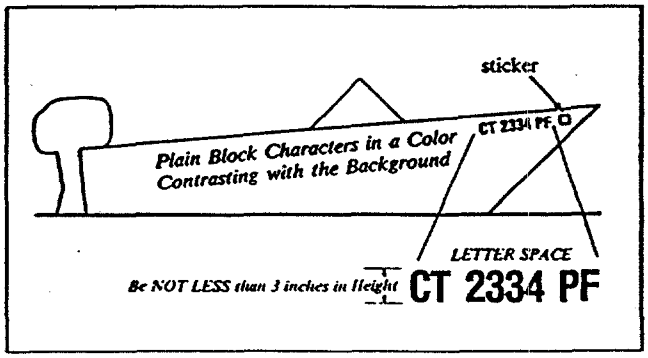
REGISTRATION AND NUMBERING REQUIREMENTS

All undocumented vessels equipped with propulsion machinery must be registered in the State of principal use. A certificate of number will be issued upon registering the vessel. These numbers must be displayed on your vessel. Some States require all vessels to be numbered, check with your State boating authority for numbering requirements.

A documented vessel is not exempt from applicable State or Federal taxes, nor is its operator exempt from compliance with Federal or State equipment carriage requirements.

DISPLAY OF NUMBER

Numbers must be painted or permanently attached to each side of the forward half of the vessel. The Coast Guard and many States issue two validation stickers. They must be affixed within six inches of the registration number. No other letters or numbers may be displayed nearby.



CERTIFICATE OF NUMBER

The owner/operator of a vessel must carry a valid certificate of number whenever the vessel is in use. When a vessel is moved to a new State of principal use, the certificate of number is valid for 60 days.

The Coast Guard issues the certificate of numbers in Alaska.

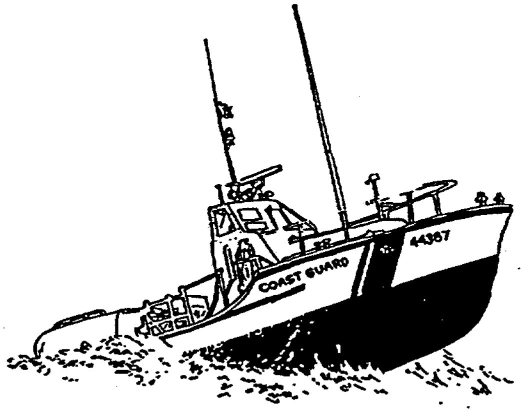
NOTIFICATION OF CHANGES

The owner of a vessel must notify the agency which issued the certificate of numbers within 15 days if:

- The vessel is transferred, destroyed, abandoned, lost, stolen or recovered.
- The certificate of number is lost, destroyed or the owner's address changes.

If the certificate of number becomes invalid for any reason, it must be surrendered in the manner prescribed by the issuing authority within 15 days.

LAW ENFORCEMENT



A vessel underway, when hailed by a Coast Guard vessel is required to heave to, or maneuver in such a manner that permits a boarding officer to come aboard.

Other Federal, State and local law enforcement officials may board and examine your vessel, whether it is numbered, unnumbered or documented. Coast Guard law enforcement personnel may also be found aboard other vessels.

The Coast Guard may impose a civil penalty up to $1,000 for failure to: comply with numbering requirements; comply with equipment requirements; report a boating accident; or comply with other Federal regulations. Failure to comply with the unified Inland Rules of the Road (Inland Navigation Rules Act of 1980) can result in a civil penalty up to $5,000.

Improper use of a radiotelephone is a criminal offense. The use of obscene, indecent or profane language during radio communications is punishable by a $10,000 fine, imprisonment for two years or both. Other penalties exist for misuse of a radio, such as improper use of Channel 16 VHF-FM.

Channel 16 is a calling and distress channel. It is not to be used for conversation or radio checks. Such traffic should be conducted on an authorized working channel.

OPERATING A VESSEL WHILE INTOXICATED became a specific federal offense effective January 13, 1988. The final rule set standards for determining when an individual is intoxicated. The BAC is .10% (.08% in Utah) for operators of recreational vessels being used only for pleasure. Violators are subject to civil penalty not to exceed $1,000 or criminal penalty not to exceed $5,000, 1 year imprisonment or both.

NEGLIGENT or GROSSLY NEGLIGENT OPERATION of a vessel which endangers lives and property is prohibited by law. The Coast Guard may impose a civil penalty for negligent operation. GROSSLY NEGLIGENT OPERATION is a criminal offense and an operator may be fined up to $5,000, imprisoned for one year, or both. Some examples of actions that may constitute negligent or grossly negligent operation are:

- Operating a boat in a swimming area.
- Operating a boat while under the influence of alcohol or drugs.
- Excessive speed in the vicinity of other boats or in dangerous waters.
- Hazardous water skiing practices.
- Bowriding, also riding on seatback, gunwale or transom.

TERMINATION OF USE

A Coast Guard boarding officer who observes a boat being operated in an UNSAFE CONDITION, specifically defined by law or regulation, and who determines that an ESPECIALLY HAZARDOUS CONDITION exists, may direct the operator to take immediate steps to correct the condition, including returning to port. Termination of unsafe use may be imposed for:

- Insufficient number of CG Approved Personal Flotation Devices (PFDs).
- Insufficient fire extinguishers.
- Overloading beyond manufacturers recommended safe loading capacity.
- Improper navigation light display.
- Fuel leakage.
- Fuel in bilges.
- Improper ventilation.
- Improper backfire flame control.
- Operating in regulated boating areas during predetermined adverse conditions. (Applies in 13th CG District Only).
- Manifestly unsafe voyage.

An operator who refuses to terminate the unsafe use of a vessel can be cited for failure to comply with the directions of a Coast Guard boarding officer, as well as for the specific violations which were the basis for the termination order. Violators may be fined not more than $1000 or imprisoned not more than one year or both.

COAST GUARD APPROVED EQUIPMENT

The Coast Guard sets minimum safety standards for vessels and associated equipment. To meet these standards various equipment must be Coast Guard approved. "Coast Guard Approved Equipment" has been determined to be in compliance with USCG specifications and regulations relating to performance, construction or materials.

PERSONAL FLOTATION DEVICES (PFDS)

PFDs must be Coast Guard Approved, in good and serviceable condition, and of appropriate size for the intended user. Wearable PFDs must be readily accessible, meaning you must be able to put them on in a reasonable amount of time in an emergency (vessel sinking, on fire, etc.). They should not be stowed in plastic bags, in locked or closed compartments or have other gear stowed on top of them. Throwable devices must be immediately available for use. Though not required, a PFD should be worn at all times when the vessel is underway. **A wearable PFD can save your life, but only if you wear it.**

Boats less than 16 feet in length (including canoes and kayaks of any length) must be equipped with one Type I, II, III, IV or V PFD for each person aboard.

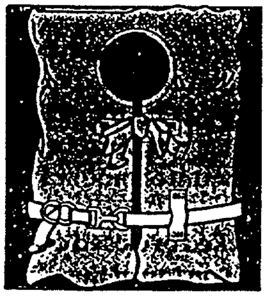
Boats 16 feet and longer must be equipped with one Type I, II, III or V for each person aboard PLUS one Type IV.

Federal law does not require PFDs on racing shells, rowing skulls and racing kayaks; State laws vary.

TYPES OF PFDS

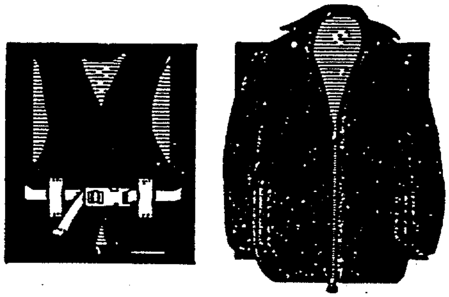
A TYPE I PFD, or OFF-SHORE LIFE JACKET provides the most buoyancy. It is effective for all waters, especially open, rough or remote waters where rescue may be delayed. It is designed to turn most unconscious wearers in the water to a face-up position. The Type I comes in two sizes. The adult size provides at least 22 pounds buoyancy, the child size, 11 pounds, minimum.

Off-shore Lifejacket



Near-Shore Buoyant Vest

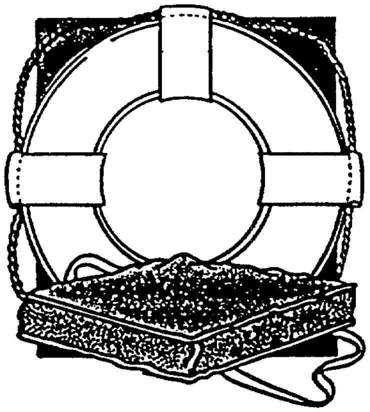
A TYPE II PFD, or NEAR-SHORE BUOYANT VEST is intended for calm, inland water or where there is a good chance of quick rescue. This type will turn SOME unconscious wearers to a face-up position in the water. The turning action is not as pronounced and it will not turn as many persons under the same conditions as a Type I. An adult size device provides at least 15 1/2 pounds buoyancy, a medium child size provides 11 pounds. Infant and small child sizes each provide at least 7 pounds buoyancy.



Flotation Aid

A TYPE III PFD, or FLOTATION AID is good for calm, inland water, or where there is a good chance of quick rescue. It is designed so wearers can place themselves in a face-up position in the water. The wearer may have to tilt head back to avoid turning face-down in the water. The Type III has the same minimum buoyancy as a Type II PFD. It comes in many styles, colors and sizes and is generally the most comfortable type for continuous wear. Float coats, fishing vests and vests designed with features suitable for various sports activities are examples of this type PFD.

A TYPE IV PFD, or THROWABLE DEVICE is intended for calm, inland water with heavy boat traffic, where help is always present. It is designed to be thrown to a person in the water and grasped and held by the user until rescued. It is not designed to be worn. Type IV devices include buoyant cushions, ring buoys and horseshoe buoys.

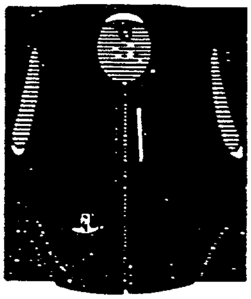


Throwable Device

A TYPE V PFD, or SPECIAL USE DEVICE is intended for specific activities and may be carried instead of another PFD only if used according to the approval conditions on the label. Some Type V devices provide significant hypothermia protection. Varieties include deck suits, work vests, board sailing vests and Hybrid PFDs.

A TYPE V HYBRID INFLATABLE PFD is the least bulky of all PFD types. It contains a small amount of inherent buoyancy, and an inflatable chamber. Its performance is equal to a Type I, II, or III PFD (as noted on the PFD label) when inflated. Hybrid PFDs must be worn when underway to be acceptable.

Inflated Hybrid



WATER SKIING

A water skier, while being towed, is considered on board the vessel and a PFD is required for the purposes of compliance with the PFD carriage requirements. Although not required by Federal law it is advisable and recommended for a skier to wear a PFD designed and intended to withstand the impact off hitting the water at high speed as when a skier falls. "Impact Class" marking refers to PFD strength, not personal protection. Some State laws require skiers to wear a PFD.

VISUAL DISTRESS SIGNALS

All vessels, used on coastal waters, the Great Lakes, territorial seas and those waters connected directly to them, up to a point where a body of water is less than two miles wide, must be equipped with visual distress signals. Vessels owned in the United States operating on the high seas must be equipped with visual distress signals. The following vessels are not required to carry day signals but must carry night signals when operating from sunset to sunrise:

- Recreational boats less than 16 feet in length.
- Boats participating in organized events such as races, regattas or marine parades.
- Open sailboats less than 26 feet in length not equipped with propulsion machinery.
- Manually propelled boats.

PYROTECHNIC VISUAL DISTRESS SIGNALS must be Coast Guard Approved, in serviceable condition and readily accessible. They are marked with a date showing the service life, which must not be expired. Launchers manufactured before January 1, 1981, intended for use with approved signals, are not required to be Coast Guard Approved. If pyrotechnic devices are selected, a minimum of three are required. That is three signals for day use and three signals for night. Some pyrotechnic signals meet both day and night use requirements. Pyrotechnic devices should be stored in a cool, dry location. A watertight container painted red or orange and prominently marked "DISTRESS SIGNALS" is recommended.

USCG Approved Pyrotechnic Visual Distress Signals and Associated Devices include:

- Pyrotechnic red flares, hand-held or aerial.
- Pyrotechnic orange smoke, hand-held or floating.
- Launchers for aerial red meteors or parachute flares.

NON-PYROTECHNIC VISUAL DISTRESS SIGNALS must be in serviceable condition, readily accessible and certified by the manufacturer as complying with USCG requirements, they include:

- Orange distress flag
- Electric distress light

The distress flag is a day signal only. It must be at least 3 x 3 feet with a black square and ball on an orange background. It is most distinctive when attached and waved on a paddle or boathook or flown from a mast.

The electric distress light is accepted for night use only and must automatically flash the international SOS distress signal (···———···). This is an unmistakable distress signal. A standard flashlight is not acceptable as a visual distress signal.

Under Inland Navigation Rules, a high intensity white light flashing at regular intervals from 50-70 times per minute is considered a distress signal. Strobe lights used in inland waters shall only be used as a distress signal.

Regulations prohibit display of visual distress signals on the water under any circumstances except when assistance is required to prevent immediate or potential danger to persons on board a vessel.

All distress signals have distinct advantages and disadvantages, no single device is ideal under all conditions or suitable for all purposes. Pyrotechnics are excellent distress signals, universally recognized. However, there is potential for injury and property damage if not properly handled. These devices produce a very hot flame, the residue can cause burns and ignite flammable material. Pistol launched and hand-held parachute flares and meteors have many characteristics of a firearm and must be handled with caution.

FIRE EXTINGUISHERS

Approved extinguishers are classified by a letter and number symbol. The letter indicates the type fire the unit is designed to extinguish (Type B designed to extinguish flammable liquids such as gasoline, oil and grease fires). The number indicates the relative size of the extinguisher (minimum extinguishing agent weight).

Approved extinguishers are hand-portable, either B-I or B-II classification and have the following characteristics:

Classes	*Foam (Gals.)*	*CO_2 (LBS)*	*Dry Chemical (LBS)*	*Halon (LBS)*
B-I	1.25	4	2	2.5
B-II	2.5	15	10	10

Fire extinguishers are required if any one or more of the following conditions exist:

- Inboard engines.
- Closed compartments under thwarts and seats where portable fuel tanks may be stored.
- Double bottoms not sealed to the hull or which are not completely filled with flotation materials.
- Closed living spaces.
- Closed stowage compartments in which combustible or flammable materials are stored.
- Permanently installed fuel tanks. Fuel tanks secured so they cannot be moved in case of fire or other emergency are considered permanently installed. There are no gallon capacity limits to determine if a fuel tank is portable. If the weight of a fuel tank is such that persons on board cannot move it, the Coast Guard considers it permanently installed.

Dry chemical fire extinguishers without gauges or indicating devices must be inspected every 6 months. If the gross weight of a carbon dioxide (CO_2) extinguisher is reduced by more than 10% of the net weight, the extinguisher is not acceptable and must be recharged.

Check extinguishers regularly to ensure gauges are free and nozzles are clear.

Minimum number of hand portable fire extinguishers required:

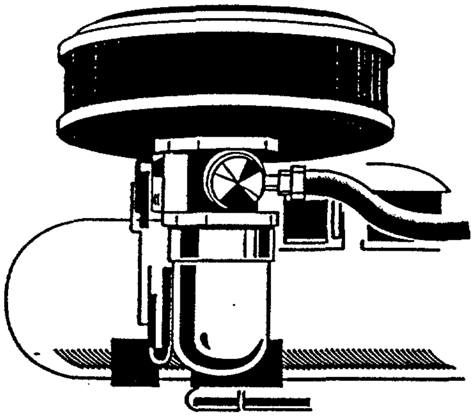
VESSEL LENGTH	NO FIXED SYSTEM	WITH APPROVED FIXED SYSTEM
Less than 26'	1 B-I	0
26' to less than 40'	2 B-I or 1 B-II	1 B-I
40' to 65'	3 B-I or 1 B-II and 1 B-1	2 B-I or 1 B-II

Coast Guard Approved extinguishers are identified by the following marking on the label: "Marine Type USCG Approved, Size . . ., Type . . ., 162.208/ . . . /", etc.

Types of Fire Extinguishers

BACKFIRE FLAME CONTROL

Gasoline engines installed in a vessel after April 25, 1940, except outboard motors, must be equipped with an acceptable means of backfire flame control. The device must be suitably attached to the air intake with a flametight connection and is required to be Coast Guard approved.



Back Fire Flame Arrester

REQUIRED NONAPPROVED EQUIPMENT

NATURAL VENTILATION

All vessels with propulsion machinery that use gasoline for fuel, with enclosed engine and/or fuel tank compartments built after April 25, 1940 and before August 1, 1980 are required to have natural ventilation.

Natural ventilation consists of at least two ventilation ducts fitted with cowls or their equivalent for the purpose of efficiently ventilating the bilges of every engine and fuel tank compartment. At least one exhaust duct extending to the lower portion of the bilge and at least one intake duct extending to a point midway to the bilge or at least below the level of the carburetor air intake is required.

Vessels built after July 31, 1978, but prior to August 1, 1980, have no requirement for ventilation of the fuel tank compartment if there is no electrical source in the compartment and the tank vents to the outside of the vessel.

POWERED VENTILATION

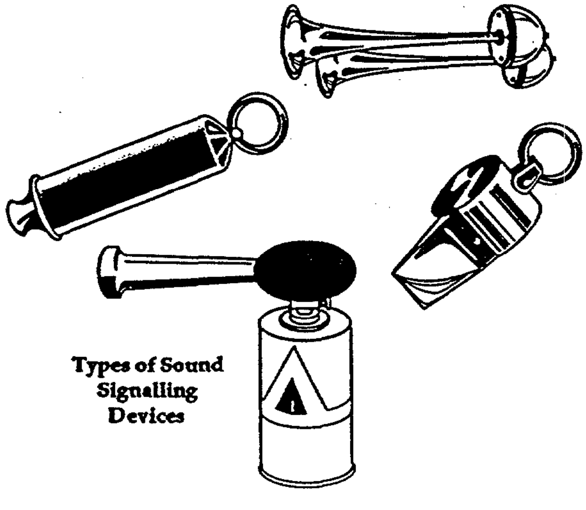
Vessels built after July 31, 1980 that have gasoline engines, with a cranking motor (starter), for electrical generation, mechanical power or propulsion in a closed compartment are required to have a powered ventilation system. This includes each compartment with such an engine.

No person may operate a vessel built after July 31, 1980 with a gasoline engine in a closed compartment unless it is equipped with an operable ventilation system that meets Coast Guard standards. The operator is required to keep the system in operating condition and ensure cowls and ducting are not blocked or torn.

SOUND SIGNALLING DEVICES

Regulations do not specifically require vessels less than 12 meters to carry a whistle, horn or bell. However, the navigation rules require sound signals to be made under certain circumstances. Meeting, crossing and overtaking situations described in Navigation Rules section are examples of when sound signals are required. Recreational vessels are also required to sound fog signals during periods of reduced visibility. Therefore, you must have some means of making an efficient sound signal.

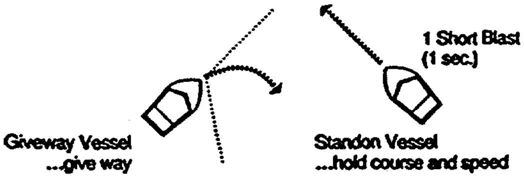
Vessels 12 meters or more in length are required to carry on board a power whistle or power horn and a bell.



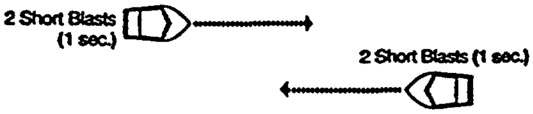
Types of Sound Signalling Devices

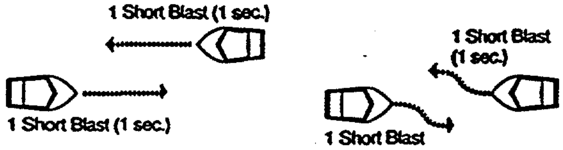
NAVIGATION RULES

The Navigation Rules establish actions to be taken by vessels to avoid collision. The vessel operator is responsible for knowing and following applicable navigation rules. The following diagrams describe the whistle signals and actions to be taken by recreational vessels in a crossing, meeting and overtaking situation. These are basic examples, for further information consult the NAVIGATION RULES International - Inland (COMDTINST M16672.2A).

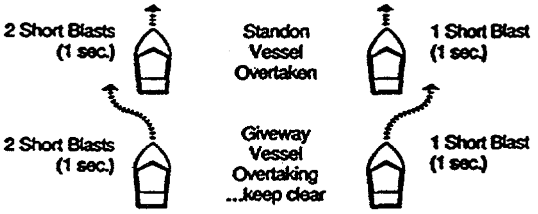


Meeting Head-On or Nearly So





Overtaking Situations

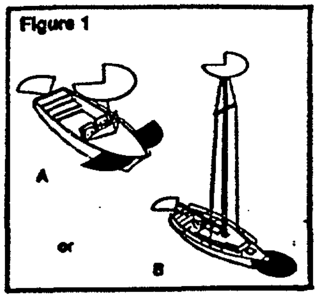


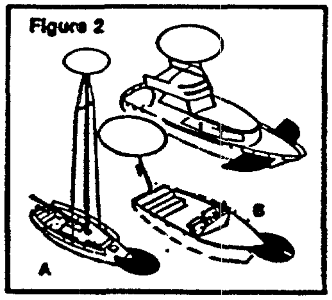
International Rules apply outside established lines of demarcation and Inland Rules apply inside the lines. Demarcation lines are printed on most navigational charts and are published in the Navigation Rules.

NAVIGATION LIGHTS

Recreational vessels are required to display navigation lights between sunset and sunrise and other periods of reduced visibility (fog, rain, haze etc.). The U. S. Coast Guard Navigation Rules, International - Inland encompasses lighting requirements for every description of watercraft. The information provided here is intended for power-driven and sailing vessels less than 20 meters.

POWER DRIVEN VESSELS





Power-driven vessels of less than 20 meters, shall exhibit navigation lights as shown in Figure 1. Vessels of less than 12 meters in length, may show the lights in either Figure 1 or Figure 2.

Power-driven vessels of less than 7 meters whose maximum speed cannot exceed 7 knots may exhibit an all-round white light, and if practicable sidelights instead of the lights prescribed above, in International Waters only.

Sailing vessels operating under machinery, or under sail and machinery are considered power-driven and must display the lights prescribed for a power-driven vessel.

SAILING VESSELS AND VESSELS UNDER OARS

Sailing vessels less than 20 meters exhibit navigation lights shown in Figures 3 or 4 or may be combined in a single lantern carried at the top of the mast as shown in Figure 5.

Sailing vessels less than 7 meters may carry an electric torch or lighted lantern showing a white light

Figure 3

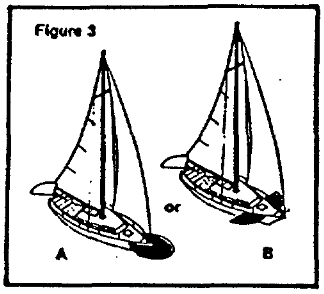


Figure 4

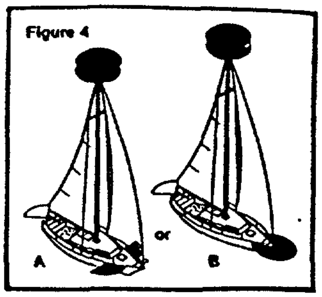


Figure 5

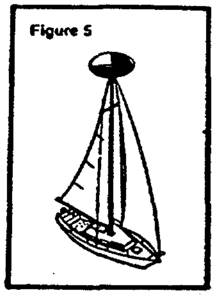
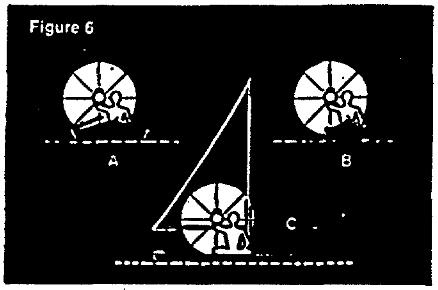


Figure 6



to be displayed in sufficient time to prevent collision (see Figure 6), if practicable, the lights prescribed for sailing vessels less than 20 meters should be displayed.

Vessels under oars may display the lights prescribed for sailing vessels, but if not, must have ready at hand an electric torch or lighted lantern showing a white light to be shown in sufficient time to prevent collision (see Figure 6).

LIGHTS FOR ANCHORED VESSELS

Power-driven vessels and sailing vessels at anchor must display anchor lights. An anchor light for a vessel less than 20 meters in length is an all-round white light visible for 2 miles exhibited where it can best be seen.

Vessels less than 7 meters are not required to display anchor lights unless anchored in or near a narrow channel, fairway or anchorage or where other vessels normally navigate.

Anchor lights are not required on vessels less than 20 meters, anchored in special anchorages designated by the Secretary of Transportation in Inland Waters.

Vessels under sail also being propelled by machinery, must exhibit forward, where it can best be seen, a conical shape, apex down (See Figure 7). Vessels less than 12 meters are not required to exhibit the dayshape in Inland Waters.

DIVING OPERATIONS

The Navigational Rules require vessels restricted in ability to maneuver to display appropriate day shapes. To meet this requirement, recreational vessels engaged in diving activities may exhibit a rigid replica of the international code flag "A" not less than one meter in height (See Figure 8).

This requirement does not affect the use of the red and white diver's flag which may be required by State or local law to mark the diver's location under water. The "A" flag is a navigation signal advertising the vessel's restricted maneuverability. It does not pertain to the diver.

DAY SHAPES
REQUIRED BETWEEN SUNRISE AND SUNSET

Figure 7

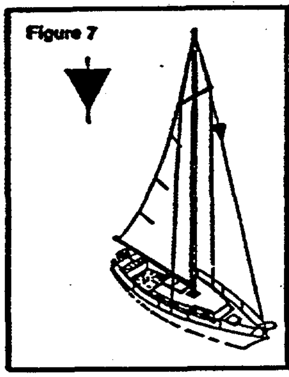
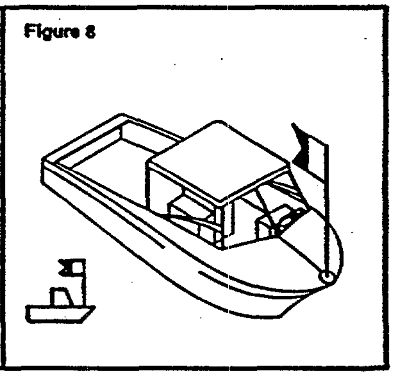


Figure 8



The operator of each self-propelled vessel 12 meters or more in length is required to carry on board, and maintain for ready reference, a copy of the Inland Navigation Rules while operating on Inland waters, subject to a penalty for failure to comply of not more than $5,000. Copies of the rules may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402 (tel: (202) 783-3238). Stock number 050-012-00205-3, $6.00 each.

POLLUTION REGULATIONS

The Refuse Act of 1899 prohibits throwing, discharging or depositing any refuse matter of any kind (including trash, garbage, oil and other liquid pollutants) into the waters of the United States. The Federal Water Pollution Control Act prohibits the discharge of oil or hazardous substances which may be harmful into U. S. navigable waters. You must immediately notify the U. S. Coast Guard if your vessel discharges oil or hazardous substances into the water. Call toll-free 800-424-8802 (In Washington, D. C. (202) 267-2675). Report the following information:

a. location c. size e. substance
b. source d. color f. time observed

Avoid flame, physical contact or inhalation of fumes near any source of pollution.

Regulations issued under the Federal Water Pollution Control Act require all vessels with machinery propulsion to have a capacity to retain oily mixtures on board. A fixed or portable means to discharge oily waste to a reception facility is required. A bucket or bailer is suitable as a portable means of discharging oily waste on recreational vessels.

No person may intentionally drain oil or oily waste from any source into the bilge of any vessel.

Vessels 26 feet in length and over must display a placard at least 5 by 8 inches, made of durable material, fixed in a conspicuous place in the machinery spaces, or at the bilge pump control station, stating the following:

DISCHARGE OF OIL PROHIBITED

The Federal Water Pollution Control Act prohibits the discharge of oil or oily waste into or upon the navigable waters of the United States or the waters of the contiguous zone if such discharge causes a film or sheen upon, or discoloration of, the surface of the water, or causes a sludge or emulsion beneath the surface of the water. Violators are subject to a penalty of $5,000.

Marine Sanitation Devices

All recreational boats with installed toilet facilities must have an operable marine sanitation device (MSD) on board. Vessels 65 feet and under may use a Type I, II or III MSD. Vessels over 65 feet must install a Type II or III MSD. All installed MSDs must be Coast Guard certified. Coast Guard certified devices are so labeled except for some holding tanks, which are certified by definition under the regulations.

REPORTING BOATING ACCIDENTS

All boating accidents or accidents resulting from the use of related equipment (which meet the criteria below), must be reported by the operator or owner of the vessel to the proper marine law enforcement authority for the State in which the accident occurred.

IMMEDIATE NOTIFICATION REQUIRED FOR FATAL ACCIDENTS. If a person dies or disappears as a result of a recreational boating accident the nearest State boating authority must be notified without delay, providing the following information:

- Date, time and exact location of the accident;
- Name of each person who died or disappeared;
- Number and name of the vessel; and
- Names and addresses of the owner and operator.

A FORMAL REPORT OF A FATALITY MUST BE FILED WITHIN 48 HOURS. If, as a result of a boating or related equipment accident, a person sustains injuries that require more than first aid, a formal report must be filed.

ACCIDENTS INVOLVING MORE THAN $200 DAMAGE MUST BE REPORTED WITHIN 10 DAYS. A formal report must be made if property damage exceeds $200; or there is a complete loss of a vessel.

If you need further information regarding accident reporting, please call the Boating Safety Hotline, 800-268-5647.

RENDERING ASSISTANCE

The master or person in charge of a vessel is obligated by law to provide assistance that can be safely provided to any individual at sea in danger of being lost, and is subject to a fine and/or imprisonment for failure to do so.

ADDITIONAL EQUIPMENT AND ADVICE

As the operator and/or owner you are responsible for the prudent and safe operation of your vessel, and for the lives and safety of your passengers and others around you. You should become familiar with Federal, State and local rules and regulations regarding safe boat operation and attempt to learn and practice good seamanship, boathandling, navigation and piloting, etc.

Besides meeting the legal requirements, prudent boaters carry additional safety equipment.

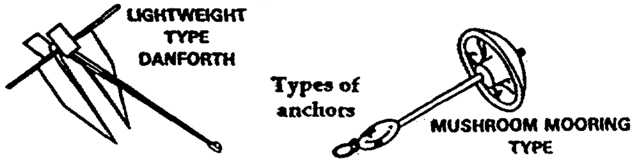
ADDITIONAL MEANS OF PROPULSION

Vessels less than 16 feet should carry alternate propulsion, such as a paddle or oars. If an alternate means of mechanical propulsion is carried it should use a separate fuel tank and starting source than the main propulsion motor.

ANCHORING

All vessels should be equipped with an anchor and line of suitable size and length for the vessel and waters in which it is being operated. Choose the right anchor for your vessel and the type of bottom you expect to be anchoring in.

To anchor, bring the bow into the wind or current and put the engine in neutral. When the vessel comes to a stop, lower, do not throw, the anchor over the bow. The anchor line should be 5 to 7 times the depth of water.


Types of anchors

STERN ANCHORING

Anchoring a small boat by the stern has caused many to capsize and sink. The transom is usually squared off and has less freeboard than the bow. In a current, the stern can be pulled under by the force of the water. The boat is also vulnerable to swamping by wave action. The weight of a motor, fuel tank, or other gear in the stern increases the risk. Do not anchor by the stern!!

BAILER

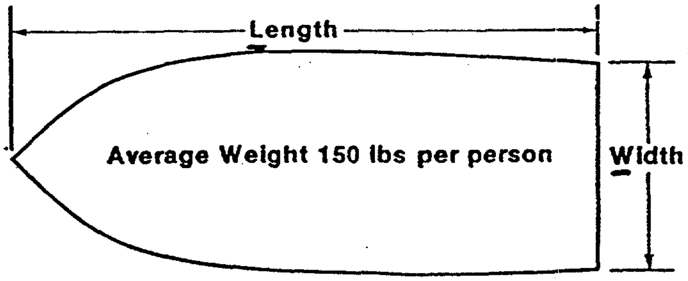
All vessels should carry at least one effective manual device (portable bilge pump, bucket, scoop, etc.) for bailing water, in addition to any installed electric bilge pump.

FIRST AID

As the operator of a small boat you should consider taking a First Aid course and becoming proficient in its application. A first aid kit and manual, bandages, gauze, adhesive tape, antiseptic, aspirin, etc. is suggested.

LOADING YOUR VESSEL

Keep the load low and evenly distributed. Do not exceed the "U. S. Coast Guard Maximum Capacities" label. If there is no capacity label use the following formula to determine the maximum number of persons you can safely carry in calm weather:



$$\text{People} = \frac{L \times W}{15}$$

Length is determined by measuring in a straight line from the foremost part to the aftermost of the vessel, parallel to the centerline, exclusive of sheer. Bowsprits, rudders, outboard motors and similar fittings are not included in the measurement.

FUELING PRECAUTIONS

Fill portable tanks off the vessel. Close all hatches and other openings before fueling. Extinguish smoking materials. Secure all electrical equipment, radios, stoves and other appliances. Secure all engines and motors.

Wipe up any spilled fuel immediately. Open all hatches to air out the vessel. Run the blower five minutes, and then check the bilges for fuel vapors before starting the engine. NEVER start the engine until all traces of fuel vapors are eliminated.

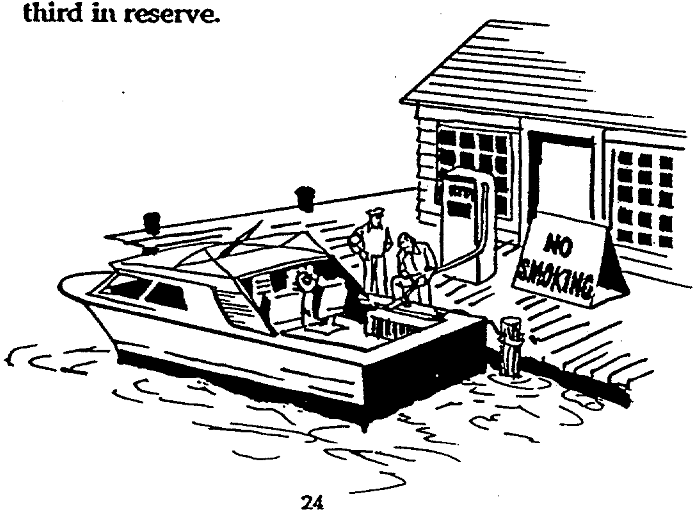
FUEL TANKS

Ensure portable fuel tanks are constructed of sturdy material and in good condition, free of excessive corrosion and do not leak. The vents on portable tanks must be operable and the tanks should have a vapor-tight, leak-proof cap. Do not allow excessive movement of portable tanks.

Permanent fuel tanks and lines should be free of corrosion and must not leak. Tanks must be vented to the outside of the hull. The fill pipe and plate must fit tightly and be located outside of closed compartments.

FUEL MANAGEMENT

Practice the "One-Third Rule" by using one-third of the fuel going out, one-third to get back and one-third in reserve.



CARE AND MAINTENANCE

All equipment and supplies should be properly secured. Keep decks and other spaces clean, free of clutter and trash. The vessel should be free of fire hazards with clean bilges and in good condition. Inspection and required maintenance on a regular schedule will ensure the hull and superstructure remain sound. Ensure all repairs are made properly and with marine rated parts. You should carry a few tools, spare parts and learn how to make minor repairs.

FLOAT PLAN

Tell a friend or relative where you are going and when you plan to return. Make sure they have a description of your vessel and other information that will make identification easier should the need arise. An example is provided on the inside front cover.

WEATHER

Check weather reports before leaving shore and remain watchful for signs of bad weather. Become familiar with National Weather Service Storm Advisory Signals and know where they are displayed.

SMALL BOATS AND WATER ACTIVITIES

Most hunters and anglers do not think of themselves as boaters. But many use small semi-v hull vessels, flatbottom jon boats or canoes to pursue their sport. These boats tend to be unstable and easily capsized. Capsizings, sinkings, and falls overboard account 70% of boating fatalities and are directly related to poor stability. These facts mean care must be used in operating small boats. You must have a greater awareness of the boat's limitations and the skill and knowledge to overcome them.

Standing in a small boat raises the center of gravity, often to the point of capsizing. Standing for any reason or even changing position in a small boat can be dangerous, as is sitting on the gunnels or seat backs or in a pedestal seat while underway. A wave or sudden turn may cause a fall overboard or capsizing because of the raised center of gravity.

SURVIVAL TIPS

It is a common belief that someone dressed in heavy clothing or waders will sink immediately if they fall over board. This is not true. Air trapped in clothing provides considerable flotation, bending the knees will trap air in waders, providing additional flotation. To stay afloat, remain calm, do not thrash about or try to remove clothing or footwear, this leads to exhaustion and increases the loss of air that keeps you afloat. Keep your knees bent, float on your back and paddle slowly to safety.

HYPOTHERMIA

Hypothermia is the loss of body heat, immersion in water speeds the loss of heat. If your boat capsizes it will likely float on or just below the surface. Vessels built after 1978 will support you even if full of water or capsized. To reduce the effects of hypothermia get in or on the boat. Try to get as much of your body out of the water as possible. If you can't get in the boat a PFD will enable you to keep your head out of the water. This is very important because about 50% of body heat loss is from the head.

SUDDEN DISAPPEARANCE SYNDROME

Sudden immersion in cold water can induce rapid, uncontrolled breathing, cardiac arrest, and other life-threatening situations which can result in drowning. Wearing a PFD will prevent this. If you must enter the water, button up your clothing, wear a PFD, cover your head if possible and enter the water slowly.

COLD WATER DROWNING

It may be possible to revive a drowning victim who has been under water for considerable time and shows no signs of life. Increasingly numerous documented cases exist where victims have been resuscitated with no apparent harmful effects after long immersions. Start CPR immediately and get the victim to a hospital as quickly as possible.

CONVERSION OF METRIC TO U. S. UNITS

Metric Measure	Feet in Decimals	Feet and Inches
50 Meters (M)	164.0 ft.	164'1/2"
20 Meters (M)	65.6 ft.	65'7 1/2"
12 M	39.4 ft.	39'4 1/2"
10 M	32.8 ft.	32'9 3/4"
8 M	26.2 ft.	26'3"
7 M	23.0 ft.	23'11 1/2"
6 M	19.7 ft.	19'8 1/4"
5 M	16.4 ft.	16'4 3/4"
4 M	13.1 ft.	13'1 1/2"
2.5 M	8.2 ft.	8'2 1/2"
1 M	3.3 ft.	3'3 1/4"

Boating Safety is no accident. To build sound knowledge, proficiency and confidence, the keys to safe boating, take a boating safety course.

Coast Guard

Boating Safety Hotline:

800-368-5647

✓ For Boating Safety Recall Information.
✓ To Report Possible Safety Defects In Boats.
✓ For Answers To Boating Safety Questions.

✓ Call, Toll Free!

For more information on boating safety and boating courses, contact your State Boating Agency, local Coast Guard District or call the Boating Safety Hotline.

Appendix B
Material Safety Data Sheets

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
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Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

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

Section 1. Material Identification

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/m^3
15-min STEL: 5 ppm, 15 mg/m^3

(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/m^3

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

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.

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

Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 23

CADMIUM
(Revision C)
Issued: September 1977
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: CADMIUM

1
3 0
-
Genium

Description (Origin/Uses): Used in electroplating other metals; in dentistry; in alloys; in nickel-cadmium batteries; and in reactor control rods.

Other Designations: Cd; CAS No. 7440-43-9

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	3	R	1
F	1	I	4
R	0	S	1
PPG*		K	4 (Dust)

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS, EXPOSURE LIMITS

Cadmium, CAS No. 7440-43-9, ca 100%

OSHA PEL
8-Hr TWA: 0.1 mg/m³ (Cd Fume)
Ceiling: 0.3 mg/m³ (Cd Fume)
8-Hr TWA: 0.2 mg/m³ (Cd Dust)
Ceiling: 0.6 mg/m³ (Cd Dust)

ACGIH NIC,* 1988-89
TLV-TWA: 0.01 mg/m³ (Cadmium and Compounds, as Cd)
ACGIH A2, Suspected Human Carcinogen

ACGIH TLVs, 1988-89
TLV-TWA: 0.05 mg/m³ (Cadmium Dusts and Salts, as Cd)
TLV-Ceiling: 0.05 mg/m³ (Cadmium Oxide Fume, as Cd)
TLV-TWA: 0.05 mg/m³ (Cadmium Oxide Production)

Toxicity Data**
Human, Inhalation, LC_{Lo}: 39 mg/m³ (20 Minutes)

*Notice of Intended Changes, Genium reference 116, p. 39.
**See NIOSH, *RTECS* (EU9800000), for additional data referring to reproductive, tumorigenic, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 1413°F (767°C)
Melting Point: 610°F (321°C)
Vapor Pressure: 0.095 Torr at 610°F (321°C)

Molecular Weight: 112 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 8.642

Appearance and Odor: A soft, blue white, malleable, lustrous metal that can be cut easily with a knife; odorless.
Comments: Cadmium has a significant vapor pressure of 0.000021 torr (corresponding to 0.12 mg/m³) at 315°F (157°C). Heating this metal without using correct engineering controls and/or personal protective equipment can result in overexposure.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method*	Autoignition Temperature*	LEL*	UEL*

Extinguishing Media: *Cadmium metal burns readily in air if it is heated. As with most metals, the reactivity/dust-cloud-explosion hazard increases as the cadmium metal becomes more finely divided. In fact, finely divided, powdered cadmium metal can be pyrophoric (it burns spontaneously in air without any source of ignition). Carbon dioxide, dry chemical, or sand are recommended extinguishing agents for cadmium fires. **Unusual Fire or Explosion Hazards:** Cadmium dust can explode during a fire. Massive cadmium metal does not present this potential explosion hazard; however, certain work operations such as grinding, welding, or cutting, can produce dust made of finely divided cadmium particles. **Warning:** Do not create a dust cloud of cadmium particles, especially during cutting, grinding, or welding operations. **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: Cadmium is stable in closed containers during routine operations. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Cadmium reacts dangerously with ammonium nitrate, hydrazoic acid, tellurium, and zinc (Genium ref. 84).
Conditions to Avoid: Avoid all exposure to sources of ignition and to incompatible chemicals. **Hazardous Products of Decomposition:** When heated, which is likely during fires and work operations such as welding and machining, cadmium metal can decompose into cadmium metal fume and cadmium oxide fume.

SECTION 6, HEALTH HAZARD INFORMATION

Carcinogenicity: The ACGIH classifies cadmium and its compounds as suspected human carcinogens (group A2); the IARC lists them as probable human carcinogens (group 2B); and the NTP classifies them as anticipated human carcinogens (group b). **Summary of Risks:** Heating cadmium metal produces intensely irritating cadmium metal fume. The acute effects of its excessive inhalation, which include severe tracheobronchitis, pneumonitis, and pulmonary edema, are life threatening and are usually delayed for several hours; their mortality rate is about 20%. Nonfatal pneumonitis has resulted from exposure to 0.5 to 2.5 mg/m³; a fatality has been reported for five hours' exposure at 9 mg/m³ and for 1 hour's exposure at 40 to 50 mg/m³. There is no warning discomfort or immediate irritation from exposure to cadmium fume. Acute gastroenteritis and symptoms of metal fume fever are associated with even lower acute exposure. Symptoms of acute overexposure include excessive salivation, a dry, burning throat; headache; aching muscles; coughing; chest tightness and pain; nausea; chills, and fever chills; and fever. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, kidneys, and blood. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** See Summary of Risks, above. **Chronic Effects:** Long-term, chronic inhalation of cadmium dust, salts, or fume causes chronic cadmium poisoning characterized by a distinctive, nonhypertrophic emphysema with or without renal tubular injury, accompanied by the urinary excretion of a protein with a molecular weight

SECTION 6. HEALTH HAZARD INFORMATION, cont.

of 20,000 to 30,000. This protein is itself a sign of early but reversible chronic poisoning. (Possible chromosomal aberrations and decreased birth weight among babies of women exposed to cadmium have been noted.) **Danger:** Continued overexposure from inhalation causes irreversible renal tubular damage. Cancer, anemia, eosinophilia, anosmia, chronic rhinitis, yellowed teeth, and bone changes have been reported. Bone pain in the ribs, backbone, and femur is common; disorders of calcium metabolism develop; and kidney stones and pulmonary fibrosis have been described. **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, 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. **Ingestion.** If a physician is not readily available, give the exposed person 2 to 3 glasses of water to drink and induce vomiting. A physician may administer a gastric lavage followed by saline catharsis. **Comments:** A comprehensive medical program is advised for those who work with cadmium or its compounds. This should include chest X rays and forced-vital-capacity tests. **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:** Chelation therapy may be useful in treatment; calcium disodium edetate and pencillamine are recommended. Dimercaprol (BAL) is not recommended because of reported renal toxicity of the cadmium-BAL complex.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup procedures must not create dusty conditions. Pick up the spilled material using vacuuming, mopping, or wet-sweeping techniques. Cleanup personnel need protection against inhalation of dust and fume (see sect. 8). **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Concentrated solutions of cadmium waste can be precipitated with lime and collected by filtration. Effluent should be treated as needed to reduce the concentration of the cadmium to a level that is within regulatory compliance limits.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. D006 (40 CFR 261.24 [Characteristic of EP toxicity])
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of a cadmium solution 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, and gauntlets, to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne levels of cadmium below the OSHA PEL 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 recommmedations. **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. Do not wear work clothes home. **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 cadmium fume. Do not expose individuals with lung, liver, kidney, and blood ailments to cadmium until such exposure is approved by a physician.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store cadmium in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. Avoid storage situations where corrosion can occur. Keep powdered cadmium in closed containers; prevent the airborne dispersion of powdered cadmium. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations to prevent static sparks. **Other Precautions:** The toxic effects of cadmium are influenced by the presence or absence of other elements such as zinc and selenium. If these materials are present in the workplace, careful evaluation of any exposure to cadmium is required to understand any contributing factors.

Hazardous Materials Table (49 CFR 172.101): Not Listed
Optional Hazardous Materials Table (49 CFR 172.102)

ID No. UN2570

IMO Shipping Name: Cadmium Compounds
IMO Hazard Class: 6.1
IMO Labels: Poison or Saint Andrew's Cross (X)*

*Harmful–Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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

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Material Safety Data Sheets Collection:

Sheet No. 83
Chromium Metal/Powder

Issued: 3/81 **Revision: A, 11/89**

Section 1. Material Identification 30

Chromium Metal/Powder Description: Obtained from chrome ore, chromite ($FeCr_2O_4$), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.

Other Designations: Chrome; Cr; CAS No. 7440-47-3.

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

R	1
I	4
S	1
K	1

Genium

HMIS	
H	2
F	1
R	1
PPG*	

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

OSHA PEL	ACGIH TLV, 1988-89*	NIOSH REL, 1987†	Toxicity Data‡
8-hr TWA: 1 mg/m³	TLV-TWA: 0.5 mg/m³	8-hr TWA (for chromium metal and insoluble salts): 1 mg Cr/m³	Rat, implant, TD_{Lo}: 1200 µg/kg body weight administered intermittently over six weeks

* This TLV is applicable to Cr^{+2} and Cr^{+3} compounds. For water soluble and water-insoluble Cr^{+6}, the 8-hr TWA is 0.05 mg Cr^{+6}/m^3. Certain water-insoluble Cr^{+6} compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).

† The NIOSH REL (10-hr TWA) for carcinogen Cr^{+6} compounds is 1 µg/m³; for noncarcinogenic Cr^{+6} compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr^{+6} (chromic acid anhydride). Any and all Cr^{+6} materials excluded from the noncarcinogenic group above are carcinogenic Cr^{+6} compounds.

‡ See NIOSH, *RTECS* (GB4200000), for additional data with references to tumorigenic effects.

Section 3. Physical Data

Boiling Point: 4788 °F (2642 °C)
Melting Point: 3452 °F (1900 °C)
Vapor Pressure: 1 mm Hg at 2941 °F (1616 °C)
Vapor Density (Air = 1): 1.79

Atomic Weight: 51.996 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.2 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: Steel-gray, lustrous metal; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	**Autoignition Temperature:** Cloud, 1076 °F (580 °C); dust layer, 752 °F (400 °C)	**LEL:** Dust cloud explosion, 0.230 oz/ft³	**UEL:** None reported

Extinguishing Media: Use dry chemical or sand.

Unusual Fire or Explosion Hazards: Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in CO_2 is ignitable and explosive when heated.

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

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high O_2 concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.

Hazardous Products of Decomposition: Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

Section 6. Health Hazard Data

Carcinogenicity: The NTP and OSHA list chromium as a human carcinogen.

Summary of Risks: When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 (Cr^{+3}) compounds show little or no toxicity. Less soluble chromium 6 (Cr^{+6}) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and skin (Sec. 2). Chromic acid or chromate salts cause irritation of the skin and respiratory passage. Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).

Medical Conditions Aggravated by Long-Term Exposure: An incresed incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

Target Organs: Respiratory system.

Primary Entry: Inhalation, percutaneous absorption, and ingestion.

Acute Effects: Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.

Chronic Effects: Asthmatic bronchitis.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Brush off chromium dust. After rinsing affected area 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 that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomoting. A physician should evaluate all ingestion cases.

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

Physician's Note: Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoetic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr^{+6} to Cr^{+3}. Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.

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

OSHA Designations

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

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* 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)

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: Wear a NIOSH-approved respirator if necessary. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 mg/m^3.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 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. Launder contaminated clothing before wearing. Remove this material from your shoes and 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 material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.

Engineering Controls: Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Hardies, MD M8

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR

DDT

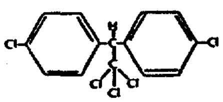
POTENTIAL HUMAN CARCINOGEN

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): 1.5×10^{-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/m^3) 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/m^3 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/m^3 as a TWA for a normal 8-hour workday and a 40-hour workweek; the short-term exposure limit (STEL) is 3 mg/m^3 (Table 1).

Table 1.—Occupational exposure limits for DDT

	Exposure limits mg/m^3
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.

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Material Safety Data Sheets Collection:

Sheet No. 830
1,1-Dichloroethane

Issued: 6/92

Section 1. Material Identification 38

1,1-Dichloroethane (CH_3CHCl_2) Description: Derived by various methods; by direct chlorination of ethane, as a side product of chloral manufacture, by treating ethylene and chlorine with calcium chloride, by action of phosphorus chloride on acetaldehyde, and the reaction of hydrogen chloride and vinyl chloride at 20 to 55 °C in the presence of an aluminum, ferric, or zinc chloride catalyst. Found as an air contaminant in submarines and space craft. Its largest industrial use is in the production of 1,1,1-trichloroethane. Also used as a cleansing agent, degreaser, solvent for plastics, oils, and fats, grain fumigant, chemical intermediate; in insecticide sprays, rubber cementing, fabric spreading, paint and varnish removers, in ore flotation, vinyl chloride production, and as a coupling agent in anti-knock gasoline. Formerly used as an anesthetic.

Other Designations: CAS No. 75-34-3; assymetrical dichloroethane; chlorinated hydrochloric ether; ethylidene chloride; ethylidene dichloride.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: 1,1-Dichloroethane is volatile and highly flammable. It is irritating to the eyes and respiratory tract and inhalation of high concentrations causes an anesthetic effect.

R	1
I	3
S	2
K	4

NFPA

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

Section 2. Ingredients and Occupational Exposure Limits

1,1-Dichloroethane, reagent grade (99.7%). Impurities consist of ethyl chloride (0.02%), trichloroethylene (0.08%), butylene oxide (0.08%), ethylene dichloride (0.01%), and unknown (0.14%).

1991 OSHA PEL
8-hr TWA: 100 ppm (400 mg/m^3)

1990 IDLH Level
4000 ppm

1990 NIOSH REL
8-hr TWA: 100 ppm (400 mg/m^3)

1991-92 ACGIH TLVs*
TWA: 200 ppm (810 mg/m^3)
STEL: 250 ppm (1010 mg/m^3)

1990 DFG (Germany) MAK
100 ppm (400 mg/m^3)
Half-life: < 2hr
Peak Exposure Limit: 200 ppm/30 min. average value/maximum of 4 peaks per shift

1985-86 Toxicity Data†
Mouse, oral, TD_{Lo}: 185 g/kg administered intermittently for 78 wk produced uterine tumors.
Rat, oral, LD_{50}: 725 mg/kg; toxic effects not yet reviewed.‡
Rat, inhalation, TC_{Lo}: 6000 ppm/7 hr administered during 6 to 15 days of pregnancy caused developmental abnormalities of the musculoskeletal system.

* Notice of intended change to 100 ppm/405 mg/m^3.
†See NIOSH, *RTECS* (KI0175000), for additional reproductive, tumorigenic and toxicity data.
‡ Considered a possible error since subsequent studies at higher concentrations failed to produce comparative results.(133)

Section 3. Physical Data

Boiling Point: 135 °F (57.3 °C)
Melting Point: -143 °F (-96.98 °C)
Vapor Pressure: 230 mm Hg at 77 °F (25 °C)
Saturated Vapor Density (air = 1.2 kg/m^3 or 0.075 lbs/ft^3): 2.076 kg/m^3 or 0.129 lbs/ft^3
Refraction Index: 1.4166 at 68 °F (20 °C)
Surface Tension: 24.75 dyne/cm at 68 °F (20 °C)
Molecular Weight: 98.97
Specific Gravity: 1.174 at 68 °F (20/4 °C)
Water Solubility: Slightly, 0.5%
Other Solubilities: Very soluble in alcohol and ether, soluble in acetone, benzene, and fixed and volatile oils.
Relative Evaporation Rate (BuAc=1): 11.6
Odor Threshold: 49 to 1359 ppm; odor is not sufficient to warn against overexposure

Appearance and Odor: Colorless, mobile, oily liquid with a chloroform odor and a saccharin taste.

Section 4. Fire and Explosion Data

Flash Point: 17 °F (-8.33 °C) CC*	**Autoignition Temperature:** 856 °F (493 °C)	**LEL:** 5.6% v/v	**UEL:** 11.4% v/v

Extinguishing Media: A Class 1B Flammable Liquid. For small fires, use dry chemical, carbon dioxide (CO_2), or "alcohol-resistant" foam. For large fires, use fog or "alcohol-resistant" foam. Water may be ineffective unless used as a "blanket".

Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. 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 firefighter's protective clothing will provide only limited protection. If possible without risk, move container from fire area. Apply cooling water to sides of containers 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 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 (explosion) or waterways.

* 22 °F (-5.5 °C), OC(148)

Section 5. Reactivity Data

Stability/Polymerization: 1,1-Dichloroethane is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Incompatible with strong oxidizers and forms acetaldehyde in contact with caustics. 1,1-Dichloroethane will attack some forms of plastics, rubber, and coatings.

Conditions to Avoid: Exposure to heat and ignition sources and contact with incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of 1,1-dichloroethane can produce carbon dioxide (CO_2), irritating hydrogen chloride (HCl) and toxic phosgene ($COCl_2$) fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list 1,1-dichloroethane as a carcinogen. However, the National Cancer Institute has recommended caution due to analogy to other chloroethanes such as 1,2-dichlorothane which are shown to cause cancer in animals.

Summary of Risks: 1,1-Dichloroethane is irritating to the eyes and respiratory system. It causes varying degrees of central nervous system (CNS) disturbance depending on the concentration and duration of exposure. Liver and kidney toxicity is controversial.

Continue on next page

Section 6. Health Hazard Data, *continued*

Some sources report that severe, acute exposures can cause damage, some quote recent detailed chronic studies which indicate little capacity for damage; still others refute the possibility of acute damage even from very high exposures. In reviewing the data it appears likely that chronic exposure will not cause kidney or liver damage but acute exposures to high concentrations may. There is definite evidence that 1,1-dichloroethane produces liver damage in monkeys, dogs, and rats when exposed to 98 ppm/90 days. It is also unclear whether or not 1,1-dichloroethane is absorbed through the skin. There are reports of absorption (although not in toxic amounts) and others claiming there is no absorption. Given this controversial data it is best to take precautions as if skin absorption, and liver and kidney damage were proven to occur. **Medical Conditions Aggravated by Long-term Exposure:** Chronic respiratory and skin disease, neurological damage, and liver or kidney disorders. **Target Organs:** Skin, CNS, liver, kidney. **Primary Entry Routes:** Inhalation and skin contact. **Acute Effects:** Inhalation symptoms include eye, nose, and throat irritation, headache, dizziness, coughing, staggering, disturbed vision, irregular heartbeat (can result in sudden death), unconsciousness, narcosis, coma, and death due to cardiac or respiratory failure. There is the risk of pulmonary edema (fluid in lungs). Skin contact is irritating and causes defatting, redness and swelling. Vapor contact with the eyes causes irritation, watering eyes and lid inflammation. Splashes to the eyes produces a burning sensation, watering, and lid inflammation. **Chronic Effects:** Repeated skin contact can cause a rash and scaliness. Repeated inhalation may have neurological effects.

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. Immediately consult an ophthamlologist. **Skin:** 1,1-Dichloroethane vaporizes easily and poses an inhalation hazard as well. *Quickly and carefully* remove contaminated clothing; *1,1-dichloroethane is flammable!* 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. After vomiting, give 2 tbsp activated charcoal in 8 oz water to drink.

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

Note to Physicians: Proper ventilation is the main treatment for acute exposure. Be prepared to support respiration if needed. Monitor liver function studies, urine analysis, and creatinine with acute and chronic exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against inhalation and skin contact. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and using nonsparking tools, place in a suitable container. For large spills, dike far ahead of liquid spill for disposal or reclamation. Do not allow 1,1-dichloroethane to enter confined areas such as a sewer because of potential explosion. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Degradation:** In soil, 1,1-dichloroethane volatilizes rapidly but may leach into groundwater. In water it will volatilize from a pond, lake, or river with a half-life of 6 to 9 days, 5 to 8 days, and 24 to 32 hr, respectively. In the atmosphere it will degrade by reaction with photochemically produced hydroxyl radicals with a 62 day half-life. It may also be carried back to soil via rain.

Ecotoxicity Values: *Artemia salina*, brine shrimp, TLm 320 mg/L/24 hr; *Lagodon rhomboides*, pinperch, TLm 160 mg/L/24 hr; *Poecilia reticulata*, guppies, LC_{50} 202 ppm/7 days.

Disposal: 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
SARA Toxic Chemical (40 CFR 372.65): Not listed
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U076
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
[* per RCRA, Sec. 3001 & 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 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 NIOSH/MSHA-approved respirator. For < 1000 ppm, use any supplied-air respirator or SCBA. For < 2500 ppm, use any supplied-air respirator operated in a continuous flow mode. For < 4000 ppm, use any supplied-air respirator or SCBA with 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 repeated or prolonged skin contact. Polyvinyl alcohol is recommended as suitable material for PPG. **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. Thoroughly decontaminate 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 ignition sources and incompatibles (Sec. 5). Label containers to indicate the contents' high flammability. Periodically inspect containers for cracks and leaks. To prevent static sparks, electrically ground and bond all equipment used in 1,1-dichloroethane manufacture, use, storage, transfer, and shipping.

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: Consider preplacement and periodic medical exams of exposed workers emphasizing the skin, CNS, liver, and kidney. Educate workers about the hazards of 1,1-dichloroethane and the necessary precautions to reduce or prevent exposure.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: 1,1-Dichloroethane
IMO Hazard Class: 3.2
ID No.: UN2362
IMO Label: Flammable Liquid
IMDG Packaging Group: II

MSDS Collection **References:** 73, 89, 101, 103, 126, 127, 131, 132, 133, 136, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171

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. 703
1,2-Dichloroethylene

Issued: 4/90

Section 1. Material Identification

31

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^-).

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

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Material Safety Data Sheets Collection:

Sheet No. 385
Ethylbenzene

Issued: 8/78 Revision: B, 9/92

Section 1. Material Identification

Ethylbenzene ($C_6H_5C_2H_5$) Description: Derived by heating benzene and ethylene in presence of aluminum chloride with subsequent distillation, by fractionation directly from the mixed xylene stream in petroleum refining, or dehydrogenation of naphthenes. Used as a solvent, an antiknock agent in gasoline; and as an intermediate in production of synthetic rubber, styrene, cellulose acetate, diethylbenzene, acetophenone, ethyl anthraquinone, propyl oxide, and α-methylbenzol alcohol.
Other Designations: CAS No. 100-41-4, ethylbenzol, EB, phenylethane, NCI-C56393.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 3
S 2*
K 4
* Skin absorption

NFPA

HMIS
H 2†
F 3
R 0
PPE - Sec. 8
† Chronic effects

Cautions: Ethylbenzene is a skin and mucous membrane irritant considered the most irritating of the benzene series. Inhalation causes acute and chronic central nervous system (CNS) effects. It is highly flammable and forms explosive mixtures with air.

Section 2. Ingredients and Occupational Exposure Limits

Ethylbenzene, ca >99.0%. Impurities include ~ 0.1% *meta & para* xylene, ~ 0.1% cumene, and ~ 0.1% toluene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 125 ppm (545 mg/m^3)
Action Level: 50 ppm (217 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH REL
TWA: 100 ppm (435 mg/m^3)
STEL: 125 ppm (545 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 125 ppm (545 mg/m^3)

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category 1: local irritants
Peak Exposure Limit: 200 ppm, 5 min momentary value, max of 8/shift
Danger of cutaneous absorption

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 100 ppm/8 hr caused eye effects, sleep, and respiratory changes.
Human, lymphocyte: 1 mmol/L induced sister chromatid exchange.
Rat, oral, LD_{50}: 3500 mg/kg; toxic effects not yet reviewed
Rat (female), inhalation, TC_{Lo}: 1000 ppm/7 hr/day, 5 days/wk, for 3 wk prior to mating and daily for 19 days of gestation produced pups with high incidence of extra ribs.[179]

* See NIOSH, *RTECS* (DA0700000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 277 °F (136 °C)
Melting Point: -139 °F (-95 °C)
Surface Tension: 31.5 dyne/cm
Ionization Potential: 8.76 eV
Viscosity: 0.64 cP at 77 °F (25 °C)
Refraction Index: 1.4959 at 68 °F (20 °C)
Relative Evaporation Rate (ether = 1): 0.0106
Bulk Density: 7.21 lb/Gal at 77 °F (25 °C)
Critical Temperature: 651 °F (343.9 °C)
Critical Pressure: 35.6 atm
Molecular Weight: 106.16
Density: 0.863 at 77 °F (25 °C)
Water Solubility: Slightly, 14 mg/100 mL at 59 °F (15 °C)
Other Solubilities: Miscible in alcohol, ether; soluble in carbon tetrachloride, benzene, sulfur dioxide, and many organic solvents; insoluble in ammonia
Odor Threshold: 2.3 ppm
Vapor Pressure: 7.1 mm Hg at 68 °F (20 °C); 10 mmHg at 78.62 °F (25.9 °C); 100 mm Hg 165.38 °F (74.1 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0768 lb/ft^3 or 1.2298 kg/m^3

Appearance and Odor: Colorless, flammable liquid with a pungent odor.

Section 4. Fire and Explosion Data

Flash Point: 64 °F (18 °C) CC	**Autoignition Temperature:** 810 °F (432 °C)	**LEL:** 1.0% v/v	**UEL:** 6.7% v/v

Extinguishing Media: Class 1B Flammable liquid. For small fires, use dry chemical, carbon dioxide, or 'alcohol-resistant' foam. For large fires, use fog or 'alcohol-resistant' foam. Use water only if other agents are unavailable; EB floats on water and may travel to an ignition source and spread fire. **Unusual Fire or Explosion Hazards:** Burning rate = 5.8 mm/min. Vapors may travel to an ignition source and flash back. Container may explode in heat of fire. EB poses a vapor explosion hazard indoors, outdoors, and 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. Cool container sides with water 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 area and let fire burn. Withdraw immediately if you hear 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: Ethylbenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Reacts vigorously with oxidizers.
Conditions to Avoid: Exposure to heat and oxidizers.
Hazardous Products of Decomposition: Thermal oxidative decomposition of EB can produce acrid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list EB as a carcinogen. **Summary of Risks:** Occupational exposure to EB alone is rare since it is usually present together with other solvents. EB is irritating to the eyes, skin, and respiratory tract. Vapor inhalation produces varying degrees of CNS effects depending on concentration. The liquid is absorbed through the skin but vapors are not. 56 to 64% of inhaled ethylbenzene is retained and metabolized. Urinary metabolites following exposure to 23 to 85 ppm for 8 hr are mandelic acid (64%), phenylglyoxylic acid (25%), and methylphenylcarbinol/1-phenyl ethanol (5%). Concurrent exposure to xylene and ethylbenzene causes slower excretion of EB metabolites. Based on the rat LD_{50}, one manufacturer gives 3 to 4 oz. as the lethal dose for a 100 lb person.

Continue on next page

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Skin and CNS diseases and impaired pulmonary function (especially obstructive airway disease). **Target Organs:** Eyes, respiratory system, skin, CNS, blood. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute Effects:** Vapor inhalation of 200 ppm caused transient eye irritation; 1000 ppm caused eye irritation with profuse watering (tolerance developed rapidly); 2000 ppm caused severe and immediate eye irritation and watering, nasal irritation, chest constriction, and vertigo; 5000 ppm was intolerable and caused eye and nose irritation. Inhalation of high concentrations may cause narcosis, cramps, and death due to respiratory paralysis. Skin exposed to pure ethylbenzene for 10 to 15 min absorbed 22 to 33 mg/cm^2/hr. Immersion of hand in solutions of 112 & 156 mg/L for 1 hr absorbed 118 & 215.7 μg/cm^2/hr, respectively. **Chronic Effects:** Repeated skin contact may cause dryness, scaling, and fissuring. Workers chronically exposed to > 100 ppm complained of fatigue, sleepiness, headache, and mild irritation of the eyes and respiratory tract. Repeated vapor inhalation may result in blood disorders, particularly leukopenia (abnormally low level of white blood cells) and lymphocytosis.

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. **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! Aspiration of even a small amount of EB in vomitus can cause severe damage since its low viscosity and surface tension will cause it to spread over a large area of the lung tissue.

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

Note to Physicians: BEI = mandelic acid in urine (1.5 g/g of creatinine), sample at end of shift at workweeks end. Since this test is not specific, test for EB in expired air for confirmation.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate and ventilate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container. Dike far ahead of large spill for later reclamation or disposal. Report any release >1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, EB partially evaporates into the atmosphere, with a half-life of hrs to wks, and some leaches into groundwater, especially in soil with low organic carbon content. Biodegradation occurs with a half-life of 2 days. Some EB may absorb to sediment or bioconcentrate in fish. Evidence points to slow biodegradation in groundwater. In air, it reacts with photochemically produced hydroxyl radicals with a half-life of hrs to 2 days. Additional amounts may be removed by rain. **Ecotoxicity Values:** Shrimp (*Mysidopsis bahia*), LC_{50} = 87.6 mg/L/96 hr; sheepshead minnow (*Cyprinodon variegatus*) LC_{50} = 275 mg/L/96 hr; fathead minnow (*Pimephales promelas*) LC_{50} = 42.3 mg/L/96 hr in hard water & 48.5 mg/L/96 hr in softwater. **Disposal:** A candidate for rotary kiln incineration at 1508 to 2912°F (820 to 1600°C), liquid injection incineration at 1202 to 2912°F (650 to 1600°C), and 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 261.21): No. D001
Listed as a SARA Toxic Chemical (40 CFR 372.65)
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 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 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 selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use a powered air-purifying respirator with an appropriate organic vapor cartridge, a supplied-air respirator (SAR), SCBA, or chemical cartridge respirator with appropriate organic vapor cartridge. For < 2000 ppm, use a SAR or SCBA with 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: 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 polyvinylchloride to prevent skin contact. **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 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 cool, dry, well-ventilated area away from ignition sources and oxidizers. Outside or detatched storage is preferred. If inside, store in a standard flammable liquids cabinet. Containers should have flame-arrester or pressure-vacuum venting. To prevent static sparks, electrically ground and bond all equipment used with ethylbenzene. Install Class 1, Group D electrical equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain levels as low as possible. Purge and ventilate reaction vessels before workers are allowed to enter for maintenance or cleanup. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, skin, blood, and respiratory system.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethylbenzene
DOT Hazard Class: 3
ID No.: UN1175
DOT Packing Group: II
DOT Label: Flammable liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) **Exceptions:** 173.150
b) **Non-bulk Packaging:** 173.202
c) **Bulk Packaging:** 173.242

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 5L
b) **Cargo Aircraft Only:** 60 L

Vessel Stowage Requirements
a) **Vessel Stowage:** B
b) **Other:** —

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 153, 159, 162, 163, 164, 167, 168, 171, 176, 179

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. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

32

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 0
I 4
S -
K 0

Genium

HMIS
H 3
F 1
R 0
PPG*
* Sec. 8

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 µg/m³
Action Level TWA*: 30 µg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 µg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 µg/m³

1988 NIOSH REL
10-hr TWA: <100 µg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 µg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*
Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
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. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system. The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.

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. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. 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, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* 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-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. 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. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations 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 washing hands 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 incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

MSDS Collection References: 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
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Material Safety Data Sheets Collection:
Sheet No. 313
Perchloroethylene
Issued: 11/78 Revision: E, 9/92

Section 1. Material Identification

39

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.

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).

R 1
I 3
S 2*
K 0
* Skin absorption

NFPA

HMIS
H 2†
F 0
R 0
PPE‡
† Chronic effects
‡ Sec. 8

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 lightheadedness 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

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
OT 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

1987 IDLH Level
250 ppm

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

* 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

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
DOT Hazard Class: Poison B
ID No.: UN1671
DOT Label: Poison
DOT Packaging Exceptions: 173.364
DOT Packaging Requirements: 173.369

IMO Shipping Name: Phenol
IMO Hazard Class: 6.1
ID No.: UN1671
IMO Label: Poison
IMDG Packaging Group: II

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

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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

27

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.

Genium

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.

HMIS

H	2	R	1
F	0	I	4
R	0	S	—
PPG*		K	—

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
1,1,2,2-Tetrachloroethane, CAS No. 0079-34-5 *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.	Ca 100	**OSHA PEL (Skin*)** 8-Hr TWA: 1 ppm, 7 mg/m^3 **ACGIH TLV (Skin*), 1988-89** TLV-TWA: 1 ppm, 7 mg/m^3 **Toxicity Data**** Human, Oral, TD_{Lo}: 30 mg/kg Human, Inhalation, TC_{Lo}: 1000 mg/m^3 (30 Mins) Rat, Oral, LD_{50}: 800 mg/kg

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

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.

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

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Material Safety Data Sheets Collection:

Sheet No. 664
Tetraethyl Lead

Issued: 8/88 Revision: A, 9/92

Section 1. Material Identification

Tetraethyl Lead [$(C_2H_5)_4Pb$] Description: Derived by alkylation of lead-sodium alloy with excess ethyl chloride in a nitrogen atmosphere or electrolysis of an ethyl Grignard reagent with an anode of lead pellets. Used as anti-knock agent in gasoline aviation fuel. Formerly used in organomercury fungicides and in the manufacture of other metal alkyls such as ethyl mercury compounds. Since 1974 its use in gasoline was largely replaced by methyl tert butyl ether [(MTBE), see *Genium* MSDS No. 735] after the USEPA issued regulations requiring its gradual reduction in gasoline. Du Pont was the last known company to produce TEL in the US and stopped production in 1990. There are still US companies with branches in Canada that continue to manufacture tetraethyl lead since it is still widely used in gasoline there and in Europe.
Other Designations: CAS No. 78-00-2, TEL, NCI-C54988, tetraethyl plumbane.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.
Cautions: Tetraethyl lead is highly toxic to the central nervous system (CNS). The liquid and vapor are easily absorbed through the skin because of TEL's lipid solubility. It is a combustible liquid and can decompose explosively if exposed to air.

R	3
I	4
S	-*
K	1

* Skin absorption

NFPA

HMIS

H	3†
F	2
R	3

PPE-Sec. 8
† Chronic effects

Section 2. Ingredients and Occupational Exposure Limits

Tetraethyl lead, ca 98%. Impurities include ethylene dibromide, ethylene dichloride, dye (red, blue, orange), and kerosene.

1991 OSHA PEL (Skin)
8-hr TWA: 0.075 mg/m^3

1990 IDLH Level
40 mg/m^3

1990 NIOSH REL (Skin)
10-hr TWA: 0.075 mg/m^3

1992-93 ACGIH TLV* (Skin)
TWA: 0.1 mg/m^3

1990 DFG (Germany) MAK (Skin)
TWA: 0.01 ppm (0.075 mg/m^3)
Category II: substances with systemic effects
Half-Life: < 2 hr
Peak Exposure Limit: 0.02 ppm, 30 min average value, 4/shift

1985-86 Toxicity Data†
Human, unreported route, TD_{Lo}: 1.47 mg/kg; toxic effects not yet reviewed.
Rat, oral, LD_{50}: 12.3 mg/kg caused aggression, altered sleep time, and convulsions or effect on seizure threshold.
Rat, inhalation, LC_{50}: 850 mg/m^3/1 hr; toxic effects not yet reviewed
Rat, oral, TD_{Lo}: 7.5 mg/kg administered from 12 to 14 days of pregnancy caused post-implantation mortality or effects on the developing fetus.

* Biologic monitoring is essential for personnel control.
† See NIOSH, *RTECS* (TP4550000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: ~ 392 °F (200 °C); decomposes
Freezing Point: -214.2 °F (-136.8 °C)
Molecular Weight: 323.45
Specific Gravity: 1.59 at 51.8 °F (11 °C)
Ionization Potential: 11.10 eV
Surface Tension: 28.5 dyne/cm
Viscosity: 0.864 mPa.s at 68 °F (20 °C)
Water Solubility: Insoluble, 0.29 mg/L at 77 °F (25 °C)
Other Solubilities: Soluble in benzene, diethyl ether, gasoline, and petroleum ether. Slightly soluble in alcohol.
Vapor Pressure: 0.2 mm Hg at 68 °F (20 °C); 1 mm Hg at 101.12 °F (38.4 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3): ~ same as air
Relative Evaporation Rate: 0.032 g/m^2 at 68 °F (20 °C) and wind speed of 4.5 meter /second
Refraction Index: 1.5198 at 68 °F (20 °C/D)

Appearance and Odor: Colorless liquid which may be dyed orange, red, blue or other color and has a slight musty odor.

Section 4. Fire and Explosion Data

Flash Point: 200 °F (93.3 °C), CC; 185 °F (85 °C), OC	Autoignition Temperature: None reported	LEL: 1.8% v/v	UEL: None reported

Extinguishing Media: A Class III B combustible liquid. 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: Container may explode in heat of fire (> 80 °C). Tetraethyl lead burns as an orange flame with a green margin and gives off extremely poisonous lead fumes.
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 is not effective for tetraethyl lead fires. Use clothing specifically recommended by manufacturer (be aware that these may or may not provide *thermal* protection). Apply cooling water to sides of fire-exposed containers 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 this is impossible, withdraw and let fire burn. Do not release runoff from fire control methods to sewers or waterways. Evacuate 1/3 mile radius if fire becomes uncontrollable.

Section 5. Reactivity Data

Stability/Polymerization: TEL decomposes slowly at room temperature and rapidly at 125 to 150 °C. It also decomposes when exposed to sun or allowed to evaporate in air. Exposure to air for several days can cause explosive decomposition. Hazardous polymerization cannot occur.
Chemical Incompatibilities: TEL solubilizes fatty materials and has solvent action on rubber. It is incompatible with strong oxidizers, sulfuryl chloride, potassium permanganate, and rust.
Conditions to Avoid: Exposure to heat, ignition sources, sunlight, air, strong oxidizers, and other incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of TEL can produce carbon dioxide (CO_2) and toxic lead (Pb) fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list tetraethyl lead as a carcinogen. One study showed liver and blood tumors (Hodgkins disease) in mice, termed unreliable because these tumors tend to occur spontaneously at times in this particular strain of mice.
Summary of Risks: *Do not* confuse the effects of tetraethyl lead (TEL) with those caused by inorganic lead exposure. TEL is organic and while both are water insoluble, TEL is lipid soluble and easily enters the as brain while inorganic lead compounds can't. Neurologic symptoms are more prevalent than any others. Tetraethyl lead has a latency period from exposure time to onset of symptoms as it must first be metabolized to triethyl lead before toxicity results. The greater the exposure concentration, the faster symptoms develop. TEL's ability to produce chronic toxicity has been debated for years as is the efficacy of chelation therapy. Chronic toxicity was thought not to occur with organic lead compounds because they did not accumulate in the bone like inorganic lead.

Continue on next page •

Section 6. Health Hazard Data

Recently, studies showed that TEL is first metabolized to triethyl lead, then over a period of months, converted to inorganic lead which is then deposited in bone. At this point chronic effects could resemble those caused by direct exposure to inorganic lead. If victim survives an acute exposure, recovery may take weeks to months. It is questionable whether all changes are reversible following heavy or long-term exposures. Teratogenic effects may occur; 'a syndrome with severe mental retardation has been seen among children of heavy gasoline sniffers'.(136)
Medical Conditions Aggravated by Long-Term Exposure: Mental disorders and hypertension. **Target Organs:** CNS, cardiovascular system, eyes, liver, kidneys. **Primary Entry Routes:** Eye, skin, inhalation, ingestion. **Acute Effects:** The primary target organ is the brain, and CNS effects occur in three categories; mild, moderate, and severe. Mild effects include anxiety, irritability, insomnia, lurid dreams, vomiting, metallic taste, paleness, cerebellar ataxia, and diarrhea. Moderate effects are disorientation, hyperexcitability, tremors, chorea (involuntary incoordination of face and limbs), bradycardia (slow heart action), hypotension (abnormally low blood pressure), and hypothermia (lowered body temperature). Severe symptoms include delusions, hallucinations, mania, convulsions, cerebellar edema (fluid in the brain), coma, and death. Ringing in the ears, impaired vision (due to weakening of the eye muscles), elevated liver enzymes, and anemia may also occur. **Chronic Effects:** May occur once TEL is metabolized to inorganic lead. Symptoms include anemia, appetite loss, weakness, insomnia, muscle and joint pain, and colic accompanied by severe abdominal pain. See *Genium* MSDS No. 713.
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. **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 an unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. Induce vomiting *only* if large amounts are ingested. **Note to Physicians:** Urine lead levels are better indicators of exposure than blood lead levels. Blood lead levels may not reflect exposure until toxicity is severe where as urine directly reflects amount of exposure. In severe acute toxicity, urine lead levels are usually > 350 μg/L but blood levels are < 50 μg/L. Chelation therapy can be useful for chronic exposure but not for acute. If blood levels are greater than 50 μg/dL begin chelation therapy with BAL, calcium EDTA, or D-penicillamine

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. For small spills, take up with earth, sand, vermiculite or charcoal absorbent (decreases evaporation) and place in suitable containers. Dike far ahead of large spill, neutralize with agricultural (slaked) lime, sodium bicarbonate, or crushed limestone and adjust to pH 7. Investigate reclamation or disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill, TLm = 2, 1.4, and 0.2 mg/L at 24, 48, and 96 hr, respectively. **Environmental Degradation:** In the atmosphere, TEL rapidly degrades by reaction with photochemically produced hydroxyl radicals and ozone molecules. The half-life is ~ 1.5 to 5 hr depending on solar intensity. In water, volatilization is expected. Half-life from a model river is 5.3 hr and 3 days in a model pond. It is also subject to hydrolysis and direct photolysis. Some TEL may degrade into dialkyl and trialkyl lead which may be more resistant in water than TEL itself. Bioaccumulation may occur in aquatic organisms. If released to soil, some TEL is expected to degrade to water soluble compounds and leach, although some may volatilize or undergo direct photolysis if exposed to sunlight. **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed (*as lead compounds*) as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 100 lbs
Listed as a RCRA Hazardous Waste (40 CFR 261.33): P110
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (4.54 kg) [* per RCRA, Sec. 3001 & CWA, Sec. 311 (b)(4)]

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. For < 0.75 mg/m^3, use any supplied-air respirator (SAR) or SCBA. For <1.875 mg/m^3, use any SAR operated in continuous-flow mode. For <3.75 mg/m^3, use any SCBA or SAR with a full facepiece or a SAR with a tight fitting facepiece operated in continuous-flow mode. For <40 mg/m^3, use any SAR 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 to prevent skin contact. *Do not* use rubber as material for PPE (TEL may degrade rubber). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into work area by controlling it at the 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 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, dark, well-ventilated area (equipped with an automatic sprinkler system) away from heat, ignition sources, and incompatibles (Sec. 5). Keep containers tightly closed; exposure to air can lead to explosive decomposition. **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. Use nonsparking tool for any maintenance procedures. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on the CNS, including personality changes. For greater assurance of individual protection, monitor urinary output of exposed workers.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Tetraethyl lead, liquid
DOT Hazard Class: 6.1
ID No.: NA1649
DOT Packing Group: I
DOT Label: Poison, Flammable liquid
Special Provisions (172.102): —

Packaging Authorizations
a) **Exceptions:** None
b) **Non-bulk Packaging:** 173.201
c) **Bulk Packaging:** None

Quantity Limitations
a) **Passenger Aircraft or Railcar:** Forbidden
b) **Cargo Aircraft Only:** Forbidden

Vessel Stowage Requirements
a) **Vessel Stowage:** E
b) **Other:** 40

MSDS Collection References: 23, 73, 89, 101, 103, 124, 126, 127, 132, 136, 140, 148, 149, 153, 159, 162, 163, 164, 167, 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. 317
Toluene
Issued: 8/79 Revision: E, 9/92

Section 1. Material Identification

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

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, dney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, akness, 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
isted as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
RA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
isted 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)

T Shipping Name: Toluene
OT Hazard Class: 3
ID No.: UN1294
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 150
b) Non-bulk Packaging: 202
c) Bulk Packaging: 242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
Vessel Stowage: B
Other: --

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

Material Safety Data Sheet

from Genium's Reference Collection

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GENIUM PUBLISHING CORP.

No. 365

1,2,4-TRICHLOROBENZENE

(Revision B)
Issued: December 1979
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: 1,2,4-TRICHLOROBENZENE

Description (Origin/Uses): Used as a dielectric fluid, as a heat-transfer medium, in lubricants and insecticides, and in organic synthesis.

Other Designations: TCB; TCB (Dielectric Grade); Trichlorobenzenes; Electrical Insulating Fluid; EIF; Electrical Trichlorobenzenes; $C_6H_3Cl_3$; CAS No. 0120-82-1

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

1
2 0
-
NFPA

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

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

Ingredients	%
1,2,4-Trichlorobenzene (NIOSH *RTECS* No. DC2100000), CAS No. 0120-82-1	Ca 100*
1,2,3-Trichlorobenzene (NIOSH *RTECS* No. DC2095000), CAS No. 0087-61-6	*
1,3,5-Trichlorobenzene (NIOSH *RTECS* No. DC2100100), CAS No. 0108-70-3	*
Trichlorobenzenes Mixture (NIOSH *RTECS* No. DC2090000), CAS No. 12002-48-1	*

*Consult with your supplier for the technical specifications of your purchased product; the two other isomers listed are likely contaminants.
**See NIOSH, *RTECS*, for additional data with references to reproductive, mutagenic, and irritative effects.

EXPOSURE LIMITS

OSHA PEL
Ceiling: 5 ppm, 40 mg/m^3

ACGIH TLV, 1988-89
TLV-Ceiling: 5 ppm, 40 mg/m^3

Toxicity Data**
Rat, Oral, LD_{50}: 756 mg/kg
Mouse, Oral, LD_{50}: 766 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 415°F (213°C)
Melting Point: 63°F (17°C)
Vapor Density (Air = 1): 6+
Molecular Weight: 181 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 1.4634 at 77°F (25°C)

Appearance and Odor: A clear, colorless, combustible, stable liquid; characteristic, aromatic odor similar to *o*-dichlorobenzene.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: 224.6°F (107°C)	Autoignition Temperature: 1060°F (571°C)	LEL: 2.5% v/v*	UEL: 6.6% v/v*

Extinguishing Media: 1,2,4-Trichlorobenzene is a slight fire and explosion hazard when heated. Use foam, dry chemical, water spray, or carbon dioxide to extinguish fires. Water may be used to blanket the fire if applied gently to prevent scattering; water spray can also be used to cool fire-exposed containers. If it is safe to do so, remove uninvolved containers of trichlorobenzene from the fire area. **Unusual Fire or Explosion Hazards:** Trichlorobenzene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back to its origin. During fires this material can thermally and oxidatively decompose to produce phosgene, hydrogen chloride, carbon monoxide, and additional toxic gases. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*Measured at 302°F (150°C).

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Trichlorobenzene is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** This stable material is not expected to react with any commonly used industrial materials except under extreme conditions. **Conditions to Avoid:** Prevent exposure to sources of ignition such as sparks, open flame, lighted tobacco products, or electric arcs. **Hazardous Products of Decomposition:** This material will decompose thermally above 575°F (302°C). Contact with an open flame or an electric arc can produce very toxic gases such as phosgene and hydrogen chloride (see Genium Industrial MSDSs 66 and 30).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: 1,2,4-Trichlorobenzene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: The available data does not indicate high systemic toxicity for trichlorobenzene. Excessive inhalation of trichlorobenzene vapor is moderately irritating to the eyes and mucous membranes. Accidental ingestion of a few ounces could prove fatal. Irritation is likely to develop if this liquid should contact the skin or eyes. Trichlorobenzene acts as a defatting agent on the skin; chronic, repeated, or prolonged exposure can cause dermatitis. **Medical Conditions Aggravated by Long-Term Exposure:** Ailments of the blood, liver, kidneys; respiratory disorders such as asthma. **Target Organs:** Skin, eyes, and the mucous membranes of the respiratory system. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Irritation of the skin, eyes, and respiratory system; drowsiness, uncoordination, narcosis, and liver damage. Levels over 5 ppm will cause severe eye irritation, tremors, weight loss, headache, nervousness, restlessness, and increased heart rate and blood pressure. **Chronic Effects:** Chronic overexposure may result in liver, kidney, and lung damage. (This conclusion is based on the results of toxicity testing with experimental animals.) FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Skin. Remove all contaminated clothing. Rinse the

SECTION 6. HEALTH HAZARD INFORMATION, cont.

affected area with flooding amounts ofwater, then wash it with soap and water for at least 5 minutes. **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.* **Ingestion.** Unlikely. Should this type of exposure occur, give the exposed person 2 to 3 glasses of milk or water to drink and induce vomiting. Never give anything by mouth to someone who is unconscious or convulsing.* A dose of 2 ounces of this material may cause liver damage and death. **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:** Do not give adrenalin to victims of inhalation or ingestion.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition and electric arcs, and provide adequate ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). 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. Dissolve the trichlorobenzene in a suitable combustible solvent. Scatter the spray of this solution into a properly regulated furnace with an up-to-date permit(s) that is equipped with an afterburner and an alkali scrubber. 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), Specific to 1,2,4-Trichlorobenzene

CERCLA Hazardous Substance, Reportable Quantity: 100 lbs (45.4 kg), per the Clean Water Act (CWA), § 307 (a).

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:** 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. Wear a respirator that is approved by NIOSH to protect against trichlorobenzene vapor, especially when ventilation systems are not able to keep airborne concentrations of this material below the OSHA PEL cited in section 2. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. Suggested materials include rubber, neoprene, and vinyl. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL 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 TCB vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store 1,2,4-trichlorobenzene in closed containers in a cool, dry, well-ventilated area away from sources of ignition and electric arcs in temperatures above 40°F (4°C). **Special Handling/Storage:** Prevent freezing of this material by installing appropriate heating elements in storage areas. If freezing should occur accidentally, place the trichlorobenzene in a warm room to thaw. Do not thaw it at high temperatures. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum, explosion-proof design. To prevent static sparks, ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations. Electric arcs must not be produced by any processing equipment. **Other:** Avoid breathing TCB vapor, especially any vapor from heated TCB. Dike fixed storage tanks and provide drainage to holding areas for high-density material.

Hazardous Materials Table (49 CFR 172.101): Not Listed
Optional Hazardous Materials Table (49 CFR 172.102)
IMO ID No. UN2831
IMO Shipping Name: Trichlorobenzene, Liquid
IMO Hazard Class: 6.1
IMO Label: Saint Andrew's Cross (X)*
IMDG Packaging Group: III

*Harmful-Stow away from Foodstuffs.

References: 1, 8, 84-94, 116, 117, 120, 121.

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

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Material Safety Data Sheets Collection:

Sheet No. 312
Trichloroethylene

Issued: 7/79 Revision: F, 9/92

Section 1. Material Identification

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.

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.

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

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

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.

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Material Safety Data Sheets Collection:
Sheet No. 382
Vinyl Chloride
Issued: 7/78 Revision: C, 9/92

Section 1. Material Identification

39

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
I 4
S 4
K 4

NFPA

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.

Continue on next page

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 roacetaldehyde. Skin absorption may occur if liquid is confined on skin but absorbed amount would be small. It is possible that the phenol inhibitor 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 li scrubber. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

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 (1910.1017). Monitor for liver cancer, scleroderma, pneumonitis, clotting abnormalities, and acro-osteolysis.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Vinyl Chloride
Hazard Class: 2.1
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

MSDS 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 31

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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K 4

NFPA

HMIS
H 2
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R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Vinylidene chloride, ca 100%

OSHA PEL	ACGIH TLVs, 1989-90	Toxicity Data*
8-hr TWA: 1 ppm, 4 mg/m³	TLV-TWA: 5 ppm, 20 mg/m³	Mouse, skin, TD_{Lo}: 4840 mg/kg has tumorigenic effects on skin, appendages, lungs, thorax, and respiration
	TLV-STEL: 20 ppm, 79 mg/m³	Rat, inhalation, LC_{50}: 6350 ppm/4 hr
	NIOSH REL, 1987	Human, inhalation, TC_{Lo}: 25 ppm produces changes in behavior (general anesthetic), the liver, kidney, ureter, and bladder
	None established	

* 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).

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
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Material Safety Data Sheets Collection:

Sheet No. 318
Xylene *(Mixed Isomers)*

Issued: 11/80 Revision: E, 9/92

Section 1. Material Identification 39

Xylene (Mixed Isomers) (C_8H_{10}) Description: The commercial product is a blend of the three isomers [*ortho*-(*o*-), *meta*-(*m*-), *para*-(*p*-)] with the largest proportion being *m*- xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics; as a general solvent for adhesives, a cleaning agent in microscope technique; as a solvent for Canada balsam microscopy; as a fuel component; in aviation gasoline, protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, and the leather industry; in the production of phthalic anhydride, isophthalic, and terephthalic acids and their dimethyl esters which are used in the manufacture of polyester fibers; and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.

Other Designations: CAS No. 1330-20-7 [95-47-6; 108-38-3; 106-42-3 (*o*-, *m*-, *p*-isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

R 1
I 2
S 2
K 3

NFPA
3
2 0
–

HMIS
H 2†
F 3
R 0
PPE ‡
† Chronic Effects
‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers): the commercial product generally contains ~ 40% *m*-xylene; 20% each of *o*-xylene, *p*-xylene, and ethylbenzene; and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m³)
15-min STEL: 150 ppm (655 mg/m³)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 100 ppm (435 mg/m³)
STEL: 150 ppm (655 mg/m³)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m³)
STEL: 150 ppm (651 mg/m³)
BEI (Biological Exposure Index): Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m³)
Category II: Substances with systemic effects
Half-life: < 2 hr
Peak Exposure: 200 ppm, 30 min, average value, 4 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo}: 10000 ppm/6 hr; toxic effects not yet reviewed.
Human, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted.
Rat, oral, LD_{50}: 4300 mg/kg; toxic effect not yet reviewed.
Rat, inhalation, LC_{50}: 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, *RTECS* (XE2100000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range: 279 to 284 °F (137 to 140 °C)*
Boiling Point: *ortho:* 291 °F (144 °C); *meta:* 281.8 °F (138.8 °C); *para:* 281.3 °F (138.5 °C)
Freezing Point/Melting Point: *ortho:* -13 °F (-25 °C); *meta:* -53.3 °F (- 47.4 °C); *para:* 55 to 57 °F (13 to 14 °C)
Vapor Pressure: 6.72 mm Hg at 70 °F (21 °C)
Saturated Vapor Density (Air = 1.2 kg/m³): 1.23 kg/m³, 0.077 lbs/ft³

Appearance and Odor: Clear, sweet-smelling liquid.

* Materials with wider and narrower boiling ranges are commercially available.

Molecular Weight: 106.16
Specific Gravity: 0.864 at 20 °C/4 °C
Water Solubility: Practically insoluble
Other Solubilities: Miscible with absolute alcohol, ether, and many other organic liquids.
Octanol/Water Partition Coefficient: logKow = 3.12-3.20
Odor Threshold: 1 ppm
Viscosity: <32.6 SUS

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 °F (17 to 25 °C) CC	Autoignition Temperature: 982 °F (527 °C) (*m*-)	LEL: 1.1 (*m*-, *p*-); 0.9 (*o*-)	UEL: 7.0 (*m*-, *p*-); 6.7 (*o*-)

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards:** Xylene vapors or liquid (which floats on water) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid flow sufficient to cause ignition. **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 will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Xylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. **Chemical Incompatibilities:** Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidindione (dichlorohydrantoin). Xylene attacks some forms of plastics, rubber, and coatings. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list xylene as a carcinogen. **Summary of Risks:** Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm; severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. Kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated milk reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next page

Section 6. Health Hazard Data, *continued*

irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. **Medical Conditions Aggravated by Long-Term Exposure:** CNS, respiratory, eye, skin, gastrointestinal (GI), liver and kidney disorders. **Target Organs:** CNS, eyes, GI tract, liver, kidneys, and skin. **Primary Entry Routes:** Inhalation, skin absorption (slight), eye contact, ingestion. **Acute Effects:** Inhalation of high xylene concentrations may cause dizziness; nausea, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid in lung); drowsiness; and unconsciousness. Direct eye contact can result in conjunctivitis and corneal burns. Ingestion may cause a burning sensation in the oropharynx and stomach and transient CNS depression. **Chronic Effects:** Repeated or prolonged skin contact may cause drying and defatting of the skin leading to dermatitis. Repeated eye exposure to high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis, and GI disturbances such as nausea, loss of appetite, and gas.

FIRST AID *Emergency personnel should protect against exposure.* **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 as it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Monitor exposed person for respiratory distress. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, *do not induce vomiting!* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs). *Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage.* **Note to Physicians:** Hippuric acid or the ether glucuronide of *ortho*-toluic acid may be useful in diagnosis of *meta-*, *para-* and *ortho*-xylene exposure, respectively. Consider gastric lavage if a large quantity of xylene was ingested. Proceed gastric lavage with protection of the airway from aspiration; consider endotracheal intubation with inflated cuff.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors. Water spray may reduce vapor, but does not prevent ignition in closed spaces. For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal. For large spills dike far ahead of liquid to contain. Do not allow xylene to enter a confined space such as sewers or drains. On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal gelling agent; and use suction hoses to remove spilled material. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** Little bioconcentration is expected. Biological oxygen demand 5 (after 5 days at 20 °C): 0.64 (no stated isomer). **Ecotoxicity values:** LD_{50}, Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. **Environmental Degradation:** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr. in the summer to 10-18 hr in winter or a typical loss of 67-86% per day. Xylenes are resistant to hydrolysis. **Soil Absorption/Mobility:** Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into groundwater. **Disposal:** As a hydrocarbon, xylene is a good candidate for controlled incineration. 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): No. U239, F003 (spent solvent)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4); per 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 respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges; any powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator; or any self-contained breathing apparatus. 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, **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times > 8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as 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. Launder contaminated work clothing before wearing. 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 clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. During transferring operations, electrically ground and bond metal containers. **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. Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating surfaces, and provide sources of gas release with enclosures and local exhaust ventilation. Use Class I, Group D electrical equipment. **Administrative Controls:** Establish air and biological monitoring programs and evaluate regularly. Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests. Consider hematologic studies if there is any significant contamination of the solvent with benzene. If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Xylenes
DOT Hazard Class: 3
ID No.: UN1307
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Nonbulk Packaging : 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: –

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 176, 180.

Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

Appendix C
Emergency Procedures for Exposure to Hazardous Materials/Waste

APPENDIX C

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.

Baker
Baker Environmental, Inc

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 ______________

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.