ROSE TOWNSHIP
DEMODE ROAD SITE
SAFETY PLAN
for Remedial Investigation/Feasibility Study

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Groundwater Quality Division
Remedial Action Section
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SAFETY PLAN

I. GENERAL INFORMATION

Site: Rose Township
Location: Oakland County, Rose Township, Michigan
Plan Prepared by: Earle N. Latimer, Michigan Department of Natural Resources
Date: January 1984
Objective: To conduct a Remedial Investigation/Feasibility Study to determine the extent of contamination.

Separate Safety Plans will be developed by each contractor for specific tasks requiring on-site activities. If the hazard level at this site changes due to information gained in this investigation, this plan will be amended. The contractor's safety plan will not replace the DNR's master site safety plan but will supplement the master plan by Proposed Date of Investigation: 1984

Background Review:

Overall Hazard: Moderate, Low
Waste Types: Contaminated soils and groundwater
Characteristic(s): Toxic, potentially corrosive
Exposure Routes: Inhalation, dermal contact with solids and liquids and ingestion

II. SITE/WASTE CHARACTERISTICS

Facility Description: The Rose Township site is in Oakland County, Michigan, approximately 40 miles northwest of Detroit. It is located in an open field on the property of Mr. , 1065 Demode Road, and the adjacent property owner, Mrs. . The 12-acre field (approximately 950' x 550') is bounded by woods to the west. Beyond the woods is a low-lying marsh. The site is on a topographic high consisting of glacial moraine material.

In a roughly triangular area at the southwest corner of the site are seven mounds of contaminated soil, spoils from the excavation and removal of approximately 5,000 barrels from the site. It is the area of most significant known contamination. Several pools of water have been created by the excavation.

A 24-inch high pressure natural gas line owned by Consumers Power Company crosses the southern end of the site.

Approximately 75 feet from the site, on the slope descending westward to the marsh, is a groundwater seep. At least one other smaller groundwater seep is located 150 feet southwest of the site.
Site History

The dumping of industrial wastes is believed to have occurred between 1966 and 1968. An unknown number of tank trucks were emptied at the site in addition to the approximately 5,000 barrels left there. According to Michigan DNR personnel, it is also possible that barrels were opened, their contents dumped on the ground, and the barrels recycled.

The first official notification of the illegal dumping was by the supervisor of Rose Township in a letter to the Oakland County Health Department in June 1968. In October of that year, Mr. [redacted], the waste hauler, was criminally charged for operating an unlicensed landfill. The judge's orders for cleanup of the site were ignored. In 1969 and again in 1971, Mr. [redacted] were taken to court and ordered to clean up the site and discontinue dumping. Though dumping was discontinued, no cleanup was conducted, although many drums were buried in response to the court order.

No further actions were taken until April 1979 when a Pollution Emergency Alerting System complaint was sent to the Michigan DNR by the Oakland County Health Department. The initial site inspection in June 1979 by Michigan DNR personnel revealed many badly rusted and leaking drums. Sampling of the drums showed the contents to be paint sludges, solvents, PCB's, oils and greases. Sampling of residential wells followed in August and continued to June 1980. Analysis of the first monthly samples indicated that various wells had higher than normal levels of lead, trichloroethylene (TCE), perchloroethylene (PCE), or di-ethyl hexyl phthalate (DEHP).

In September 1979, the site, along with a site in Springfield Township, was declared an environmental emergency by the Michigan Toxic Substances Control Commission. Excavation and removal of the drums was begun the same month. In October, a special appropriation was made by the State Legislature for the cleanup of the wastes and investigation of the impact on groundwaters. By July 1980, about 5,000 barrels had been removed.

Phase I hydrogeologic investigations by the Michigan DNR were begun in September, 1980. Eight monitoring wells were drilled onsite or immediately offsite. The Phase I hydrogeologic report was completed in October 1981. Additional investigations were recommended and a Phase II hydrogeologic investigation was begun in May 1982. A draft report was completed in December 1982.

The initial Remedial Action Master Plan (RAMP) site visit was conducted on December 13, 1982, by personnel from CH2M Hill, EPA, and Michigan DNR. A site visit memorandum and detailed chronology of available site history is in Appendices A and B of the RAMP.
Principal Disposal Method: An unknown number of tank trucks possibly containing organics, PCB's were emptied on the site. In addition, approximately 5,000 barrels were left there. It is also possible that barrels were opened, their contents dumped on the ground, and the barrels recycled. By July of 1980, about 5,000 barrels had been removed by the MDNR.

Status: Inactive

Unusual Features: A 24-inch high pressure natural gas line owned by Consumers Power Company crosses the southern end of the site.

Maximum levels of contaminants were generally found in the soil mounds.

Approximately 75 feet from the site, on the slope descending westward to the marsh, is a groundwater seep. At least one other smaller groundwater seep is located 150 feet north. There is a small pond in the woods 200 feet southwest of the site.

Data Limitations:

- Areal extent of surface water contamination is not clearly defined. Sampling to date has not produced a clear understanding of contaminated waters and sediments or migration pathways.

- Areal extent of contaminated soil. Data on soil is limited to the major disposal area and a few surrounding sites. The location of other "hot-spots" or areas contaminated by surface erosion has not been clearly identified. Removal of some of the contaminated soil mounds during the State of Michigan's cleanup activities may invalidate existing data in the area of major contamination.

- The extent of the contaminated groundwater plume has not been fully defined, either horizontally or vertically.

- It is not known if all buried drums have been removed.

The only known air quality measurements were recorded during a site visit on December 13, 1982. Measurements were made with an HNU Photoionization Detector. Measurements of organic vapors two to four times background levels were recorded on the site though no odors could be detected. The air temperature was 25°F and the ground was frozen. Odors at the site have been reported by MDNR personnel, especially during the summer.

- Topographic data is limited to USGS 10-foot contour intervals and elevations at well heads.

- The degree of contamination of stormwater runoff has not been defined.

- Bioaccumulation effects of contaminants on fish and wildlife has not been analyzed.
Study Area Characteristics: The study area is outlined on the study area map. Figure 1.

The Rose Township site is in a sparsely populated rural woodland area. Generally, upland areas, such as the woods next to the main disposal area, are covered by mixed hardwood forest.

III. HAZARD EVALUATION

The most significant threat to public health and safety posed by the Rose Township site is the potential contamination of residential wells by pollutants migrating in the groundwater. The presence of pollutants in the groundwater up to 650 feet offsite in sufficient concentration to be toxic or carcinogenic has been documented. The full areal extent of contaminated groundwater has not been identified.

The contamination of surface water and soil also poses a threat to public health and safety. Contamination of onsite surface water and the marsh 1,300 feet west of the site has been found. Onsite soil has also been found to be contaminated. The pollutants introduce the possibility of bioaccumulation of such substances as PCB. Wildlife commonly hunted and fish caught in surrounding lakes may accumulate contaminants and pass them on to consumers.

People walking on or near the site could also encounter a health threat either directly from contaminated soil or from contaminants in the air. Walking on contaminated soil could cause direct skin contact with the contaminants or ingestion by hand contamination. Though the presence of toxic or carcinogenic substances in the air has not been documented, contaminants from the soil, particularly volatile organics, could enter the air.

The high pressure natural gas pipeline in the highly contaminated area of the site is a potential public safety problem. The pipeline could corrode and rupture because of soil contamination from the many industrial wastes that were disposed of onsite, many of which are still unknown.

IV. ENVIRONMENTAL AND SOCIOECONOMIC FEATURES

Environment

Pollutants from the Rose Township site could significantly affect aquatic and terrestrial life. Aquatic life in the nearby lakes is threatened by contaminants in the groundwater beneath the site and by surface runoff carrying pollutants from the onsite soil. PCB's and cadmium have been found in levels far exceeding those harmful to aquatic life at the swamp 1,300 feet west of the site. PCB's have also been found at levels above aquatic life criteria in Cheese Lake 3,000 feet northwest of the site and a marsh 4,000 feet southwest of the site although some uncertainty exists as to the validity of this result.
Terrestrial life may be adversely affected by drinking contaminated waters, feeding on vegetation or other animals that have become contaminated, or by direct contact with contaminated soil.

No adverse impacts on vegetation have been found except for small areas where "tarry" substances have been found on bushes or where a hardened material covers the ground.

**Socioeconomics**

Several socioeconomic impacts were identified in a Southeast Michigan Council of Governments study. These are:

- Lower property values or marketability of property.
- Costs incurred for such things as laboratory tests on water supplies, attorney's fees, purchase of bottled water, telephone and auto mileage costs, and business liability insurance.
- Psychological stress due to the uncertainty of future contamination. Also the stress associated with the feeling of being unable to sell one's home and move away.

The impacts can be expected to continue until public fears and apprehensions are resolved.

**V. SITE SAFETY WORK PLAN**

**A. Site Management:**

There will be an on-site manager/safety officer present during site activity. This person is responsible for:

1. The implementation, enforcement and monitoring of the Site Safety Plan.

2. The indoctrination of all on-site personnel with regard to this safety plan and other safety requirements to be observed during site operations, including:
   - Potential hazards.
   - Personnel hygiene principles.
   - Personnel protective equipment.
   - Respiratory protection equipment usage and fit testing.
   - Emergency procedures dealing with fire and medical situations.

3. Alerting the U.S. EPA Onscene Coordinator (OSC) for this site prior to the Contractor starting any particularly hazardous work.

4. Maintenance and separation of the contamination, decontamination and support zones and enforcing decontamination procedures.
5. On-site monitoring of hazards during site operations. 
(See Appendix V)

6. Maintenance of a log of (i) personnel site entries and 
exit times, (ii) reason for entry, (iii) digest of activities 
performed by each individual, (iv) problems encountered 
and actions taken, and (v) documentation of any chemical 
exposure symptoms to workers while on or after leaving 
the site.

7. Maintenance of site security by allowing only authorized 
individuals with proper training on site.

B. Perimeter Establishment

1. Map/sketch attached? Yes (See Figure 1 in Appendix 
II).

2. Site Secured? Contaminated soil area is not fenced.

3. Zone of Contamination Identified? Only known areas are 
identified. See Figure 1 in Appendix II.

C. Personnel Protection

1. Level of Protection: See Appendix III.

2. Surveillance Equipment and Materials: There is little 
air quality monitoring information on site. Before site 
entry when dust generation could be a factor, baseline 
air monitoring will be performed using a high volume 
sampler with the filters analyzed for heavy metals. 
An HNU photoionization detector with a 10.2 ev lamp will 
be used to determine if volatile organics are present. 
In addition, a minimum of 4 wind flags will be placed 
in locations visible to all personnel at the site.

3. Medical Surveillance: Personnel engaged in waste site 
work activities will have health monitoring examinations 
at least annually. In addition, all personnel must have 
a physician's written approval to wear respiratory protection 
and protective garments.

4. Personnel Safety/Hygiene: Personnel will not be allowed 
to eat, smoke, or chew tobacco except in clean areas. 
Water will be provided to staff to replace perspiration. 
Water should be in sealed containers and not poured until 
ready to drink. Water will be kept in the support area. 
See Appendix I for symptoms of heat stress, site safety 
equipment, and personnel hygiene practices to be followed.

Contact lenses shall not be worn when working in the 
study area. All personnel shall notify the study area 
manager prior to entry, if he/she is wearing contact 
lenses.
5. Personnel Training: Training will be provided to staff working on this site in use of personnel protective equipment required on the site as defined in EFA's Interim Standard Operating Safety Procedures. In addition, all personnel will be briefed on safety and hygiene procedures, general decontamination procedures, symptoms of chemical exposure, heat stress, site entry and exit, and notification of emergency personnel. Periodic site safety meetings will be held to inform site workers of changes in the safety plan and/or site conditions.

D. Decontamination Procedures

All boots, gloves, and other contaminated garments which have come in contact with potentially contaminated surfaces will be washed at the hot line. All disposable garments will be removed at the decontamination station and bagged or drummed for later disposal. All heavy equipment will be steam cleaned or washed with soap prior to leaving the site. All purged groundwater, contaminated soils, and wash water will be placed in containers for later disposal (see Appendix _).

E. Site Entry Procedures

All personnel must enter the site through the designated entry point and their names entered into the site log. Before engaging in work on the site, all personnel will be briefed on the following:

1. MDNR staff person in charge as site study manager.
2. Boundaries and exit and entry point locations of the study area.
3. Decontamination procedures when required.
4. Chemical contaminants known to be on the site and their signs and symptoms of exposure.
5. Location of first aid equipment and qualified personnel.
6. Procedures to be used in contacting emergency response personnel, including potential evacuation procedures to be pursued in case of emergencies.
7. Location of emergency exit equipment.
8. Location of emergency evaluation meeting point.
9. Contractor staff person in charge.
10. Activities taking place that day.

11. Location of emergency eyewash station.

12. Heat stress symptoms. All personnel will be advised to watch for signs of heat stress in staff working in exclusion zones.

13. Fire station and hospital emergency telephone numbers.

F. Team Members

A list of authorized personnel will be kept on site.

G. Work Limitations

See Personnel Safety/Hygiene. Work will only proceed when a site manager/safety officer is on site.

H. Investigation

Derived Material Disposal: All contaminated disposable clothes will be bagged, labeled and disposed. Decontamination liquid, purged groundwater and soils will be contained and properly disposed.

VI. SITE RESOURCES

A. Water Supply: To be brought to the site.

B. Telephone: Maintained in an on-site trailer.

C. Radio: Mobile radio and contact with local MDNR district office.

VII. EMERGENCY INFORMATION

A. Local Resources

- Fire Department, Holly Fire Dept. Emergency 313-634-4311
  Routine 313-634-8221
- Police Department, Michigan State Police, Emergency 313-634-6700
  Brighton Post Routine 313-227-1051
- Ambulance, Holly Volunteer Ambulance 313-634-8221
- Oakland County Office of Emergency Medical Services and Disaster Center 313-858-5300
- Pontiac General Hospital 313-857-7257
- Poison Control, Children's Hospital, Detroit 313-494-5711 or 1-800-462-6642
B. Michigan DNR Contacts

James S. Linton        Project Manager    517-373-8448
Earle N. Latimer       Site Manager       517-373-4800
Pollution Emergency Alerting System, 24 hours 1-800-292-4706
Cathy Simon            Health Monitoring Personnel 1-517-373-2190

Emergency Notification of Department of Natural Resources, Contact: 1-800-292-4706 or 1-517-373-7660

C. Emergency Routes

From the site to Pontiac General Hospital in Pontiac, take DeMode Road west to Hickory Ridge Road, south (left) to State Route 59, (turn west (M-59) (right), go to first left that crosses median, about one block) then go east on Route 59 to Seminole south (right). Hospital on Left.

D. Emergency Response Protocol

All emergency telephone numbers and emergency route map to the hospital will be posted at the headquarters near the telephone. In the event of physical injury, the site safety officer or any other qualified person will initiate first aid and, if necessary, call the ambulance. If chemical exposure is encountered, the physician will be informed, as specifically as possible, the chemical(s) the person has been exposed to and the toxicological properties of the chemical(s).

This safety plan was developed with the most recent and available information. If through the site investigation additional pertinent information to safety is made available, it will be used to amend this plan. In addition, the site manager may use this information to increase personnel protective measures on the site.
Chemical Fact Sheet

ACETONE

December 1982

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Propanone, dimethylketone, beta-ketopropane; CAS 67-64-1.

Trade Names: None found.

Uses: A solvent for paints, plastics and rubber; general cleaning agent for oils and greases; intermediate in the production of ketones.

PHYSICAL INFORMATION

Appearance: Clear, colorless liquid.

Odor: Pungent.

Minimum Detectable by Odor: 47 ppm.

Behavior in Water: Soluble.

Evaporation: Rapid.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure -- 1,000 ppm.

NIOSH Recommended Limit: Average 8 hour exposure -- 250 ppm.

ACGIH Recommended Limit: Average 8 hour exposure -- 750 ppm.

Short Term Exposure:

Inhalation: Levels of 300 ppm have cause irritation of eyes, nose and throat. Levels of 500 to 1,000 ppm for 6 hours have caused, in addition, general weakness and heaviness of the eyelids. Exposures of 12,000 ppm for a few minutes may cause weakness in arms and legs and fainting. 20,000 ppm may be fatal on brief exposure.

Skin: Liquid acetone may cause drying of the skin, irritation, redness, and an increased chance of

Eyes: Irritation has been reported at 500 ppm after 3-6 hours. Splashes into the eye may result in swelling, irritation, damage to the cornea and blindness.

Ingestion: 20 ml (2/3 fluid ounce) may result in excess salivation, nausea, vomiting, stomach pain and possible liver and kidney damage. 200 ml (7 fluid ounces) has resulted in these symptoms and, additionally, swelling of the throat, sores in the mouth and throat, shallow breathing and coma. Although 200 ml has been survived with prompt medical attention, death may occur from as little as 100 ml (3 1/4 fluid ounces).

Long Term Exposure:

Levels of 500 to 1,000 ppm can produce eye irritation after 3 hours. Daily exposures at this level have resulted in irritation of throat and lungs, dizziness
EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move victim to fresh air. Administer oxygen or artificial respiration as required. Seek medical attention, if necessary.

Skin: Remove soaked clothing. Wash affected area with large amounts of water. Seek medical attention, if required.

Eyes: Wash with large amounts of water immediately. Seek immediate medical attention.

Ingestion: Seek immediate medical attention.

Note to Physician: Blood, urine and expired air analysis have been used as an index of exposure.

FIRE AND EXPLOSION INFORMATION

General: Highly flammable; can form explosive mixtures in air. Will ignite at 0°F (-18°C).

Explosive Limits: Upper - 13%, Lower - 2.1%.

Extinguisher: Carbon dioxide, dry chemical or alcohol foam.

REACTIVITY

Conditions to Avoid: Heat and flame.

Materials to Avoid: Violent and explosive reactions may occur when acetone contacts potassium tert-butoxide, sulfuric acid-dichromate solution, or chloroform in the presence of a strong base (i.e., potassium hydroxide). May react violently with oxidizing agents such as chlorine, permanganate, dichromate or peroxides.

PROTECTIVE MEASURES

Storage and Handling: Store in cool, ventilated area away from fire hazard. Acetone will dissolve plastic items such as eyeglass frames pens and pencils, and some synthetic fabrics such as rayon.

Engineering Controls: Provide adequate ventilation. Sinks, showers and eyewash stations should be available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Wear rubber gloves, apron and goggles that are impervious to acetone if contact with acetone is likely.

Protective Equipment: For levels up to 2,500 ppm, use a gas mask with an organic vapor canister, a Type C supplied-air respirator with a full facepiece, or a self-contained breathing apparatus with a full facepiece. For levels greater than 2,500 ppm, use a self-contained breathing apparatus with a full facepiece in a positive pressure mode or a combination Type C supplied-air respirator with a full facepiece in pressure-demand mode with a positive pressure auxiliary air supply.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of spill area. Put on respirator and other protective clothing. Eliminate sources of flame. Ventilate area to remove fumes and maintain levels below explosive limits. For final disposal, contact your regional office of the New York State Department of Environmental Conservation. For more information: Contact the local Supervisor or Safety Officer at your worksite or the New York State Depart-
Fact Sheet

Information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing, handling and is not designed for the population at large. Any generalization beyond occupational exposure should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals as low as is practical.

Chemical Names: Benzol, phenyl hydride, cyclohexatriene; CAS 71-43-2.

Trade Names: Benzole, Benzelene, Carbon Oil, Carbon Naphtha, Mineral Naphtha, Motor benzol, Nitration benzene, Phene, Pyrobenzol and others.

Uses: In the manufacture of styrene, phenol, detergents, organic chemicals, pesticides, plastics and resins, synthetic rubber, aviation fuel, pharmaceuticals, dyes, explosives, gasoline, flavors and perfumes, paints and coatings. Used in the industrial processing of nylon, certain food products and photographic chemicals.

Physical Information

Appearance: Colorless liquid.

Odor: Strong, pleasant.

Minimum Detectable by Odor: 5 ppm.

Behavior in Water: Slightly soluble, floats.

Evaporation: Rapid.

Health Hazard Information

SHA Standard: Average 8 hour exposure limit — 10 ppm.

SH Recommended Limit: 1 ppm.

CUP Recommended Limit: Average 8 hour exposure limit — 10 ppm.

Short Term Exposure:

Inhalation: Benzene may produce both nerve and blood effects. Irritation of the nose, throat and lungs may occur (3,000 ppm may be tolerated for only 30 to 60 minutes). Lung congestion may occur. Nerve effects may include an exaggerated feeling of well-being, excitement, headache, dizziness and slurred speech. At high levels, slowed breathing and death may result. Death has occurred at 20,000 ppm for 5 to 10 minutes, or 7,500 ppm for 30 minutes.

Skin: Irritation may occur, with redness and blistering if not promptly removed. Benzene is poorly absorbed. Whole body exposure for 30 minutes has been reported with no health effects.

Eyes: May cause severe irritation.

Ingestion: May cause irritation of mouth, throat and stomach. Symptoms are similar to those listed under inhalation. One tablespoon may cause collapse, bronchitis, pneumonia and death.

Long Term Exposure:

May cause loss of appetite, nausea, weight loss, fatigue, muscle weakness, headache, dizziness, nervousness and irritability. Mild anemia has been reported from exposures of 25 ppm for 7 years and 100 ppm for 3 months. At levels between 100 and 200 ppm for periods of 6 months, or more, severe irreversible blood changes and damage to the liver and heart may occur.

Benzene is a known human carcinogen. Exposure has been linked to increased risk of several forms of leukemia. Periodic blood tests of occupationally exposed individuals should be conducted.

EMERGENCY AND FIRST AID INSTRUCTIONS

**Inhalation:** Remove to fresh air. Give artificial respiration or oxygen if necessary. Seek medical attention.

**Skin:** Remove soiled clothing immediately. Wash thoroughly with soap and water for at least 5 minutes. Seek medical attention, if necessary.

**Eyes:** Irrigate eyes with water for at least 15 minutes. Seek medical attention.

**Ingestion:** Do not try to induce vomiting. Seek medical attention immediately.

**Note to Physician:** Severe exposure may require supportive measures for pulmonary edema.

FIRE AND EXPLOSION INFORMATION

**General:** Flammable vapor may spread considerable distance to a source of ignition and flash back. Ignites at 119°C (220°F).

**Explosive Limits:** Upper 7.1%, Lower 1.3%

**Extinguisher:** Carbon dioxide, dry chemical or foam.

REACTIVITY

**Materials to Avoid:** Contact with strong oxidizers, or iron in the presence of chlorine or bromine.

**Conditions to Avoid:** Exposure to sources of ignition.

PROTECTIVE MEASURES

**Storage and Handling:** Protect containers against physical damage. Storage preferred in an outdoor or detached building. If storage is indoor, use a standard flammable liquid storage room.

**Engineering Controls:** Use only with efficient ventilation.

**Protective Clothing:** (Should not be substituted for proper handling and engineering controls). Self-direct contact is likely; wear protective rubber clothing, gloves and eye goggles.

**Protective Equipment:** For levels up to 10 ppm, wear either a supplied-air respirator or self-contained breathing apparatus. For levels up to 50 ppm, wear the above with full facepiece. For levels up to 1,000 ppm, wear a Type-C supplied-air respirator operated pressure demand, positive pressure, or continuous flow mode. For levels up to 2,000 ppm, wear equipment for 1,000 ppm with full facepiece. For escape from a contaminated area wear a gas mask with cartridge suitable for benzene or self-contained breathing apparatus.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of spill area. Put on protective clothing and equipment when entering spill area for clean-up. Spread absorbent material on spill, sweep up and keep contained in fiber carton tightly sealed. For final disposal, contact your regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substances Management, Empire State Plaza, Tower Building, Room 359, Albany, New York 12237.
Fact Sheet

Cadmium Compounds

Information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing, handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Common Names: Cadmium, CAS 7440-43-9; cadmium oxide, CAS 1306-19-4; cadmium sulfide, CAS 1306-23-6; Cadmium Chloride, CAS 10108-64-2.

Use: Electroplating, bearing and low melting alloys; electrical equipment, brazing alloys, fire-protection systems, solar and storage batteries, TV phosphors, basis of pigments, rubber and plastic products, Weston standard cell, control of atomic fission in nuclear reactors, fungicides, photography and lithography, insecticides, hematocides and semiconductors.

Physical Information

Appearance: Silver-white, blue-tinged lustrous metal, easily cut with a knife; available in the form of bars, sheets or wire or a gray, granular powder. Other compounds will have different appearances.

odor: None.

Stability in Water: Insoluble.

Health Hazard Information

NHA Standard: Average 8 hour exposure -- 0.20 mg/m^3 (dust); 0.10 mg/m^3 (fumes).

OSHA Recommended Limit: Average 10 hour day or 40 hour work week -- 0.4 mg/m^3 (dust and fumes).

ACGIH Recommended Limit: Average 8 hour exposure -- 0.05 mg/m^3 (dust, salts and fumes).

Inhalation: Dust may cause irritation of the nose and throat. Non-fatal lung inflammation has been reported from concentrations of 0.5 to 2.5 mg/m^3 in 4 to 10 hours after exposure. Severe chest pain, with persistent cough and difficult breathing, headache, chills, muscle aches, nausea, vomiting, diarrhea. Fluid in the lungs and dark-purple coloration of the skin may occur. Breathing becomes more difficult and is accompanied by wheezing or coughing of blood. Other symptoms which may occur 12 to 36 hours after exposure in addition to those above include dizziness, irritability, gastrointestinal disturbances, shortness of breath, fever, profuse sweating, exhaustion and inflammation of the lungs. Death may result within 7 to 10 days after exposure. The average concentrations of fume responsible for fatalities have been 40 to 50 mg/m^3 for 1 hour, or 5 mg/m^3 for 5 hours.

Skin: Absorption is negligible.

Eyes: Cadmium compound dust may cause irritation. No injury to the eyes of human beings has been reported.

Ingestion: A dose of 15-30 mg (1/1000 oz) of metal or soluble compounds may cause increased salivation, choking, vomiting, abdominal pain, anemia, kidney malfunction, diarrhea, and persistent desire to empty the bladder. Symptoms may occur within 15-30 minutes after ingestion.

Long Term Exposure:

Continued exposure to low levels of cadmium in air may cause irreversible lung injury, abnormal lung function and kidney disease. Other consequences of cadmium exposure are inflammation of the nose and throat, open sores in the nose, soreness, bleeding and reduced nose size; loss of sense of smell, damage to the olfactory nerve, yellow cadmium stains on teeth, sleeplessness, nausea, lack of appetite, weight loss, anemia, lung distension with scar formation, and liver damage. Inhalation of 0.05 mg/m^3 - 0.08 mg/m^3 for 4 to 8 years may cause throat irritation, cough, chest pain, upset stomach and fatigue. Exposure to levels of 3.0 - 15.0 mg/m^3 of fume or dust over a period of 20 years has caused lung distension, anemia, protein in urine and kidney dysfunction.

Studies indicate that there is an increased incidence of prostatic cancer and possible kidney and respiratory cancer in cadmium workers. Cadmium causes birth defects in rats, mice and hamsters; whether it does so in humans is not known.

Prepared by the Bureau of Toxic Substances Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see "Toxic Substances: How Toxic is Toxic" available from the New York State Department of Health.
EMERGENCY AND FIRST AID INSTRUCTIONS

**Inhalation**: Move the victim to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the person warm and quiet. Get medical attention immediately.

**Skin**: Wash contaminated area using soap and mild detergent and water for at least 5 minutes. Seek medical attention, if necessary.

**Eyes**: Wash immediately with large amounts of water, lifting the lower and upper lids occasionally for at least 15 minutes. If irritation continues after washing, seek medical attention.

**Ingestion**: If the person is conscious, give large amounts of water immediately. Seek immediate medical attention.

**Note to Physician**: Urine should be examined for low molecular weight proteins. Fumes may cause pulmonary edema which may not become evident until 8-24 hours after exposure. Periodic surveillance is indicated. A chelating agent such as calcium edetate may be effective treatment for ingestion.

**FIRE AND EXPLOSION INFORMATION**

**General**: Dust or powder is flammable, toxic gases and vapors (such as cadmium oxide fumes) may be released in a fire involving cadmium dust.

**Extinguisher**: Dry powder for metal fires.

**REACTION**

**Materials to Avoid**: Reacts with strong oxidizers, elemental sulfur, selenium, tellurium, zinc, hydrazoic acid, and ammonium nitrate.

**Conditions to Avoid**: Heat or flame may cause fire or explosion.

**PROTECTIVE MEASURES**

**Storage and Handling**: Store and keep in closed containers at all times. Protect containers against physical damage.

**Engineering Controls**: Process Local exhaust systems or enclosures, fume hoods, showers and eye wash stations should be provided within the immediate work area.

**Protective Clothing** (Should not be substituted for proper handling and engineering controls): Dust-resistant, safety goggles should be worn if contact with cadmium compounds is likely. Protective coveralls and rubber gloves should also be worn.

**Protective Equipment**: For levels up to 1 mg/m³, use a dust respirator, a high efficiency particulate respirator, a supplied-air respirator or a self-contained breathing apparatus. For up to 5 mg/m³ use the above (except a fume respirator) with a full facepiece. For up to 40 mg/m³ use a powered air-purifying respirator with a high efficiency particulate filter or a Type C supplied-air respirator operated in a positive pressure mode. For levels above 40 mg/m³ or for entry and escape in areas of unknown concentration use a self-contained breathing apparatus or a combination Type C supplied-air respirator with an auxiliary self-contained breathing apparatus, all with a full facepiece and operated in a positive pressure mode. For escape from a contaminated area use a high efficiency particulate filter respirator with a full facepiece or a self-contained breathing apparatus.

**Miscellaneous**: Be sure to wash hands well before eating or smoking and at the close of work. Contact lenses should not be worn when working with this chemical.

**PROCEDURES FOR SPILLS AND LEAKS**

Warn other workers of spill. Put on protective equipment and clothing. Remove all sources of ignition, ventilate the area. Collect released material in sealed containers. For final disposal contact your local office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
Occupational Health Guideline for Chlorobenzene

INTRODUCTION

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

SUBSTANCE IDENTIFICATION

• Formula: C₆H₅Cl
• Synonyms: Monochlorobenzene; chlorobenzol; phenyl chloride; MCB
• Appearance and odor: Colorless liquid with a mild aromatic odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for chlorobenzene is 75 parts of chlorobenzene per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 350 milligrams of chlorobenzene per cubic meter of air (mg/m³).

HEALTH HAZARD INFORMATION

• Routes of exposure
Chlorobenzene can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.
• Effects of overexposure
1. Short-term Exposure: Chlorobenzene may cause drowsiness, incoordination, and unconsciousness. It may also cause irritation of the eyes, nose, and skin. Exposure to high levels might also cause liver damage.  
2. Long-term Exposure: Prolonged or repeated skin contact with chlorobenzene liquid may cause skin burns. Prolonged or repeated exposure to this chemical might also result in liver, kidney, or lung damage. 
3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to chlorobenzene.
• Recommended medical surveillance
The following medical procedures should be made available to each employee who is exposed to chlorobenzene at potentially hazardous levels:
1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from chlorobenzene exposure.
   - Skin disease: Chlorobenzene can cause dermatitis on exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.
   - Liver disease: Chlorobenzene is known as a liver toxin in animals. The importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.
   - Kidney disease: Although chlorobenzene is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.
   - Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of chlorobenzene might cause exacerbation of symptoms due to its irritating properties.
2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.
• Summary of toxicology
Chlorobenzene vapor is a narcotic. Cats exposed to 8,000 ppm showed severe narcosis after ½ hour and died 2 hours after removal from exposure, but 660 ppm for 1 hour was tolerated. Exposed animals showed eye and nose irritation, drowsiness, incoordination, and coma followed by death from the most severe exposures. Several species of animals exposed to 1,000 ppm for 7 hours/day, 5 days/week over a period of 44 days showed histopathologic changes in the lungs, liver, and

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration
kidneys, but at 475 ppm there was only slight liver histopathology in guinea pigs. Toxicologic studies and experience indicate that chlorobenzene does not cause type of blood changes seen with benzene exposure. In man, eye and nasal irritation begin to occur at 200 ppm, and at that level the odor is pronounced and unpleasant; industrial experience indicates that occasional short exposures are not likely to result in more than minor skin irritation, but prolonged or frequently repeated contact may result in skin burns. In one case of accidental poisoning from ingestion of the liquid by a child there was pallor, cyanosis, and coma, followed by complete recovery. Occupational intoxication has not been reported.

CHEMICAL AND PHYSICAL PROPERTIES

- Physical data
  1. Molecular weight: 112.3
  2. Boiling point (760 mm Hg): 132 C (270 F)
  3. Specific gravity (water = 1): 1.1
  4. Vapor density (air = 1 at boiling point of chlorobenzene): 3.9
  5. Melting point: -44 C (-47 F)
  6. Vapor pressure at 20 C (68 F): 8.8 mm Hg
  7. Solubility in water, g/100 g water at 20 C (68 F): 0.05
  8. Evaporation rate (butyl acetate = 1): 1

- Reactivity
  - Conditions contributing to instability: Heat
  - Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
  - Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released in a fire involving chlorobenzene.
  - Special precautions: Liquid chlorobenzene will attack some forms of plastics, rubber, and coatings.

- Flammability
  1. Flash point: 28.9 C (84 F) (closed cup)
  2. Autoignition temperature: 638 C (1 180 F)
  3. Flammable limits in air, % by volume: Lower: 1.3; Upper: 7.1

- Extinguishant: Carbon dioxide; dry chemical, foam

- Warning properties

According to both Deichmann and Gerarde and the AIHA Hygienic Guide, the odor of chlorobenzene is "barely perceptible" at 60 ppm, a concentration below that of the permissible exposure. Chlorobenzene is considered to have good warning properties. It is an eye irritant, as stated by Patty, but the exact concentrations at which this irritation occurs are not mentioned.

MONITORING AND MEASUREMENT PROCEDURES

- General

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- Method

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure chlorobenzene may be used. An analytical method for chlorobenzene is in the NIOSH Manual of Analytical Methods. 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid chlorobenzene.

- Clothing wet with liquid chlorobenzene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of chlorobenzene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the chlorobenzene, the person performing the operation should be informed of chlorobenzene's hazardous properties.

- Any clothing which becomes wet with liquid chlorobenzene should be removed immediately and not
reworn until the chlorobenzene is removed from the clothing.  
• Employees should be provided with and required to use splash-proof safety goggles where liquid chlorobenzene may contact the eyes.

SANITATION

• Skin that becomes wet with liquid chlorobenzene should be promptly washed or showered with soap or mild detergent and water to remove any chlorobenzene.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to chlorobenzene may occur and control methods which may be effective in each case:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use in manufacture of phenol in synthesis of polymeric materials</td>
<td>Local exhaust ventilation</td>
</tr>
<tr>
<td>Use as an intermediate in manufacture of ortho- and para-nitrobenzenes for use in dye manufacture; manufacture of DDT, aniline, picric acid, beta-chloroanthraquinone, and other chemicals; manufacture of rubber adhesives and adhesives</td>
<td>Process enclosure</td>
</tr>
<tr>
<td>Use as fiber swelling agent and dye carrier in textile processing</td>
<td>Local exhaust ventilation</td>
</tr>
<tr>
<td>Use as tar and grease remover in cleaning and degreasing operations</td>
<td>Local exhaust ventilation</td>
</tr>
<tr>
<td>Use as solvent in surface coatings and surface coating removers</td>
<td>Process enclosure; local exhaust ventilation; personal protective equipment</td>
</tr>
<tr>
<td>Use as extractant in manufacture of disocyanates, rubber, perfumes, and pharmaceuticals</td>
<td>Local exhaust ventilation</td>
</tr>
</tbody>
</table>

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure
If chlorobenzene gets into the eyes, wash eyes immediately with large amounts of water, lifting the upper and lower lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure
If chlorobenzene gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If chlorobenzene soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing
If a person breathes in large amounts of chlorobenzene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing
If chlorobenzene has been swallowed, do not induce vomiting. Get medical attention immediately.

• Rescue
Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility’s emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If chlorobenzene is spilled or leaked, the following steps should be taken:
  1. Remove all ignition sources.
  2. Ventilate area of spill or leak.
  3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Chlorobenzene should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of chlorobenzene vapors are permitted.

• Waste disposal method:
Chlorobenzene may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
REFERENCES


**RESPIRATORY PROTECTION FOR CHLOROBENZENE**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum Respiratory Protection* Required Above 75 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vapor Concentration</strong></td>
<td></td>
</tr>
<tr>
<td>&quot;00 ppm or less</td>
<td>A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).</td>
</tr>
<tr>
<td>2400 ppm or less</td>
<td>A gas mask with a chin-style or a front- or back-mounted organic vapor canister.</td>
</tr>
<tr>
<td></td>
<td>Any supplied-air respirator with a full facepiece, helmet, or hood.</td>
</tr>
<tr>
<td></td>
<td>Any self-contained breathing apparatus with a full facepiece.</td>
</tr>
<tr>
<td>Greater than 2400 ppm or entry and escape from unknown concentrations</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td></td>
<td>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Fire Fighting</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Escape</td>
<td>Any gas mask providing protection against organic vapors.</td>
</tr>
<tr>
<td></td>
<td>Any escape self-contained breathing apparatus.</td>
</tr>
</tbody>
</table>

*Only NIOSH-approved or MSHA-approved equipment should be used.*
Chloroform

December 1982

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Trichloromethane, methyl trichloride, trichloroform, trichloroform methane; CAS 67-66-3.

Trade Names: Freon 20, R20 and others.

Uses: Refrigerant, solvent, extracting agent for penicillin and pharmaceuticals, in the manufacture of plastics and synthetic fibers, anesthetic.

PHYSICAL INFORMATION

Appearance: Clear, colorless liquid.


Behavior in Water: Only very slightly soluble; sinks.

Evaporation: Rapid, fumes generally heavier than air.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure -- 50 ppm.

NIOSH Recommended Limit: Average 8 hour exposure -- 10 ppm.

ACGIH Recommended Limit: Average 8 hour exposure -- 25 ppm.

Short Term Exposure:

Inhalation: Symptoms are generally not observed at exposures below 90 ppm for 7 minutes. Effects may include headaches, pounding heart, dizziness, slowed reactions, unconsciousness, coma and death. Delayed effects of exposure which may not occur for up to 24 hours can include cramps, muscle tremors, jaundice, profuse sweating, liver damage, coma and death.

Skin: Can cause reddening of the skin, followed by blistering and chemical burns on prolonged contact.

Eyes: Vapors may cause stinging sensation. Splashes may cause pain, burning, redness and damage to tissues.

Ingestion: May cause nausea, vomiting and other symptoms as listed under inhalation. For an adult, death may result from 30 ml. (1 liquid ounce).

Long Term Exposure:

The following symptoms have been observed in people exposed to levels up to 200 ppm over periods of weeks, months or years: depression, hallucination, sluggishness, loss of appetite, fatigue and liver and kidney damage.
Chloroform is a cancer suspect agent because high levels cause kidney and liver cancer in rats and mice.

**EMERGENCY AND FIRST AID INSTRUCTIONS**

**Inhalation:** Move victim to fresh air. Give artificial respiration or oxygen as required. Seek medical attention.

**Skin:** Remove soaked clothing. Wash affected areas with soap and water for at least 5 minutes. Seek medical attention if necessary.

**Eyes:** Wash eyes with large amounts of water for at least 15 minutes. Seek medical attention.

**Ingestion:** Seek medical attention immediately.

**Note to Physician:** Expired air and blood levels may be useful in estimating levels of acute exposure.

**FIRE AND EXPLOSION INFORMATION**

**General:** Chloroform is non-flammable and non-explosive.

**REACTIVITY**

**Conditions to Avoid:** Sunlight will decompose chloroform to highly toxic fumes.

**Materials to Avoid:** Strong alkalies like lye and potassium hydroxide decompose chloroform to chloride salts and formates.

**PROTECTIVE MEASURES**

**Storage and Handling:** Store in dark bottles or cans in a cool place. Do not wear jewelry or contact lenses when using chloroform.

**Engineering Controls:** Provide adequate ventilation, eye wash stations and showers.

**Protective Clothing (Should not be substituted for proper handling and engineering controls):** Impervious gloves, splash proof goggles and apron should be worn if contact is likely.

**Protective Equipment:** For levels up to 500 ppm, use a supplied-air respirator or self-contained breathing apparatus. For levels up to 1,000 ppm use a supplied-air respirator with full facepiece or self-contained breathing apparatus with full facepiece.

**PROCEDURES FOR SPILLS AND LEAKS**

Get all workers out of spill area. Use respirator and protective clothing when spreading absorbent material on spill. Shovel into buckets and take to safe place in open air. Allow to evaporate. Wash spill area with soap and water. For final disposal, contact your regional office of the New York State Department of Environmental Conservation.

**More Information:**
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: CAS 7440-47-3.

Trade Names: Chrome.

Uses: In the manufacture of chrome-steel and chrome-nickel-steel alloys and for chrome plating of other metals.

PHYSICAL INFORMATION

Appearance: Steel-gray metal or silver metal powder.

Odor: None.

Behavior in Water: Insoluble.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure — 1 mg/m³.

NIOSH Recommended Limit: None established.

ACGIH Recommended Limit: Average 8 hour exposure — 0.5 mg/m³.

Short Term Exposure:

- Inhalation: Dust may cause irritation of the nose and throat.
- Skin: Dust may cause irritation.
- Eyes: Dust may cause irritation.
- Ingestion: Dust may cause irritation of the mouth and throat.

Long Term Exposure:

- No effects reported.
EMERGENCY AND FIRST AID INSTRUCTIONS

Chromium(metal)

Inhalation: Move victim to fresh air. Give artificial respiration or oxygen as required. Seek medical attention, if necessary.

Skin: Wash affected area with soap and water. Seek medical attention, if necessary.

Eyes: Wash with water for at least 15 minutes. Seek medical attention, if necessary.

Ingestion: Seek medical attention, if necessary.

FIRE AND EXPLOSION INFORMATION

General: Dust may be flammable.

REACTIVITY

Materials to Avoid: Reacts with alkalies, alkali carbonates, dilute sulfuric and dilute hydrochloric acid.

PROTECTIVE MEASURES

Storage and Handling: Store in a sealed container away from materials listed above.

Engineering Controls: Provide adequate ventilation to prevent high concentrations of dust. Sinks, showers and eyewash stations should be readily available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Wear eye protection.

Protective Equipment: For levels up to 5 mg/m³ use a dust and mist respirator. For up to 10 mg/m³ use the above (except single-use or quarter-mask types), a fume respirator, a high efficiency particulate respirator, a supplied-air respirator, or a self-contained breathing apparatus. For up to 50 mg/m³ use a high efficiency particulate filter respirator, a supplied-air respirator or a self-contained breathing apparatus, all with a full facepiece. For up to 500 mg/m³ use a powered air-purifying respirator with a high efficiency particulate filter or a Type C supplied-air respirator operated in a positive pressure mode. For levels greater than 500 mg/m³ or entry and escape in areas of unknown concentration use a self-contained breathing apparatus or a combination Type C supplied-air respirator with an auxiliary self-contained breathing apparatus, all with a full facepiece and operated in a positive pressure mode.

PROCEDURES FOR SPILLS AND LEAKS

Warn other workers of the spill. Put on proper protective clothing and equipment. Clean up using wet methods or by vacuuming. Place in suitable containers. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:

Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
Chemical Fact Sheet*  COPPER  July 1982

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Metallic copper, copper (0); CAS 7440-50-8.

Trade Names: Allbri Natural Copper, CDA, C.I.Pigment Metal 2, Raney Copper, Arwood Copper, and others.

Uses: In the manufacture of copper alloys such as brass and bronze; as an electrical conductor; in the production of copper salts; and many others.

PHYSICAL INFORMATION

Appearance: Reddish, lustrous metal that becomes dull on exposure to air.

Odor: None.

Behavior in Water: Insoluble, sinks.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure — 1 mg/m$^3$ (dusts and mists).

Average 8 hour exposure — 0.1 mg/m$^3$ (fumes).

NIOSH Recommended Limit: None established.

^G^H Recommended Limit: Average 8 hour exposure — 1 mg/m$^3$ (dust and mists).

Average 8 hour exposure — 0.2 mg/m$^3$ (fumes).

Short Term Exposure:

Inhalation: Copper or copper oxide fumes may cause metal fume fever which includes chills, fever, aching muscles, dry mouth and throat, headache, nausea, vomiting, diarrhea and stomach pain. Onset may be delayed several hours.

Skin: May cause irritation. Metal solutions can cause swelling and itching.

Eyes: May cause irritation. See long term exposure.

Ingestion: May cause stomach pain, nausea, vomiting and diarrhea. These symptoms reported from ingestion of 10 mg of copper by an adult and 8.5 mg by a child.

Long Term Exposure:

No long term effects from inhalation or ingestion reported. Copper fragments in the cornea may cause cataracts, discoloration (Kaper - Fleischer rings), and loss of the eye. Note: Individuals with Wilson's Disease may wish to limit occupational exposure to copper.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Dept. of Health.

For an explanation of the terms and abbreviations used, see "Toxic Substances: How Toxic..."
EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move victim to fresh air. Give oxygen or artificial respiration as necessary. Seek medical attention, if necessary.

Skin: Remove chemically soiled clothing. Wash with large amounts of water for at least 5 minutes. Seek medical attention if symptoms persist.

Eyes: Wash with large amounts of water for at least 15 minutes. See an ophthalmologist (eye doctor) if symptoms persist.

Ingestion: Seek medical attention.

Note to Physician: Penicillamine or triethylene tetramine dihydrochloride may be beneficial in reducing body burden.

FIRE AND EXPLOSION INFORMATION

General: Fine copper powder is a moderate fire hazard.

Extinguisher: Powdered dolomite, sodium chloride (common salt) or graphite. Do NOT use water.

REACTIVITY

Materials to Avoid: Reacts violently with acetylene, ammonium nitrate, bromates, chlorates, iodates, chlorine, chlorine trifluoride, ethylene oxide, fluorine, hydrogen peroxide, hydrazine mononitrate, hydrogen sulfide, hydrazoic acid, lead azide, potassium peroxide, sodium azide, and sodium peroxide.

Conditions to Avoid: High temperatures of smelting, welding, or fire may cause production of copper fumes.

PROTECTIVE MEASURES

Storage and Handling: Avoid conditions which create fumes or fine dusts.

Engineering Controls: Ventilate as needed. Sinks, showers, and eyewash stations should be readily available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Dust and splash-proof safety goggles.

Protective Equipment: If fumes are present: For levels up to 1 mg/m^3 use a high efficiency particulate respirator, a fume filter respirator, a supplied-air respirator or a self-contained breathing apparatus. For levels up to 5 mg/m^3 use the above, except fume filter respirator, with full facepiece. For levels up to 100 mg/m^3 use a powered air-purifying respirator with high efficiency filter or a Type C supplied-air respirator operated in a positive pressure mode. For levels up to 200 mg/m^3 use a Type C supplied-air respirator with full facepiece helmet or hood operated in a positive pressure mode. If fumes are NOT present then for levels up to 50 mg/m^3 use a high efficiency particulate respirator with full facepiece, a supplied-air respirator with full facepiece or self-contained breathing apparatus with full facepiece. For levels up to 2000 mg/m^3 use a supplied-air respirator with full facepiece operated in a positive pressure mode.

PROCEDURES FOR LEAKS AND SPILLS

Warn other workers of spill. Put on proper protective equipment and clothing. Sweep or vacuum up solids being careful not to raise dust levels. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
Occupational Health Guideline for Cyanide

INTRODUCTION

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

APPLICABILITY

The general guidelines contained in this document apply to all cyanides. Physical and chemical properties of two specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Potassium cyanide
- Formula: KCN
- Synonyms: None
- Appearance and odor: White solid with a faint almond odor.

Sodium cyanide
- Formula: NaCN
- Synonyms: None
- Appearance and odor: White solid with a faint almond odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for cyanide is 5 milligrams of cyanide per cubic meter of air (mg/m³) averaged over an eight-hour work shift. NIOSH has recommended that the permissible exposure limit be changed to a ceiling of 5 milligrams cyanide per cubic meter of air averaged over a 10-minute period. The NIOSH Criteria Document for Hydrogen Cyanide and Cyanide Salts should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- Routes of exposure
  Cyanide can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. Sufficient cyanide may be absorbed through the skin, especially if there are cuts to cause fatal poisoning.

- Effects of overexposure
  1. Short-term Exposure: Inhalation or ingestion of cyanide salts may be rapidly fatal. Larger doses by inhalation or swallowing may cause the person to rapidly lose consciousness, stop breathing, and die. In some cases, there are convulsions. At lower levels of exposure, the earlier symptoms include weakness, headache, confusion, nausea, and vomiting. These symptoms may be followed by unconsciousness and death. Occasionally, convulsions occur. Milder forms of intoxication may result only in weakness, dizziness, headache, and nausea. The dust of cyanide salts is irritating to the eyes. In the presence of tears, it may cause the symptoms of poisoning described above. The dust of cyanide salts may produce irritation of the nose and skin. Strong solutions of cyanide salts are corrosive and may produce ulcers.
  2. Long-term Exposure: Effects from chronic exposure to cyanide are non-specific and rare.
  3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to cyanide.

- Recommended medical surveillance
  The following medical procedures should be made available to each employee who is exposed to cyanide at potentially hazardous levels:
  1. Initial Medical Examination:
     - A complete history and physical examination with the purpose is to detect pre-existing conditions that may place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of fainting spells, such as occur in various types of cardiovascular and nervous disorders,

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.
and those unusually susceptible to effects of anoxia or
with anemia would be expected to be at increased risk
at exposure. Examination of the cardiovascular, ner-
vous, and upper respiratory systems, and thyroid should
be stressed. The skin should be examined for evidence of
chronic disorders.

—Skin disease: Cyanide is a defatting agent and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—14” x 17” chest roentgenogram: Cyanide causes human lung damage. Surveillance of the lungs is indicated.
—FVC and FEV (1 sec): Cyanide is a respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveil-
ance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

3. First Aid Kits: First aid kits should be readily available in workplaces where there is a potential for the release of cyanide. These kits should contain a minimum of 48 ampules, each of 0.3 ml amyl nitrate, and complete instructions for use. In addition, 2 physician’s kits should be immediately available to trained medical personnel. These kits should contain the above quantity of amyl nitrate as well as sterile sodium nitrite solution (3%) and sterile sodium thiosulfate solution (25%). All of the above drugs should be replaced at least biannual-
ly to ensure their potency.

—Summary of Toxicology
The dust of cyanide salts, a source of cyanide ion, is an asphyxiant due to an inhibitory action on metabolic enzyme systems and can be rapidly fatal. Cyanide exerts the effect because it inactivates certain enzymes by forming very stable complexes with the metal in them. Cytochrome oxidase is probably the most important of these, since it occupies a fundamental position in the respiratory process and is involved in the ultimate electron transfer to molecular oxygen. Since cytochrome oxidase is present in practically all cells that function under aerobic conditions, and since the cyanide ion diffuses easily to all parts of the body, it is capable of suddenly bringing to a halt practically all cellular respiration. In the presence of even weak acids, hydrocyanic acid (HCN) gas is liberated from cyanide salts; if few inhalations of higher concentrations of HCN may be followed by almost instantaneous collapse and cessation of respiration; 270 ppm HCN is immediately fatal to humans, 181 ppm is fatal after 10 minutes, 135 ppm after 30 minutes, and 110 ppm may be fatal in 1 hour. The ingestion by humans of 50 to 100 mg of sodium or potassium cyanide may also be fatal. At lower levels of exposure to HCN, the earliest symptoms of intoxication may include weakness, headache, confusion, and occasionally nausea and vomiting; respiratory rate and depth is usually increased initially and at later stages becomes slow and gasping; if cyanosis is present, it usually indicates that respiration has either ceased or has been very inadequate for a few minutes. Humans tolerate 45 to 54 ppm for ½ to 1 hour without immediate or delayed effects, while 18 to 36 ppm may result in some symptoms after an exposure of several hours. Sodium cyanide dust is irritating to the eyes; in the presence of tears it may liberate HCN, which can be absorbed and cause systemic intoxication. Skin contact with dust may be irritating; strong solutions on the skin produce ulcers which are slow in healing. Cyanide is one of the few toxic materials for which an antidote exists; it functions as follows: First, amyl nitrite (inha-
ation) and sodium nitrite (intravenously) are adminis-
tered to form methemoglobin, which binds firmly with free cyanide ions. This traps any circulating cyanide ions. The formation of 10 to 20% methemoglobin usually does not involve appreciable risk, yet provides a large amount of cyanide-binding substance. Second, sodium thiosulfate is administered intravenously to increase the rate of conversion of cyanide to the less toxic thiocyanate: Methylene blue should not be adminis-
tered, because it is a poor methemoglobin former and, moreover, promotes the conversion of methemoglobin back to hemoglobin.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data—Potassium cyanide
  1. Molecular weight: 65.1
  2. Boiling point (760 mm Hg): Data not available
  3. Specific gravity (water = 1): 1.55
  4. Vapor density (air = 1 at boiling point of potas-
sium cyanide): Not applicable
  5. Melting point: 635 C (1175 F)
  6. Vapor pressure at 20 C (68 F): Essentially zero
  7. Solubility in water, g/100 g water at 20 C (68 F): 71.6
  8. Evaporation rate (butyl acetate = 1): Not applicable

• Physical data—Sodium cyanide
  1. Molecular weight: 49
  2. Boiling point (760 mm Hg): 1500 C (2732 F)
cretapolated)
  3. Specific gravity (water = 1): 1.6
  4. Vapor density (air = 1 at boiling point of sodium
cyanide): Not applicable
  5. Melting point: 560 C (1040 F)
  6. Vapor pressure at 20 C (68 F): Essentially zero
  7. Solubility in water, g/100 g water at 20 C (68 F): 58
  8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity
  1. Conditions contributing to instability: None. Haz-
ardous if kept in closed containers. It may form toxic
centractions of hydrogen cyanide gas when in pro-
longed contact with air in a closed area.
  2. Incompatibilities: Contact with strong oxidizers
such as nitrates and chlorates may cause fires and
explosions. Contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas.

3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen cyanide and carbon monoxide) may be released when cyanide decomposes.

4. Special precautions: Cyanide may react with carbon dioxide in ordinary air to form toxic hydrogen cyanide gas.

- Flammability
- Not combustible

- Warning properties
- Odor Threshold: No quantitative information is available concerning the odor threshold of sodium or potassium cyanide. HCN, however, is evolved from these substances in the presence of moisture. The Manufacturing Chemists Association states that "although HCN has a characteristic odor, its toxic action at hazardous concentrations is so rapid that it is of no value as a warning property."

2. Eye Irritation Level: Cyanide (as CN) is not known to be an eye irritant. However, according to Grant, HCN can produce eye irritation after chronic exposures.

3. Evaluation of Warning Properties: Although cyanide (as CN) has a negligible vapor pressure, in the presence of moisture HCN can be given off. HCN does not have adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- Eight-Hour Exposure Evaluation
Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- Ceiling Evaluation
Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of cyanide. Each measurement should consist of a ten (10) minute sample or series of consecutive samples totalling ten (10) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- Method
Sampling and analyses may be performed by collection of cyanide with a cellulose membrane filter and an impinger containing sodium hydroxide, followed by analysis by direct potentiometry. An analytical method for cyanide is given in the "NIOSH Manual of Analytical Methods."
Where there is any possibility that employees' eyes may be exposed to cyanide or liquids containing cyanide, an eye-wash fountain should be provided within immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with cyanide should be immediately washed or showered with soap or mild detergent and water to remove any cyanide.
- Workers subject to skin contact with cyanide should wash with soap or mild detergent and water any areas of the body which may have contacted cyanide at the end of each work day.
- Eating and smoking should not be permitted in areas where cyanide or liquids containing cyanide are handled, processed, or stored.
- Employees who handle cyanide or liquids containing cyanide should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to cyanide may occur and control methods which may be effective in each case:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use as fumigants and pesticides in greenhouses, ships, mills, and warehouses; use of cyanogen chloride as a warning agent in fumigant gases</td>
<td>Local exhaust ventilation; general dilution ventilation; personal protective equipment</td>
</tr>
<tr>
<td>Use in metal treatment in nitriding, tempering, and case hardening steel; coloring of metals by chemical or electrolytic process; cleaning and coating metals; welding and cutting of heat-resistant metals; liberation during ore extraction and metal purification</td>
<td>Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment</td>
</tr>
</tbody>
</table>

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- Eye Exposure
  If cyanide gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with cyanides.

- Skin Exposure
  If cyanide gets on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If cyanide penetrates through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.

- Breathing
  If a person breathes in large amounts of cyanide, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- Swallowing
  When cyanide has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
Rescue
Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES
- Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.
- If cyanide is spilled, the following steps should be taken:
  - Ventilate area of spill.
  - Collect spilled material in the most convenient and safe manner for reclamation, or for treatment in a cyanide disposal system.
- Waste disposal method:
  After treatment as in above, cyanide may be disposed of in a secured sanitary landfill.

REFERENCES
- American Conference of Governmental Industrial Hygienists: "Cyanide (as CN)," Documentation of the Threshold Limit Values for Substances in Workroom Air (3rd ed., 2nd printing), Cincinnati, 1974.
# Respiratory Protection for Cyanide

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum Respiratory Protection* Required Above 5 mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Concentration</td>
<td></td>
</tr>
<tr>
<td>50 mg/m³ or less</td>
<td>Any supplied-air respirator. Any self-contained breathing apparatus.</td>
</tr>
<tr>
<td>Greater than 50 mg/m³ or entry and escape from unknown concentrations</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Fire Fighting</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Escape</td>
<td>Any gas mask providing protection against hydrogen cyanide and particulates. Any escape self-contained breathing apparatus.</td>
</tr>
</tbody>
</table>

*Only NIOSH-approved or MSHA-approved equipment should be used.
INTRODUCTION

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

SUBSTANCE IDENTIFICATION

- Formula: \( \text{CH}_2\text{CHCl}_2 \)
- Synonyms: Asymmetrical dichloroethane; ethylidene chloride; 1,1-ethylidene dichloride.
- Appearance and odor: Colorless liquid with a chloroform-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for 1,1-dichloroethane is 100 parts of 1,1-dichloroethane per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 400 milligrams of 1,1-dichloroethane per cubic meter of air (mg/m³). The American Conference of Governmental Industrial Hygienists has recommended for 1,1-dichloroethane a Threshold Limit Value of 200 ppm.

HEALTH HAZARD INFORMATION

- Routes of exposure
  1,1-Dichloroethane can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.
- Effects of overexposure
  1. Short-term Exposure: Breathing 1,1-dichloroethane vapor may cause drowsiness and unconsciousness. It might also cause damage to the liver, kidneys, and lungs. Splashing the liquid in the eyes may cause irritation.
  2. Long-term Exposure: Prolonged, confined, or repeated skin contact with 1,1-dichloroethane can produce a slight burn.
  3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to 1,1-dichloroethane.
- Recommended medical surveillance
  The following medical procedures should be made available to each employee who is exposed to dichloroethane at potentially hazardous levels:
  1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from 1,1-dichloroethane exposure.
     - Skin disease: 1,1-Dichloroethane can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.
     - Liver disease: Although 1,1-dichloroethane is known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.
     - Kidney disease: Although 1,1-dichloroethane is known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration to those with impaired renal function.
     - Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of 1,1-dichloroethane might cause exacerbation of symptoms due to its irritant properties.
  2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.
- Summary of toxicology
  1,1-Dichloroethane vapor is a narcotic. Rats exposed to 32,000 ppm for 30 minutes did not survive. The most consistent findings in animals exposed to concentrations...
of above 8,000 ppm for up to 7 hours were pathologic changes in the kidney and liver, and at much higher concentrations, near 64,000 ppm, damage to the lungs as well. Repeated daily exposure of several species of animals to 1,000 ppm resulted in no pathologic or hematologic changes. The liquid applied to the intact or abraded skin of rabbits produced slight edema and very slight necrosis after six daily applications. Instilled in the eyes of rabbits there was immediate, moderate conjunctival irritation and swelling which subsided within a week. There have been no reported cases of human overexposure by inhalation; prolonged, confined, or repeated skin contact can produce a slight burn.

**CHEMICAL AND PHYSICAL PROPERTIES**

- **Physical data**
  1. Molecular weight: 99
  2. Boiling point (760 mm Hg): 57.3 °C (135 °F)
  3. Specific gravity (water = 1): 1.2
  4. Vapor density (air = 1 at boiling point of 1,1-dichloroethane): 3.4
  5. Melting point: -96.7°C (-142 °F)
  6. Vapor pressure at 20°C (68°F): 182 mm Hg
  7. Solubility in water, g/100 g water at 20°C (68°F): Less than 0.1
  8. Evaporation rate (butyl acetate = 1): 11.6

- **Reactivity**
  1. Conditions contributing to instability: Heat
  2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions. Contact with strong caustics will cause formation of flammable and toxic acetaldehyde gas.
  3. Hazardous decomposition products: Toxic gases such as vinyl chloride, hydrogen chloride, phosgene, and carbon monoxide may be released in a fire involving 1,1-dichloroethane.
  4. Special precautions: 1,1-Dichloroethane will attack some forms of plastics, rubber, and coatings.

- **Flammability**
  1. Flash point: -8.5 °C (17 °F) (closed cup)
  2. Autoignition temperature: Data not available
  3. Flammable limits in air, % by volume: Lower: 5.9; Upper: 15.9

- **Extinguishant**: Foam, dry chemical, carbon dioxide

- **Warning properties**

  The AIHA Hygienic Guide reports that 1,1-dichloroethane has a distinctive, easily recognizable odor at the TLV. 1,1-Dichloroethane is not known to be an eye irritant.

**MONITORING AND MEASUREMENT PROCEDURES**

- **General**

  Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

  Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure 1,1-dichloroethane may be used. An analytical method for 1,1-dichloroethane is in the NIOSH Manual of Analytical Methods. 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

**RESPIRATORS**

- **Good industrial hygiene practices recommend that**

  engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- **In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.**

**PERSONAL PROTECTIVE EQUIPMENT**

- **Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid 1,1-dichloroethane.**

- **Clothing wet with liquid 1,1-dichloroethane should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of 1,1-dichloroethane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the 1,1-dichloroethane, the person performing the operation should be informed of 1,1-dichloroethane's hazardous properties.**

- **Any clothing which becomes wet with liquid 1,1-dichloroethane should be removed immediately and not**
reworn until the 1,1-dichloroethane is removed from the clothing.

- Employees should be provided with and required to use splash-proof safety goggles where liquid 1,1-dichloroethane may contact the eyes.

SANITATION

- Skin that becomes wet with liquid 1,1-dichloroethane should be immediately washed or showered with soap or mild detergent and water to remove any 1,1-dichloroethane.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to 1,1-dichloroethane may occur and control methods which may be effective in each case:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use as dewaxer of mineral oils; extractant for heat-sensitive substances</td>
<td>General dilution ventilation; local exhaust ventilation; personal protective equipment</td>
</tr>
<tr>
<td>Use as a fumigant</td>
<td>General dilution ventilation of work area; personal protective equipment</td>
</tr>
<tr>
<td>Use in manufacture of vinyl chloride by vapor phase cracking; use in manufacture of high vacuum rubber and silicon grease; use as a chemical intermediate</td>
<td>General dilution ventilation; local exhaust ventilation; personal protective equipment</td>
</tr>
</tbody>
</table>

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- Eye Exposure
  If 1,1-dichloroethane gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.
- Skin Exposure
  If 1,1-dichloroethane gets on the skin, promptly flush the contaminated skin using soap or mild detergent and water. If 1,1-dichloroethane soaks through the clothing, remove the clothing immediately and flush the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.
- Breathing
  If a person breathes in large amounts of 1,1-dichloroethane, move the exposed person to fresh air at once. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- Swallowing
  When 1,1-dichloroethane has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.
- Rescue
  Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
- If 1,1-dichloroethane is spilled or leaked, the following steps should be taken:
  1. Remove all ignition sources.
  2. Ventilate area of spill or leak.
  3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. 1,1-Dichloroethane should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of 1,1-dichloroethane vapors are permitted.
- Waste disposal method:
  1,1-Dichloroethane may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

REFERENCES


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**RESPIRATORY PROTECTION FOR 1,1-DICHLOROETHANE**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum Respiratory Protection* Required Above 100 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapor Concentration</td>
<td></td>
</tr>
<tr>
<td>1000 ppm or less</td>
<td>Any chemical cartridge respirator with an organic vapor cartridge(s). Any supplied-air respirator. Any self-contained breathing apparatus.</td>
</tr>
<tr>
<td>4000 ppm or less</td>
<td>A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.</td>
</tr>
<tr>
<td>Greater than 4000 ppm or entry and escape from unknown concentrations</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Fire Fighting</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Escape</td>
<td>Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.</td>
</tr>
</tbody>
</table>

*Only NIOSH-approved or MSHA-approved equipment should be used.*
1,2-DICHLOROETHANE

CAS Registry No.: 107-06-2

Synonyms: Ethylene dichloride; EDC; glycol dichloride; *syn-* dichloroethane

Physical and Chemical Characteristics

Appearance: Colorless liquid
Odor: Sweet odor like chloroform
Odor Threshold: 6-10 ppm
Flash Point: 55°F
Explosive Limits: Upper = 16%; Lower = 6%

Health Hazard Information

OSHA Standard: TWA = 50 ppm; ceiling level = 100 ppm

NIOSH Recommended Limit: TWA = 1 ppm; ceiling limit = 2 ppm/15 min.

ACGIH Recommended Limit: TLV = 10 ppm; STEL = 15 ppm

Effects of over-exposure: Acute and chronic toxicity symptoms for humans are similar by all routes of entry including ingestion, inhalation, and skin absorption. These effects include CNS depression with symptoms of headache, weakness, dizziness, unconsciousness, coma, and death. Exposure to EDC can cause GI disturbances, producing nausea, vomiting, and abdominal pain. In addition, EDC can cause liver, kidney, heart, and lung damage. EDC has also been found to be carcinogenic in laboratory animals. In the absence of adequate data in humans, this chemical should be considered to present a carcinogenic risk to humans.
Occupational Health Guideline for 1,2-Dichloroethylene

INTRODUCTION

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

SUBSTANCE IDENTIFICATION

- Formula: CICH₂CHCl
- Synonyms: Acetylene dichloride; dioform; trans-acetylene dichloride; sym-dichloroethylene
- Appearance and odor: Colorless liquid with an ether-like, slightly acrid odor, like chloroform.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for 1,2-dichloroethylene is 200 parts of 1,2-dichloroethylene per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 790 milligrams of 1,2-dichloroethylene per cubic meter of air (mg/m³).

HEALTH HAZARD INFORMATION

- Routes of exposure
  1,2-Dichloroethylene can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.
- Effects of overexposure
  Exposure to 1,2-dichloroethylene may cause dizziness, drowsiness, and unconsciousness.
- Reporting signs and symptoms
  A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to 1,2-dichloroethylene.
- Recommended medical surveillance
  The following medical procedures should be made available to each employee who is exposed to 1,2-dichloroethylene at potentially hazardous levels:
  1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from 1,2-dichloroethylene exposure.
     - Liver disease: Although 1,2-dichloroethylene is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.
     - Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of 1,2-dichloroethylene might cause exacerbation of symptoms due to its irritant properties.
  2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.
- Summary of toxicology
  1,2-Dichloroethylene vapor is a narcotic and a mucous membrane irritant. Variations in toxicity of the cis- compared with the trans-form have been reported. A concentration of 39,000 ppm was lethal to guinea pigs and narcosis was produced at 18,000 ppm. Dogs exposed to high concentrations of vapor developed superficial corneal turbidity which was reversible. No effects were observed in several species with repeated exposure for up to 6 months at 1000 ppm. It has been used as a general anesthetic in man; one industrial fatality was due to very high vapor inhalation in a small enclosure.

CHEMICAL AND PHYSICAL PROPERTIES

- Physical data
  1. Molecular weight: 96.9
  2. Boiling point (760 mm Hg): 45 to 60 C (113 to 140 F)
  3. Specific gravity (water = 1): 1.27
  4. Vapor density (air = 1 at boiling point of 1,2-dichloroethylene): 3.34
  5. Melting point: -49 to -81.5 C (-56 to -115 F)
  6. Vapor pressure at 20 C (68 F): 180 to 265 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 5 to 0.63
8. Evaporation rate (butyl acetate = 1): Data not available

Reactivity
1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released in a fire involving 1,2-dichloroethylene.
4. Special precautions: 1,2-Dichloroethylene will attack some forms of plastics, rubber, and coatings.

Flammability
1. Flash point: 2.2 to 3.9 C (36 to 39 F) (closed cup)
2. Autoignition temperature: 460 C (860 F) for trans-1,2-dichloroethylene
3. Flammable limits in air, % by volume: Lower: 9.7; Upper: 12.8
4. Extinguishant: Dry chemical, foam, carbon dioxide

Warning properties
May report an odor threshold of 0.085 ppm for dichloroethylene. For the purposes of this guideline, 1,2-dichloroethylene is treated as a material with adequate warning properties.
1,2-Dichloroethylene is an eye irritant, according to Grant, but the concentrations at which irritation occurs are not mentioned.

MONITORING AND MEASUREMENT PROCEDURES

General
Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

Method
Sampling and analyses may be performed by collection of 1,2-dichloroethylene vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure 1,2-dichloroethylene may be used. An analytical method for 1,2-dichloroethylene is in the NIOSH Manual of Analytical Methods, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

PERSONAL PROTECTIVE EQUIPMENT

Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid 1,2-dichloroethylene.

Clothing wet with liquid 1,2-dichloroethylene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of 1,2-dichloroethylene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the 1,2-dichloroethylene, the person performing the operation should be informed of 1,2-dichloroethylene's hazardous properties.

Any clothing which becomes wet with liquid 1,2-dichloroethylene should be removed immediately and not reworn until the 1,2-dichloroethylene is removed from the clothing.

Employees should be provided with and required to use splash-proof safety goggles where liquid 1,2-dichloroethylene may contact the eyes.

SANITATION

Skin that becomes wet with liquid 1,2-dichloroethylene should be promptly washed or showered with soap or mild detergent and water to remove any 1,2-dichloroethylene.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to 1,2-dichloroethylene may occur and control methods which may be effective in each case:
### Operation

**Use as a low-temperature solvent for heat-sensitive substances in extraction of caffeine, perfume oils, and fats from flesh of animals**

**Use in rubber and dye industries in extraction and application**

**Use as a direct solvent in gums, waxes, oils, camphor, and phenol; use in solvent mixtures for esters and ether derivatives, lacquers, resins, thermoplastics, and artificial fibers**

**Use in organic synthesis for polymers and telomers**

**Use in miscellaneous applications as liquid dry cleaning agent, cleaning solution for printed circuit boards, food packaging adhesives, and germicidal fumigants**

### Controls

**Local exhaust ventilation; general dilution ventilation; personal protective equipment**

**Process enclosure; local exhaust ventilation; personal protective equipment**

**Process enclosure; local exhaust ventilation; personal protective equipment**

**General dilution ventilation; local exhaust ventilation; personal protective equipment**

### EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**
  If 1,2-dichloroethylene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**
  If 1,2-dichloroethylene gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If 1,2-dichloroethylene soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

- **Breathing**
  If a person breathes in large amounts of 1,2-dichloroethylene, move the exposed person to fresh air at once. If Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**
  When 1,2-dichloroethylene has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

- **Rescue**
  Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

### SPILL, LEAK, AND DISPOSAL PROCEDURES

- **Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.**

- **If 1,2-dichloroethylene is spilled or leaked, the following steps should be taken:**
  1. Remove all ignition sources.
  2. Ventilate area of spill or leak.
  3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to complete. Clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. 1,2-Dichloroethylene should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of 1,2-dichloroethylene vapors are permitted.

- **Waste disposal method:**
  1,2-Dichloroethylene may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
REFERENCES


RESPIRATORY PROTECTION FOR 1,2-DICHLOROETHYLENE

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum Respiratory Protection* Required Above 200 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vapor Concentration</strong></td>
<td></td>
</tr>
<tr>
<td>1000 ppm or less</td>
<td>A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).</td>
</tr>
<tr>
<td>0 ppm or less</td>
<td>A gas mask with a chin-style or a front- or back-mounted organic vapor canister.</td>
</tr>
<tr>
<td></td>
<td>Any supplied-air respirator with a full facepiece, helmet, or hood.</td>
</tr>
<tr>
<td></td>
<td>Any self-contained breathing apparatus with a full facepiece.</td>
</tr>
<tr>
<td>Greater than 4000 ppm or entry and escape from unknown concentrations</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td></td>
<td>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Fire Fighting</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Escape</td>
<td>Any gas mask providing protection against organic vapors.</td>
</tr>
<tr>
<td></td>
<td>Any escape self-contained breathing apparatus.</td>
</tr>
</tbody>
</table>

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

September 1975
Occupational Health Guideline for Ethyl Benzene

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

SUBSTANCE IDENTIFICATION

• Formula: C₆H₅CH₃
• Synonyms: Phenylethane; ethylbenzol
• Appearance and odor: Colorless liquid with an aromatic odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)
The current OSHA standard for ethyl benzene is 100 parts of ethyl benzene per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 435 milligrams of ethyl benzene per cubic meter of air (mg/m³).

HEALTH HAZARD INFORMATION

• Routes of exposure
  Ethyl benzene can affect the body if it is inhaled, is swallowed, or comes in contact with the eyes or skin.

• Effects of overexposure
  1. Short-term Exposure: Ethyl benzene causes irritation of the eyes, nose, throat, and skin. With exposure to high concentrations, irritating effects are more pronounced, and a person may begin to feel weak, dizzy, drowsy, and become unconscious.
  2. Long-term Exposure: Prolonged or repeated ethyl benzene exposure of the skin may cause skin rash.
  3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to ethyl benzene.

• Recommended medical surveillance
  The following medical procedures should be made available to each employee who is exposed to ethyl benzene at potentially hazardous levels:
  1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from ethyl benzene exposure.
     - Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of ethyl benzene might cause exacerbation of symptoms due to its irritant properties or psychic reflex bronchospasm.
     - Kidney disease: Although ethyl benzene is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with possible impairment of renal function.
     - Liver disease: Although ethyl benzene is not known as a liver toxin in humans, the importance of the organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.
     - Skin disease: Ethyl benzene is a defatting agent and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.
  2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

• Summary of toxicology
  Ethyl benzene is primarily an irritant of skin and, to some degree, of eyes and upper respiratory tract. Systemic absorption causes depression of the central nervous system with narcosis at very high concentrations. Aspiration of small amounts causes extensive edema and hemorrhage of lung tissue. It is readily metabolized and excreted chiefly as mandelic acid in the urine.

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service... Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration
CHEMICAL AND PHYSICAL PROPERTIES

Physical data
1. Molecular weight: 106
2. Boiling point (760 mm Hg): 136 °C (277 °F)
3. Specific gravity (water = 1): 0.865
4. Vapor density (air = 1 at boiling point of ethyl benzene): 3.66
5. Melting point: -95 °C (-139 °F)
6. Vapor pressure at 20 °C (68 °F): 7.1 mm Hg
7. Solubility in water, g/100 g water at 20 °C (68 °F): 0.015
8. Evaporation rate (butyl acetate = 1): Less than 1

Reactivity
1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizing agents may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving ethyl benzene.
4. Special precautions: None

Flammability
1. Flash point: 15 °C (59 °F) (closed cup)
2. Autoignition temperature: 432 °C (810 °F)
3. Flammable limits in air, % by volume: Lower: 1.0; Upper: 6.7
4. Extinguishant: Dry chemical, foam, or carbon dioxide

Warning properties
1. Odor Threshold: According to the Department of Transportation's CHRSIS Hazardous Chemical Data, ethyl benzene has an odor threshold of 140 ppm.
2. Eye Irritation Level: According to the AIHA Hygienic Guide, "the vapor caused a noticeable eye irritation in humans at concentrations of 200 ppm."
3. Evaluation of Warning Properties: Through its odor and irritant effects, ethyl benzene can be detected at a concentration less than twice the permissible exposure limit. Therefore, for the purposes of this guideline, ethyl benzene is treated as a material with adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

General
Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

Method
Sampling and analyses may be performed by collection of ethyl benzene vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure ethyl benzene may be used. An analytical method for ethyl benzene is in the NIOSH Manual of Analytical Methods, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid ethyl benzene.
- Clothing wet with liquid ethyl benzene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of ethyl benzene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the ethyl benzene, the person performing the operation should be informed of ethyl benzene's hazardous properties.
- Non-impervious clothing which becomes contaminated with liquid ethyl benzene should be removed promptly and not reworn until the ethyl benzene is removed from the clothing.
- Any clothing which becomes wet with liquid ethyl benzene should be removed immediately and not reworn until the ethyl benzene is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid ethyl benzene may contact the eyes.
SANITATION

• Skin that becomes contaminated with liquid ethyl benzene should be promptly washed or showered with soap or mild detergent and water to remove any ethyl benzene.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to ethyl benzene may occur and control methods which may be effective in each case:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liberation during manufacture of styrene monomer</td>
<td>Local exhaust ventilation</td>
</tr>
<tr>
<td>Use during spray application of vinyl resin surface coating</td>
<td>Local exhaust ventilation; personal protective equipment</td>
</tr>
<tr>
<td>Liberation during manufacture of paints, varnishes, and other surface coatings</td>
<td>Local exhaust ventilation; general dilution ventilation</td>
</tr>
<tr>
<td>Use in manufacture and application of rubber adhesives</td>
<td>General dilution ventilation; local exhaust ventilation; personal protective equipment</td>
</tr>
<tr>
<td>Use during electroplating of aluminum on copper or steel</td>
<td>Local exhaust ventilation for open-surface tanks</td>
</tr>
<tr>
<td>Liberation during baking and drying of surface coatings</td>
<td>Local exhaust ventilation for ovens</td>
</tr>
<tr>
<td>Liberation during application of surface coatings by dipping, flow coatings, and roller coating</td>
<td>Local exhaust ventilation</td>
</tr>
<tr>
<td>Liberation during use as an intermediate in dye manufacture</td>
<td>General dilution ventilation</td>
</tr>
<tr>
<td>Use as a heat-transfer medium; use as a dielectric</td>
<td>General dilution ventilation; personal protective equipment</td>
</tr>
<tr>
<td>Liberation during production of acetophenone by oxidation of ethyl</td>
<td>General dilution ventilation</td>
</tr>
</tbody>
</table>

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance:

• Eye Exposure
  If ethyl benzene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• Skin Exposure
  If ethyl benzene gets on the skin, promptly flush the contaminated skin with water. If ethyl benzene soaks through the clothing, remove the clothing immediately and flush the skin with water. When there is skin irritation, get medical attention.

• Breathing
  If a person breathes in large amounts of ethyl benzene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing
  If ethyl benzene has been swallowed, do not induce vomiting. Get medical attention immediately.

• Rescue
  Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If ethyl benzene is spilled or leaked, the following steps should be taken:
  1. Remove all ignition sources.
  2. Ventilate area of spill or leak.
  3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber. Combustion may be improved by mixing with a more flammable liquid. Ethyl benzene should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

• Waste disposal methods:
  Ethyl benzene may be disposed of:
  1. By absorbing it in vermiculite, dry sand, earth or similar material and disposing in a secured sanitary landfill.
2. By atomizing in a suitable combustion chamber. Combustion may be improved by mixing with a more flammable liquid.

REFERENCES


**RESPIRATORY PROTECTION FOR ETHYL BENZENE**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum Respiratory Protection* Required Above 100 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vapor Concentration</strong></td>
<td></td>
</tr>
<tr>
<td>1000 ppm or less</td>
<td>A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).</td>
</tr>
<tr>
<td>2000 ppm or less</td>
<td>A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.</td>
</tr>
<tr>
<td>Greater than 2000 ppm or entry and escape from unknown concentrations</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Fire Fighting</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Escape</td>
<td>Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.</td>
</tr>
</tbody>
</table>

*Only NIOSH-approved or MSHA-approved equipment should be used.
INTRODUCTION

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

SUBSTANCE IDENTIFICATION

- Formula: HCN
- Synonyms: Hydrocyanic acid; prussic acid; formonitrile
- Appearance and odor: Colorless or pale blue liquid or gas with a bitter almond odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for hydrogen cyanide is 10 parts of hydrogen cyanide per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 11 milligrams of hydrogen cyanide per cubic meter of air (mg/m³). NIOSH has recommended that the permissible exposure limit be reduced to 5 mg cyanide/m³ averaged over a 10-minute period. The NIOSH Criteria Document for Hydrogen Cyanide and Cyanide Salts should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- Routes of exposure
  Hydrogen cyanide can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. It may enter the body through the skin.
- Effects of overexposure
  1. Short-term Exposure: Inhalation, ingestion, or skin absorption of hydrogen cyanide may be rapidly fatal. Larger doses may cause the person to rapidly lose consciousness, stop breathing, and die. At lower levels of exposure, a person may experience weakness, headache, confusion, nausea, and vomiting. These symptoms may be followed by unconsciousness and death. Hydrogen cyanide liquid may irritate the eyes.
  2. Long-term Exposure: Effects from chronic exposure to hydrogen cyanide are non-specific and rare.
  3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to hydrogen cyanide.
- Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to hydrogen cyanide at potentially hazardous levels:
  1. Initial Medical Examination:

     - A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of fainting spells, such as occur with various types of cardiovascular and nervous disorders, and those who are unusually susceptible to effects of anoxia or with anemia would be expected to be at increased risk from exposure. Examination of the cardiovascular, nervous, and upper respiratory systems and thyroid should be stressed.
     - Cardiovascular disease: Persons with cardiac disease may be at increased risk. An electrocardiogram should be performed on workers over 40 years of age and where indicated.

  2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

  3. First Aid Kits: First aid kits should be immediately available in workplaces where there is a potential for the release of hydrogen cyanide. These kits should contain a minimum of 48 ampules, each of 0.3 ml amyl nitrate, and complete instructions for use. In addition, physicians' kits should be immediately available to trained medical personnel. These kits should contain the above quantity of amyl nitrate as well as sterile sodium...
Nitrate solution (3%) and sterile sodium thiosulfate solution (25%). All of the above drugs should be placed at least biannually to ensure their potency.

**Summary of toxicology**

Hydrogen cyanide (HCN) vapor, a source of cyanide ion, is an asphyxiant due to an inhibitory action on metabolic enzyme systems and can be rapidly fatal. Cyanide exerts this effect because it inactivates certain enzymes by forming very stable complexes with the metal in them. Cytochrome oxidase is probably the most important of these since it occupies a fundamental position in the respiratory process and is involved in the ultimate electron transfer to molecular oxygen. Since cytochrome oxidase is present in practically all cells that function under aerobic conditions, and since the cyanide ion diffuses easily to all parts of the body, it is capable of suddenly bringing to a halt practically all cellular respiration. A few inhalations of high concentrations of HCN may be followed by almost instantaneous collapse and cessation of respiration; 270 ppm HCN is immediately fatal to humans, 181 ppm is fatal after 10 minutes, 135 ppm after 30 minutes, and 110 ppm may be fatal in 1 hour. At lower levels of exposure to HCN, the earliest symptoms of intoxication may include weakness, headache, confusion, and occasionally nausea and vomiting; respiratory rate and depth usually cease initially and at later stages become slow and gasping; if cyanosis is present, it usually indicates that respiration has either ceased or has been very inadequate for a few minutes. Humans tolerate 45 to 54 ppm for ½ to 1 hour without immediate or delayed effects, while 18 to 36 ppm may result in some symptoms after an exposure of several hours. The ingestion by humans of 50 to 100 mg of HCN may also be fatal. Eye contact with liquid HCN may cause irritation. Cyanide is one of the few toxic substances for which an antidote exists, and it functions as follows. First, amyl nitrite (inhalation) and sodium nitrite (intravenously) are administered to form methemoglobin, which binds firmly with free cyanide ions. This traps any circulating cyanide ions. The formation of 10 to 20% methemoglobin usually does not involve appreciable risk, yet provides a large amount of cyanide-binding substance. Second, sodium thiosulfate is administered intravenously to increase the rate of conversion of cyanide to the less toxic thiocyanate. Methylene blue should not be administered, because it is a poor methemoglobin former and, moreover, promotes the conversion of methemoglobin back to hemoglobin.

**CHEMICAL AND PHYSICAL PROPERTIES**

**Physical data**

1. Molecular weight: 27
2. Boiling point (760 mm Hg): 26 C (79 F)
3. Specific gravity (water = 1): 0.7
4. Vapor density (air = 1 at boiling point of hydrogen cyanide): 0.93

5. Melting point: -14.4 to -16.8 C (7 to 2 F)
6. Vapor pressure at 20 C (68 F): 620 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Miscible in all proportions
8. Evaporation rate (butyl acetate = 1): Data not available

**Reactivity**

1. Conditions contributing to instability: Older samples may polymerize and explode unless acid stabilizer is maintained at proper concentration. Samples containing more than 2—5% of water are less stable than dry material. Samples stored more than 90 days are hazardous.
2. Incompatibilities: Contact with bases such as caustics and amines may cause violent polymerization and explosion.
3. Hazardous decomposition products: None more toxic than hydrogen cyanide.
4. Special precautions: Liquid hydrogen cyanide will attack some forms of plastics, rubber, and coatings.

**Warning properties**

1. Odor Threshold: The AIHA Hygienic Guide states that "the odor of HCN is usually described as 'sweet'; trained persons describe the odor as that of bitter almonds and can detect it at about one ppm." The Manufacturing Chemists Association (MCA) states that "although hydrocyanic acid has a characteristic odor, its toxic action at hazardous concentrations is so rapid that it is of no value as a warning."
2. Eye-Irritation Level: Grant states that "only occasionally has reference been made to an irritation of the eye, conjunctivitis, or superficial keratitis developing after chronic exposure to hydrogen cyanide gas."
3. Evaluation of Warning Properties: For the purposes of this guideline, hydrogen cyanide has been treated as a material with poor warning properties. Although the odor threshold appears to be below the permissible exposure limit, Patty states that "the sense of smell is . . . easily fatigued; and there is wide individual variation in the minimum odor threshold."

**MONITORING AND MEASUREMENT PROCEDURES**

- Eight-Hour Exposure Evaluation

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).
Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of hydrogen cyanide. Each measurement should consist of a ten (10) minute sample or series of consecutive samples totalling ten (10) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method


RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with liquid hydrogen cyanide.

• Where there is any possibility of exposure of an employee's body to liquid hydrogen cyanide, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Any clothing which becomes wet with, or non-impervious clothing which becomes contaminated with, liquid hydrogen cyanide should be removed immediately and not rewarmed until the hydrogen cyanide is

• Clothing wet with hydrogen cyanide should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of hydrogen cyanide from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the hydrogen cyanide, the person performing the operation should be informed of hydrogen cyanide's hazardous properties.

• Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid hydrogen cyanide contacting the eyes.

• Where there is any possibility that employees' eyes may be exposed to hydrogen cyanide, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

• Skin that becomes contaminated with hydrogen cyanide should be immediately washed or showered to remove any hydrogen cyanide.

• Employees who handle hydrogen cyanide should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROL

The following list includes some common operations which exposure to hydrogen cyanide may occur and control methods which may be effective in each case.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use in fumigation of structures and agricultural crops</td>
<td>Process enclosure; local exhaust ventilation; personal protective equipment</td>
</tr>
<tr>
<td>Liberation during use of cyanide salts or solutions in metal treatment operations, blast furnace and coke oven operations, metal ore processing, and photoengraving operations</td>
<td>Process enclosure; local exhaust ventilation; personal protective equipment</td>
</tr>
<tr>
<td>Use in production of intermediates in synthesis of acrylic plastics, nylon 66, chelating agents, dyes, pharmaceuticals, and specialty chemicals</td>
<td>Process enclosure; local exhaust ventilation; personal protective equipment</td>
</tr>
</tbody>
</table>
EMERGENCY FIRST AID PROCEDURES

At the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**
If liquid hydrogen cyanide gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**
If liquid hydrogen cyanide gets on the skin, immediately flush the contaminated skin with water. If liquid hydrogen cyanide soaks through the clothing, remove the clothing immediately and flush the skin with water. Get medical attention immediately.

• **Breathing**
If a person breathes in large amounts of hydrogen cyanide, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**
When hydrogen cyanide has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**
Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If hydrogen cyanide is spilled or leaked, the following steps should be taken:
  1. Remove all ignition sources.
  2. Ventilate area of spill or leak.
  3. If in the gaseous form, stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair the leak or allow the cylinder to empty.
  4. If in liquid form, for small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber. Hydrogen cyanide should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of hydrogen cyanide vapors are permitted.

• **Waste disposal method**
Liquid hydrogen cyanide may be disposed of by atomizing in a suitable combustion chamber.

REFERENCES


• Johnstone, R. T., and Miller, S. E.: Occupational Disease and Industrial Medicine, Saunders, Philadelphia, 1960.


Chemical Fact Sheet*  LEAD (Metallic and Inorganic Compounds)  June 1982

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposure should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Lead, CAS 7439-92-1; lead carbonate, CAS 598-63-0; lead chloride, CAS 7758-95-4; lead monoxide, CAS 1317-36-8; lead sulfide, CAS 1314-87-0; and others.

Trade Names: C.I. Pigment Metal 4, C.I. 77575, Lead flake, Whole lead, Litharge and others.

Uses: Tank linings, piping and other chemical reaction equipment; petroleum refining; manufacture of gasoline additives; pigments for paint; storage batteries, solder and fusible alloys; radiation shielding and others.

PHYSICAL INFORMATION

Appearance: Bluish white to silvery grey solid (lead metal).

Odor: None.

Behavior in Water: Insoluble.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure — 0.05 mg/m³ (lead).

NIOSH Recommended Limit: Average 10 hour day/40 hour week exposure — 0.1 mg/m³ (lead).

ACGIH Recommended Limit: Average 8 hour exposure — 0.15 mg/m³ (lead).

NOTE: Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to .060 mg lead per 100 ml. blood, he must be removed from all exposures to lead and cannot return to an exposed environment until the blood level fall to .040 mg lead per 100 ml. blood or less.

Short Term Exposure:

Lead is a cumulative poison. Increasing amounts build up in the body and eventually a point is reached where symptoms and disability may occur. Lead dust carried home on contaminated clothing can cause symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Inhalation: The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance, headache, aching bones, and muscles, constipation, abdominal pain and decreased appetite. These effects are reversible and complete recovery is possible. Inhalation of large amounts of lead may lead to seizures, coma and death.

Skin: May cause irritation.

Eyes: May cause irritation.

Ingestion: See effects listed for inhalation. Ingestion of large amounts of lead may lead to seizures, coma and death.

Long Term Exposure:

Lead can accumulate in the body over a period of time. Therefore, long term exposures to lower levels can result in a build up of lead in the body and more severe symptoms. These may include anemia, pale skin, a blue line at the gum margin, decreased hand-grip strength, abdominal pain, severe constipation, nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium and death. In non-fatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Continuous exposure can result in decreased fertility. Lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

*prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health.
Lead (Metallic and Inorganic Compounds)

EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move victim to fresh air. Give artificial respiration as needed. Get medical attention immediately.

Skin: Wash area with plenty of soap and water. Remove any contaminated clothing immediately.

Eyes: Rinse eyes with plenty of water for 15 minutes. Seek medical attention, if necessary.

Ingestion: If victim is conscious, give water. Seek medical attention.

Note to Physician: Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio, urine ALA, and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents such as edetate disodium calcium and penicillamine are generally useful in the therapy of acute lead intoxication.

FIRE AND EXPLOSION INFORMATION

General: Not combustible. If exposed to fire, may release toxic fumes or sulfur and lead oxides.

Extinguisher: Use extinguisher appropriate to burning material. When fighting fire, wear a self-contained breathing apparatus with a full facepiece and operated in positive pressure mode.

REACTIVITY

Conditions to Avoid: Excessive heat.

Materials to Avoid: Reacts violently with potassium.

PROTECTIVE MEASURES

Storage and Handling: Store in an area away from heat and keep separate from potassium.

Engineering Controls: Adequate ventilation, sinks, showers and eyewash stations should be provided.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Full body work clothing should be worn including bump caps or hard hats, rubber gloves, and eye protection. Employees should routinely wash their skin thoroughly and change clothing at the end of each work shift.

Protective Equipment: For levels up to 0.5 mg/m³ use any dust and mist respirator, except single-use. For up to 1 mg/m³ use any dust and mist respirator, except single-use or quarter mask, or any fume respirator or high efficiency particulate filter respirator. For up to 5 mg/m³ use a high efficiency particulate filter respirator with a full facepiece. For up to 100 mg/m³ use a powered air-purifying respirator with a high efficiency particulate filter or a Type C supplied-air respirator operated in pressure demand or other positive-pressure or continuous flow mode. For up to 200 mg/m³ use a Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive-pressure mode or with a full facepiece, helmet or hood operated in continuous-flow mode. For levels greater than 200 mg/m³ escape or entry into unknown concentrations use a self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive-pressure mode or a combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive-pressure or continuous flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode.

Miscellaneous: No eating, drinking, or smoking in areas where the dusts or fumes of lead or its compounds are present.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of spill area. Put on necessary protective equipment including respirators. If spill is on hard surfaces, cover with absorbent and shovel into suitable container. If spill is in powder form, vacuum尽可能 avoid raising dust by sweeping or blowing. Place in suitable container. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

Procedures for spills and leaks

for more information:

Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
METHYL ETHYL KETONE

CAS Registry No. 78-93-3

Synonyms: 2-butanone; ethyl methyl ketone; methyl acetone; MEK

Physical and Chemical Characteristics

Appearance: Colorless liquid

Odor: Resembles acetone; fragrant mint like moderately sharp odor.

Flash Point: 22°F

Explosive limits: Upper = 10%; Lower = 2.1%

Health Hazard Information

ACGIH recommended limit: TLV = 200 ppm

Routes of exposure: MEK is readily absorbed by all routes of exposure, including inhalation, dermal and ingestion.

Effects of overexposure: MEK is irritating to the eyes, nose, and throat by inhalation. Exposure to high concentrations may cause headache, nausea, and CNS depression. MEK is irritating to the skin on direct exposure, and may cause dermatitis with repeated exposure.
METHYL ISOBUTYL KETONE

CAS Registry No.: 108-10-1

Synonyms: hexone; isobutyl methyl ketone; isopropyl acetone;
2-methyl-4-pentanone; MIK; MIBK

Physical and Chemical Characteristics

Appearance: Clear, colorless liquid
Odor: Resembles acetone; sweet, sharp odor
Odor Threshold: 0.10-8 ppm
Flash Point: 73° F (22.7°C)
Explosive Limits: Upper = 7.5%; Lower = 1.4%

Health Hazard Information

NIOSH Recommended Limit: 50 ppm
ACGIH Recommended Limit: TLV = 50 ppm; STEL = 75 ppm

Effects of over-exposure: High vapor concentrations (100 ppm) are
irritating to the eyes, nose, and throat. Inhalation of higher concentra-
tions can cause CNS depression with symptoms of weakness, headache,
nausea, light headedness, vomiting, dizziness, incoordination, and unconscious-
ness.
Chemical Fact Sheet

NICKEL METAL

and

SOLUBLE NICKEL COMPOUNDS

June 1982

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Nickel metal; (CAS 7440-02-0), soluble nickel salts such as nickel nitrate (CAS 13138-45-9) and nickel sulfate (CAS 7786-81-4); there are many others.

Trade Names: Raney Nickel.

Uses: For nickel plating, nickel alloys, coins, batteries, magnets, stainless steel; as a chemical catalyst.

PHYSICAL INFORMATION

Appearance: Silvery white workable metal. Nickel salts may be white or colored crystals or powders.

Odor: Most are odorless.

Behavior in Water: Nickel metal is insoluble; the salts considered here are all soluble.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure — 1 mg/m³.

NIOSH Recommended Limit: Average 10 hour day/40 hour week — 0.015 mg/m³.

ACGIH Recommended Limit: Average 8 hour exposure — 1 mg/m³ (metal). Average 8 hour exposure — 0.1 mg/m³ (soluble compounds).

Short Term Exposure:

Inhalation: Dusts and mists can cause lung irritation, shortness of breath, coughing and wheezing.

Skin: Can cause itching, burning and sores. This is referred to as 'nickel itch'.

Eyes: May cause irritation and damage to the cornea.

Ingestion: May cause giddiness and nausea.

Long Term Exposure:

May cause symptoms listed above, as well as impairment of sense of smell, chest pain, destruction of nasal tissues and asthmatic lung disease allergic sensitivity may also develop.

Inhalation of nickel dust has been associated with an increased risk of lung and nasal cancer.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see "Toxic Substances: How Toxic is Toxic" available from the New York State Department of Health.
EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move victim to fresh air. Give artificial respiration or oxygen as required. Seek medical attention, if necessary.

Skin: Remove contaminated clothes. Wash affected area with soap and water for at least 5 minutes. Seek medical attention if irritation persists.

Eyes: Wash with large amounts of water for at least 15 minutes. Seek medical attention, if necessary.

Ingestion: Give victim large amounts of water. Seek medical attention. Never force an unconscious person to drink.

FIRE AND EXPLOSION INFORMATION

General: Fine nickel dust or fumes may be flammable.

REACTIVITY

Materials to Avoid: Reacts violently with fluorine, ammonium nitrate, hydrazine, performic acid, phosphorous sulfur, selenium, mixtures of hydrogen and dioxane, mixtures of titanium and potassium perchlorate, and carbon monoxide. Nickel metal reacts with strong mineral acids to give off hydrogen gas.

Conditions to Avoid: No special precautions.

PROTECTIVE MEASURES

Storage and Handling: Store in tightly closed containers, away from acids, oxidizers, and carbon monoxide. No eating, drinking or smoking in areas where nickel-containing materials are handled, processed or stored.

Engineering Controls: Process enclosure or local ventilation. Sinks, showers and eyewash stations should be readily available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Safety goggles or face shield, gloves, apron or protective clothing should be worn if contact with nickel compounds is likely. Clothing should be changed daily or upon contamination. Decontamination of clothing should be done by a trained person.

Protective Equipment: As dust or mist: For levels up to 5 mg/m³ use any dust or mist respirator. For up to 10 mg/m³ use a dust or mist respirator except single-use or quarter-mask respirator. For up to 50 mg/m³ use a high-efficiency particulate filter respirator with a full facepiece, any supplied-air respirator with full facepiece, helmet or hood, or any self-contained breathing apparatus with a full facepiece. For up to 1,000 mg/m³ use a powered air-purifying respirator with a high-efficiency particulate filter, or a Type C supplied-air respirator operated in pressure-demand or other positive pressure continuous-flow mode. For levels up to 2,000 mg/m³ use a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet or hood operated in continuous flow mode. For levels above 2,000 mg/m³ or entry and escape from unknown concentrations use a self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet or hood operated in continuous flow mode. For entry and escape from unknown concentrations use a self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode, or a combination Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode. For fire fighting wear a self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.

If fumes are present at levels up to 10 mg/m³, use either a fume respirator or high efficiency particulate respirator, a supplied air respirator or a self-contained breathing apparatus. Above 10 mg/m³ use the guidelines above.

PROCEDURES FOR SPILLS AND LEAKS

Warn other workers of spill. Put on proper protective clothing and equipment. Absorb liquids on vermiculite or other inert material. Place in suitable container. Vacuum cleaning or other wet methods which do not raise levels of airborne nickel may be used. For final disposal contact your regional office of the New York State Department of Environmental Conservation

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building.
PCBs

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Name: Polychlorinated biphenyls.


Ingredients: A mixture of several biphenyls with different numbers of chlorine atoms. The names will often be followed by a number e.g., Aroclor 1254, Kaneclor 600.

Use: As an insulating, non-flammable, thermally conductive, fluid in electrical capacitors and transformers.

**PHYSICAL INFORMATION**

Appearance: May be a clear, colorless, oily liquid, light to dark yellow resin or wax, or white to yellow powder.

Odor: Aromatic, acrid.

Behavior in Water: Does not mix; sinks.

Evaporation: Very slow.

**HEALTH HAZARD INFORMATION**

OSH Standard: Average 8 hour exposure -- 1.0 mg/m³ (42% chlorine).

Average 8 hour exposure -- 0.5 mg/m³ (54% chlorine).

NIOSH Recommended Limit: Average 10 hour day/40 hour week -- 0.001 mg/m³.

ACGIH Recommended Limit: Average 8 hour exposure -- 1.0 mg/m³ (42% chlorine).

Average 8 hour exposure -- 0.5 mg/m³ (54% chlorine).

Short Term Exposure:

Inhalation: May produce irritation to nose, throat and lungs. Levels above 10 mg/m³ are reported to be unbearable. Inhalation may contribute significantly to all symptoms of long term exposure.

Skin: Absorption moderate. Contributes significantly to all symptoms of long term exposure. Sensitized individuals may develop a rash after 2 days exposure by contact or inhalation.

Eyes: May produce irritation. Levels of 10 mg/m³ are severely irritating.

Ingestion: Absorption in digestive system contributes significantly to all symptoms of long term exposure. There are no reported deaths of humans due to a single ingestion. However, experiments in animals suggest that ingestion of 6 to 10 fluid ounces would cause death to a healthy 150 pound adult.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health.*
**PCBs**

Long Term Exposure:

PCBs are readily absorbed into the body by all routes of exposure. They may persist in tissues for years after exposure stops. The symptoms below may be due to PCBs or to chemical contaminants.

- **High levels of PCB vapor, 1 to 10 mg/m³**, may produce burning feeling in eyes, nose, and face; dry throat; lung and throat irritant; nausea; dizziness and aggravation of acne. These may be felt immediately or be delayed weeks or months.

- Chemical acne, black heads, dark patches on skin, and unusual eye discharge have been reported by all routes of exposure. These effects may last for months. Although some sensitive individuals have reported these effects after two days, onset may not occur for months.

- Liver damage and digestive disturbances have been reported in some individuals.

- PCBs at high levels have been shown to produce cancer and birth defects in laboratory animals. Whether PCBs produce these effects in humans is not known.

**Emergency and First Aid Instructions**

- **Inhalation**: Move person to fresh air and get medical attention if symptoms continue.

- **Skin**: Remove contaminated clothing immediately. Blot excess with paper towels. Wash affected area thoroughly with soap and water for at least 15 minutes.

- **Eye**: Rinse eyes with water for at least 15 minutes. A drop of vegetable oil may be added to relieve irritation. Seek medical attention if necessary.

- **Ingestion**: Get immediate medical attention.

**To Poisened Person**

Serum SGOT, SGPT and triglyceride levels have been used to monitor liver damage.

**Fire and Explosion Information**

- **Non-flammable.**

**Reactivity**

- **Endoms to Avoid**: High heat and electrical discharge may produce the highly poisonous substances phosgene, crotonic acid and chlorinated dibenzofurans.

**Protective Measures**

- **Storage and Handling**: Store in a tightly closed container with proper EPA labelling. Storage for more than 30 days must be in an EPA approved facility.

- **Engineering Controls**: Provide local exhaust ventilation system. Sinks, showers and eyewash stations should be readily available.

- **Protective Clothing**: (Should not be substituted for proper handling and engineering controls) Wear gloves and aprons made of neoprene, viton or polyethylene, safety glasses with side shields and impervious shoes.

- **Protective Equipment**: For levels up to 5 mg/m³ use a supplied-air respirator or self-contained breathing apparatus. For escape from a contaminated area, wear a gas mask with organic vapor and acid gas cartridges, and particulate filter.

**Procedures for Spills and Leaks**

Get workers out of spill area. Wearing protective clothing and equipment, ventilate area to reduce vapor levels. Absorb on nonreactive material such as sand or vermiculite. In the event of a spill and for disposal information contact your regional office of the New York State Department of Environmental Conservation and the U.S. Environmental Protection Agency.

For more information:

Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
**PHENOL**

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

**Chemical Names:** Hydroxybenzene, carbolic acid, phenyl hydroxide, phenylc alcohol; CAS 108-95-2.

**Trade Names:** None found.

**Uses:** A general disinfectant; used in the manufacture of resins, dyes and other industrial products; a reagent in chemical analysis.

**PHYSICAL INFORMATION**

- **Appearance:** Colorless or white crystalline solid that may reddish on exposure to light and heat. Also sold as a liquid solution.
- **Odor:** Sweet, tarry. Minimum Detectable by Odor: 0.05 ppm.
- **Behavior in Water:** Slightly soluble.
- **Evaporation:** Slow.

**HEALTH HAZARD INFORMATION**

- **C3 Standard:** Average 8 hour exposure—5 ppm.
- **NIOSH Recommended Limit:** Average 10 hour day/40 hour week—5 ppm.
- **ACGIH Recommended Limit:** Average 8 hour exposure—5 ppm.

**Short Term Exposure:**

- **Inhalation:** At levels of 48 ppm can cause irritation of nose and throat, nausea, vomiting, and other symptoms as listed under skin. No reported deaths from inhalation alone.

- **Skin:** Can cause white patches and wrinkles on skin. Intense pain may develop if not promptly removed. Absorption through skin may cause severe poisoning and death.

- **Eyes:** Can cause irritation, swelling and severe damage that can lead to blindness.

- **Ingestion:** Can cause burning sensation and pain in mouth and throat, sores, abdominal pain, nausea, vomiting, diarrhea and skin rash. Larger doses may also cause muscle weakness, irregular rapid breathing, blue coloration of skin, shock, unconsciousness, collapse and death. Death may occur from as little as 1 gram (1/30 ounce).

**Long Term Exposure:**

Prolonged exposure by any route to levels above the standard may cause difficult
**EMERGENCY AND FIRST AID INSTRUCTIONS**

**Inhalation:** Move person to fresh air. Give oxygen or artificial respiration as required. Seek medical attention, if necessary.

**Skin:** Immediately remove soaked clothing. Wash affected area for at least 5 minutes. Seek medical attention if large area is affected.

**Eyes:** Immediately wash with water for at least 15 minutes. Seek medical attention immediately, preferably an eye doctor (ophthalmologist).

**Ingestion:** If conscious, give large quantities of milk or water. Seek medical attention immediately.

**Note to Physician:** Urine analysis may be useful in determining severity of exposure. Diazepam (I.V.) may be useful in treating convulsions.

**FIRE AND EXPLOSION INFORMATION**

**General:** Flammable, may ignite at 79°C, 175°F.

**Explosive Limits:** Lower – 1.7%, Upper – 8.6%.

**Extinguisher:** Alcohol foam, carbon dioxide or dry chemical.

**REACTIVITY**

**Materials to Avoid:** Can react violently with butadiene and mixtures of aluminum chloride and nitrobenzene. May react vigorously with strong oxidizers such as permanganates or chlorine.

**Conditions to Avoid:** May give off toxic fumes of carbon monoxide when heated.

**PROTECTIVE MEASURES**

**Storage and Handling:** Keep in tightly closed container protected from light. Do not handle without good skin protection. Do not eat, drink or smoke when using phenol. Wash hands thoroughly after use.

**Engineering Controls:** Adequate ventilation or process enclosure. Sinks, showers and eyewash stations should be readily available.

**Protective Clothing (Should not be substituted for proper handling and engineering controls):** Splash-proof goggles or faceshield, rubber or polyethylene gloves and apron should be used if contact with phenol is likely.

**Protective Equipment:** For levels up to 50 ppm use a chemical cartridge respirator with organic vapor cartridges and dust and mist filters, a supplied-air respirator or a self-contained breathing apparatus. For levels up to 100 ppm use the above with full facepiece or a gas mask with an organic vapor canister and dust and mist filter. For levels above 100 ppm, or entry or escape from areas of unknown concentration use a self-contained breathing apparatus with full facepiece operated in pressure demand or other positive pressure mode, or a combination Type C supplied-air respirator with full facepiece operated in pressure demand or other positive pressure mode, or a combination Type C supplied-air respirator with full facepiece operated in pressure demand or other positive pressure or continuous-flow mode with an auxiliary self-contained breathing apparatus operated in pressure demand or positive pressure mode. Supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne phenol. Above 100 ppm supplied-air suits should be supplemented with an auxiliary self-contained breathing apparatus operated in a positive pressure mode.

**PROCEDURES FOR SPILLS AND LEAKS**

Warn other workers of spill and make sure persons not wearing protective clothing and equipment are kept out of the area. Put on proper protective clothing and equipment. Absorb liquid on inert material. Sweep into suitable container. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:

Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York.
Occupational Health Guideline for Tetrachloroethylene*

INTRODUCTION

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

SUBSTANCE IDENTIFICATION

• Formula: \( \text{C}_2\text{Cl}_4 \)
• Synonyms: Perchloroethylene; perchlorethylene; tetrachlorethylene
• Appearance and odor: Colorless liquid with an odor like chloroform or ether.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for tetrachloroethylene is 100 parts of tetrachloroethylene per million parts of air (ppm) averaged over an eight-hour work shift, with a ceiling level of 200 ppm and a maximum acceptable peak of 300 ppm for 5 minutes in any three-hour period. NIOSH has recommended that the permissible exposure limit be reduced to 50 ppm (339 mg/m\(^3\)) averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 100 ppm (678 mg/m\(^3\)) averaged over a 12-minute period. The NIOSH Criteria Document for Tetrachloroethylene should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

• Routes of exposure
  Tetrachloroethylene can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.
• Effects of overexposure
  1. Short-term Exposure: Tetrachloroethylene may cause headache, nausea, drowsiness, dizziness, incoordination, and unconsciousness. It may also cause irritation of the eyes, nose, and throat and flushing of the face and neck. In addition, it might cause liver damage with such findings as yellow jaundice and dark urine. The liver damage may become evident several weeks after this exposure.
  2. Long-term Exposure: Prolonged or repeated overexposure to liquid tetrachloroethylene may cause irritation of the skin. It might also cause damage to the liver and kidneys.
  3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to tetrachloroethylene.
• Recommended medical surveillance
  The following medical procedures should be made available to each employee who is exposed to tetrachloroethylene at potentially hazardous levels:
  1. Initial Medical Examination:
     — A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the liver and the cardiovascular and neurological systems should be stressed. The skin should be examined for evidence of chronic disorders.
     — Liver function tests: Tetrachloroethylene may cause liver damage. A profile of liver function should be obtained by using a medically acceptable array of biochemical tests.
     — Urinalysis: Since kidney damage has also been observed from exposure, a urinalysis should be obtained to include at minimum specific gravity, albumin, glucose, and a microscopic examination of centrifuged sediment.
  2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.
• Summary of toxicology
  Tetrachloroethylene vapor is a narcotic. Rats did not survive when exposed for longer than 12-18 minutes to 12,000 ppm; when exposed repeatedly to 470 ppm they showed liver and kidney injury. Cardiac arrhythmias

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration
attributed to sensitization of the myocardium to epinephrine have been observed with certain other chlorinated hydrocarbons, but exposure of dogs to concentrations of 5000 and 10,000 ppm tetrachloroethylene did not produce this phenomenon. Four human subjects were unable to tolerate 5000 ppm in a chamber for 6 minutes. They experienced vertigo, nausea, and mental confusion during the 10 minutes following cessation of exposure. In an industrial exposure to an average concentration of 275 ppm for 3 hours, followed by 1100 ppm for 30 minutes, a worker lost consciousness; there was apparent clinical recovery 1 hour after exposure but the monitored concentration of tetrachloroethylene in the patient's expired air diminished slowly over a 2-week period. Long-term industrial exposures have been reported to cause various neuropathies, such as numbness, trembling, neuritis, and defects of memory. During the second and third post-exposure weeks, the levels of liver function tests became abnormal, suggesting that acute exposure had had a significant effect upon the liver. Other instances of liver injury following industrial exposure have been reported. Other effects on humans of inhalation of various concentrations are as follows: 2000 ppm, mild narcosis within 5 minutes; 600 ppm, sensation of numbness around the mouth, dizziness, and some incoordination after 10 minutes. In van experiments, 7-hour exposures at 100 ppm resulted in mild irritation of the eyes, nose, and throat; flushing of the face and neck; headache; somnolence; and slurred speech. Exposure of the skin to the liquid for 40 minutes resulted in a progressively severe burning sensation beginning within 5 to 10 minutes; the result was marked erythema, which subsided after 1 to 2 hours. The liquid sprayed into rabbits' eyes produced intermediate pain and blepharospasm; patches of epithelial were lost, but the eyes recovered completely within 2 days.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data
1. Molecular weight: 165.85
2. Boiling point (760 mm Hg): 121.2 C (250 F)
3. Specific gravity (water = 1): 1.62
4. Vapor density (air = 1): 1.62
5. Melting point: -22.4 C (-8 F)
6. Vapor pressure at 20 C (68 F): 14 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.015
8. Evaporation rate (butyl acetate = 1): 2.8
• Reactivity
2. Incompatibilities: Tetrachloroethylene reacts with strong oxidizers and chemically active metals such as barium, lithium, and beryllium.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released when tetrachloroethylene decomposes.
• Flammability
1. Not combustible
• Warning properties
1. Odor threshold: Both May and Stern state that 50 ppm is the odor threshold for tetrachloroethylene.
2. Eye irritation level: Grant reports that "exposure to high concentrations of (tetrachloroethylene) vapor causes mild sensation of irritation to the eyes, but serious injury is not likely." The exact concentrations producing irritation are not mentioned by Grant.
3. Other information: Spector reports that a 10-minute exposure to 513 to 690 ppm produces nose and throat irritation.
4. Evaluation of warning properties: Since the odor threshold of tetrachloroethylene is below the permissible exposure limit, and since eye irritation occurs at a concentration only twice the permissible exposure limit, its warning properties are considered to be adequate.

MONITORING AND MEASUREMENT PROCEDURES
• Eight-hour exposure evaluation
Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).
• Ceiling evaluation
Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of tetrachloroethylene. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.
• Peak above ceiling evaluation
Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of tetrachloroethylene. Each measurement should consist of a 30-minute sample or a series of consecutive samples totalling 30 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of
three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method
Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure tetrachloroethylene may be used. An analytical method for tetrachloroethylene is in the NIOSH Manual of Analytical Methods, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS
• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT
• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid tetrachloroethylene.
• Non-impervious clothing which becomes contaminated with liquid tetrachloroethylene should be removed promptly and not worn until the tetrachloroethylene is removed from the clothing.
• Clothing wet with liquid tetrachloroethylene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of tetrachloroethylene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the tetrachloroethylene, the person performing the operation should be informed of tetrachloroethylene's hazardous properties.

• Employees should be provided with and required to use splash-proof safety goggles where liquid tetrachloroethylene may contact the eyes.

SANITATION
• Skin that becomes contaminated with liquid tetrachloroethylene should be promptly washed or showered with soap or mild detergent and water to remove any tetrachloroethylene.
• Employees who handle liquid tetrachloroethylene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS
The following list includes some common operations which exposure to tetrachloroethylene may occur and control methods which may be effective in each case:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use as dry cleaning solvent; as degreasing and metal cleaning agent in vapor degreasing of metal parts</td>
<td>Local exhaust ventilation; general dilution; personal protective equipment</td>
</tr>
<tr>
<td>Use as chemical intermediate in production of fluorocarbons, pesticides, and trichloroacetic acid</td>
<td>Process enclosure; local exhaust ventilation; general dilution ventilation</td>
</tr>
<tr>
<td>Use as scouring, sizing, desizing, solvent and grease remover in processing and finishing of textiles</td>
<td>Local exhaust ventilation; general dilution; personal protective equipment</td>
</tr>
<tr>
<td>Use as general industrial solvent in rubber, textile, printing, soap, and paint remover industries</td>
<td>Local exhaust ventilation; general dilution; personal protective equipment</td>
</tr>
<tr>
<td>Use as extraction agent for vegetable and mineral oils and in pharmaceutical industry; as vermifuge; as laundry treatment for presoaking and as drying medium in metal and wood industries</td>
<td>Local exhaust ventilation; general dilution ventilation; personal protective equipment</td>
</tr>
</tbody>
</table>
EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**
  If tetrachloroethylene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**
  If tetrachloroethylene gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If tetrachloroethylene soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• **Breathing**
  If a person breathes in large amounts of tetrachloroethylene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**
  When tetrachloroethylene has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

• **Rescue**
  Remove the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility’s emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If tetrachloroethylene is spilled or leaked, the following steps should be taken:
  1. Ventilate area of spill or leak.
  2. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:
  Tetrachloroethylene may be disposed of by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

REFERENCES

• American Conference of Governmental Industrial Hygienists: “Perchloroethylene (Tetrachloroethylene),” Documentation of the Threshold Limit Values for Substances in Workroom Air (3rd ed., 2nd printing), Cincinnati, 1974.


• Manufacturing Chemists Association, Inc.: Chemical Safety Data Sheet SD-24, Tetrachloroethylene, Washington, D.C.


**SPECIAL NOTE**

Tetrachloroethylene appears on the OSHA “Candidate List” of chemicals being considered for further scientific review regarding its carcinogenicity (Federal Register, Vol. 45, No. 157, pp. 5372-5379, 12 August 1980). The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 20, 1979.

### RESPIRATORY PROTECTION FOR TETRACHLOROETHYLENE

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum Respiratory Protection* Required Above 100 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vapor Concentration</strong></td>
<td></td>
</tr>
<tr>
<td>500 ppm or less</td>
<td>Any chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.</td>
</tr>
<tr>
<td>Greater than 500 ppm or entry and escape from unknown concentrations</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td><strong>Fire Fighting</strong></td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td><strong>Escape</strong></td>
<td>Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.</td>
</tr>
</tbody>
</table>

*Only NIOSH-approved or MSHA-approved equipment should be used.*
The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Methylbenzene, methylbenzol, phenylmethane, toluol; CAS 108-88-3.

Trade Names: Methacide, Antisal I, and others.

Uses: Used in the manufacture of benzoic acid, benzaldehyde, explosives, dyes and adhesives.

PHYSICAL INFORMATION

Appearance: Clear, colorless liquid.


Behavior in Water: Only a very small amount will mix, the rest will float.

Evaporation: Liquid evaporates very slowly.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure limit — 200 ppm.

NIOSH Recommended Limit: Average 8 hour exposure — 100 ppm.

ACGIH Recommended Limit: Average 8 hour exposure — 100 ppm.

Short Term Exposure:

Inhalation: 100 ppm exposure can cause dizziness, drowsiness and hallucinations. 100-200 ppm can cause depression. 200-500 ppm can cause headaches, nausea, loss of appetite, loss of energy, loss of coordination and coma. In addition to the above, death has resulted from exposure to 10,000 ppm for an unknown time.

Skin: Can cause dryness and irritation.

Eyes: Can cause irritation at 300 ppm.

Ingestion: Can cause a burning sensation in the mouth and stomach, upper abdominal pain, cough, hoarseness, headache, nausea, loss of appetite, loss of energy, loss of coordination and coma.

Long Term Exposure:

Levels below 200 ppm may produce headache, tiredness and nausea.
From 200 to 500 ppm some loss of memory and loss of appetite may occur.
Levels up to 1,500 ppm may cause heart palpitations and loss of coordination. Blood effects and anemia have been reported but are probably due to contamination by benzene. Most of these effects seem to go away when exposure stops.
EMERGENCY AND FIRST AID INSTRUCTIONS

**Toluene**

**Inhalation:** Get to fresh air. Keep warm and quiet. Give artificial respiration, if necessary. Seek medical attention, if necessary.

**Skin:** Take off clothing soaked with liquid. Wash contaminated area with soap and water for at least 5 minutes. Seek medical attention, if necessary.

**Eyes:** Wash with large amounts of water for at least 15 minutes. Seek immediate medical attention.

**Ingestion:** Do not induce vomiting. Give one or two ounces of mineral oil. Seek immediate medical attention. Note: Never force an unconscious person to drink.

**Note to Physician:** Hippuric acid levels above 5 gm/liter of urine may result from exposure greater than 200 ppm. Blood levels for toluene may also be determined.

**FIRE AND EXPLOSION INFORMATION**

**General:** Flammable liquid. Fumes may spread a considerable distance and flash back. Will ignite at 44°C, 110°F.

**Explosive Limits:** Upper Limit — 7.0%, Lower Limit — 1.27%.

**Extinguisher:** Water spray, carbon dioxide, dry chemical or foam.

**REACTIVITY**

**Materials to Avoid:** Reacts violently with chlorine, permanganate and dichromate.

**Conditions to Avoid:** Sources of ignition.

**PROTECTIVE MEASURES**

**Storage and Handling:** Store outdoors or in a detached building, if possible. If indoors, store in a standard flammable liquid storage room or cabinet. Protect containers from physical damage.

**Engineering Controls:** Use in well ventilated area. Eyewash stations, sinks and showers should be readily available.

**Protective Clothing:** (Should not be substituted for proper handling and engineering controls):

- If direct contact is likely, wear viton, PVA, NBR or polyethylene clothing.

**Protective Equipment:** For levels up to 500 ppm use a chemical cartridge respirator with organic vapor cartridges, supplied-air respirator or a self-contained breathing apparatus. For up to 1,000 ppm use a chemical cartridge respirator with organic vapor cartridges and full facepiece. For up to 2,000 ppm use a gas mask with an organic cartridge, a supplied-air respirator with a full facepiece, hood or helmet or a self-contained breathing apparatus with a full facepiece. For escape from a contaminated area use a gas mask with an organic vapor canister or a self-contained breathing apparatus.

**PROCEDURES FOR SPILLS OR LEAKS**

Get all workers out of the spill area. Put on a respirator and other protective clothing. Spread sand or other absorbent material over liquid to absorb it. Shovel into buckets, take to a safe place in the open air. Wash area of spill with soap and water. For final disposal contact your regional office of the N.Y.S. Department of Environmental Conservation.

For more information: Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, 112 N. Pearl St., Albany, New York 12237.
The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at-large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

**Chemical Names:** Chloroethane, methyl chloroform, alpha-trichloroethane, methyl trichloroethane; CAS 71-55-6.

**Trade Names:** Inhibisol, Chlorten, Chlorothene NU, Chlorothene VG, Chlorothene, Alpha-T, Aerothene TT and others.

**Uses:** Cleaning of plastics molds and cold type metal, dry cleaning and degreasing.

**PHYSICAL INFORMATION**

**Appearance:** Colorless liquid.

**Odor:** Sweetish, like chloroform. **Minimum Detectable by Odor:** 400 ppm.

**Behavior in Water:** Not soluble, sinks.

**Evaporation:** Rapid.

**HEALTH HAZARD INFORMATION**

**OSHA Standard:** Average 8 hour exposure — 350 ppm.

**NIOSH Recommended Limit:** 350 ppm.

**AHH Recommended Limit:** Average 8 hour exposure — 350 ppm.

**Short Term Exposure:**

- **Inhalation:** Levels above 900 ppm can cause dizziness, mental confusion, drowsiness, loss of coordination and unconsciousness. Death may result.
- **Skin:** Can cause irritation and rash. Absorption is moderate; may contribute significantly to health hazard.
- **Eyes:** Has caused irritation at levels of 450 ppm.
- **Ingestion:** May cause symptoms similar to inhalation. In addition, may cause mouth, throat and stomach irritation.

**Long Term Exposure:**

Repeted or prolonged contact at levels of 450 ppm or above may result in irritation and dry, scaley, fractured skin. Dizziness, mental confusion, slowed response time and generally reversible liver and kidney damage may result from prolonged inhalation.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see "Toxic Substances: How Toxic is Toxic" available from the New York State Department of Health.*
**1,1,1-Trichloroethane**

**EMERGENCY AND FIRST AID INSTRUCTIONS**

**Inhalation:** Move victim to fresh air. Give artificial respiration or oxygen as required. Seek medical attention if necessary.

**Skin:** Remove soaked clothing. Wash affected areas with soap and water. Seek medical attention as required.

**Eyes:** Flush with water for at least 15 minutes. Seek medical attention immediately.

**Ingestion:** Seek medical attention immediately.

**Note to Physician:** Expired air analysis may be useful in monitoring exposure.

**FIRE AND EXPLOSION INFORMATION**

**General:** Non-flammable.

**REACTIVITY**

**Materials to Avoid:** Reacts violently with acetone, nitrites, oxygen, sodium and sodium hydroxide. Corrosive to aluminum.

**Conditions to Avoid:** Hot metals or ultraviolet radiation will decompose 1,1,1-trichloroethane to form irritating and poisonous gases.

**PROTECTIVE MEASURES**

**Handling and Storage:** Store in a cool, dark, dry place. Do not store in aluminum container.

**Engineering Controls:** Provide adequate ventilation. Sinks, showers and eyewash stations should be readily available.

**Protective Clothing (Should not be substituted for proper handling and engineering controls):** Gloves and apron of polyvinyl alcohol, neoprene (Do not use natural rubber) or leather, and splash proof goggles should be worn if contact with trichloroethane is likely.

**Protective Equipment:** For exposure up to 500 ppm use a supplied-air, or self-contained breathing apparatus with face shield. For escape from a contaminated area use a gas mask with organic vapor canister, or self-contained breathing apparatus.

**PROCEDURES FOR SPILLS AND LEAKS**

Keep workers out of spill area. Use sand or other absorbent to absorb material. Shovel into suitable container. Wash spill area with soap and water. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

**For more information:**

Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
INTRODUCTION

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

SUBSTANCE IDENTIFICATION

- **Formula**: CHCl₂CH₂Cl
- **Synonyms**: Vinyl trichloride; beta-trichloroethane
- **Appearance and odor**: Colorless liquid with a sweet odor, like chloroform.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for 1,1,2-trichloroethane is 10 parts of 1,1,2-trichloroethane per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 45 milligrams of 1,1,2-trichloroethane per cubic meter of air (mg/m³).

HEALTH HAZARD INFORMATION

- **Routes of exposure**: 1,1,2-Trichloroethane can affect the body if it is inhaled if it comes in contact with the eyes or skin, or if it is swallowed. It may be absorbed through the skin.
- **Effects of overexposure**
  1. **Short-term Exposure**: 1,1,2-Trichloroethane may cause irritation of the eyes and nose, drowsiness, incoordination, unconsciousness, and death. It might also cause liver and kidney damage.
  2. **Long-term Exposure**: Repeated or prolonged exposure to 1,1,2-trichloroethane might cause liver or kidney damage.
  3. **Reporting Signs and Symptoms**: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to 1,1,2-trichloroethane.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
  1. Molecular weight: 133.4
  2. Boiling point (760 mm Hg): 113 C (236 F)
  3. Specific gravity (water = 1): 1.43
  4. Vapor density (air = 1 at boiling point of 1,1,2-trichloroethane): 4.55
  5. Melting point: -37 C (-34 F)
  6. Vapor pressure at 20 C (68 F): 18.8 mm Hg
  7. Solubility in water, g/100 g water at 20 C (68 F):
8. Evaporation rate (butyl acetate = 1): Data not available

* Reactivity
2. Incompatibilities: Contact with strong oxidizers, strong caustics, and chemically active metals such as aluminum and magnesium powders, sodium or potassium may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released in a fire involving 1,1,2-trichloroethane.
4. Special precautions: Liquid 1,1,2-trichloroethane will attack some forms of plastics, rubber, and coatings.

* Flammability
1. Flash point: None in normal test method
2. Autoignition temperature: Data not available
3. Flammable limits in air, % by volume: Lower 6.0; Upper: 15.5 (high energy ignition source required)
4. Extinguishant: Foam, carbon dioxide, dry chemical

* Warning properties
1. Odor Threshold: Although 1,1,2-trichloroethane is known to have a sweet, chloroform-like odor, no quantitative data are available concerning the odor threshold of this substance.
2. Eye Irritation Level: Grant reports that high concentrations of the vapors are irritating to the eyes. The concentrations at which this irritation occurs are not stated.
3. Other Information: Grant reports that high concentrations of the vapors are irritating to the respiratory tract, but no quantitative information is given.
4. Evaluation of Warning Properties: Since no quantitative information is available relating the warning properties to air concentrations of 1,1,2-trichloroethane, this substance has been treated as a material with poor warning properties.

**MONITORING AND MEASUREMENT PROCEDURES**

* General
Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

Method
Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure 1,1,2-trichloroethane may be used. An analytical method for 1,1,2-trichloroethane is in the NIOSH Manual of Analytical Methods, 2nd Ed., Vol. 5, 1979, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00349-1).

**RESPIRATORS**

* Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

* In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

**PERSONAL PROTECTIVE EQUIPMENT**

* Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid 1,1,2-trichloroethane.

* Clothing wet with liquid 1,1,2-trichloroethane should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of 1,1,2-trichloroethane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the 1,1,2-trichloroethane, the person performing the operation should be informed of 1,1,2-trichloroethane's hazardous properties.

* Non-impervious clothing which becomes contaminated with liquid 1,1,2-trichloroethane should be removed promptly and not reworn until the 1,1,2-trichloroethane is removed from the clothing.

* Employees should be provided with and required to use splash-proof safety goggles where liquid 1,1,2-trichloroethane may contact the eyes.

**SANITATION**

* Skin that becomes contaminated with liquid 1,1,2-trichloroethane should be promptly washed or showered with soap or mild detergent and water to remove any 1,1,2-trichloroethane.
• Eating and smoking should not be permitted in areas where liquid 1,1,2-trichloroethane is handled, processed, or stored.
• Employees who handle liquid 1,1,2-trichloroethane should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS
The following list includes some common operations in which exposure to 1,1,2-trichloroethane may occur and control methods which may be effective in each case:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Use in organic synthesis in production of vinylidene chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>General dilution ventilation; personal protective equipment</td>
</tr>
</tbody>
</table>

EMERGENCY FIRST AID PROCEDURES
In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure
If 1,1,2-trichloroethane gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• Skin Exposure
If 1,1,2-trichloroethane gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If 1,1,2-trichloroethane soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing
If a person breathes in large amounts of 1,1,2-trichloroethane, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing
When 1,1,2-trichloroethane has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

• Rescue
Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility’s emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES
• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
• If 1,1,2-trichloroethane is spilled or leaked, the following steps should be taken:
  1. Remove all ignition sources.
  2. Ventilate area of spill or leak.
  3. Collect for reclamation or absorb in vermiculite, dry sand, or a similar material.
• Waste disposal method:
1,1,2-Trichloroethane may be disposed of by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

REFERENCES
• American Conference of Governmental Industrial Hygienists: "1,1,2-Trichloroethane," Documentation of the Threshold Limit Values for Substances in Workroom Air (3rd ed., 2nd printing), Cincinnati, 1974.
• Union Carbide Corporation, Industrial Medicine and Toxicology Department: Toxicology Studies - 1,1,2-Trichloroethane, New York, 1972.

* SPECIAL NOTE
1,1,2-Trichloroethane appears on the OSHA "Candidate List" of chemicals being considered for further scientific review regarding its carcinogenicity (Federal Register, Vol. 45, No. 157, pp. 5372-5379, 12 August 1980).
The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See IARC Monograph on the Evaluation of Carcinogenic Risk of Chemicals to Man. Volume 20, 1979.
# Respiratory Protection for 1,1,2-Trichloroethane

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum Respiratory Protection* Required Above 10 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vapor Concentration</strong></td>
<td></td>
</tr>
<tr>
<td>500 ppm or less</td>
<td>Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.</td>
</tr>
<tr>
<td>Greater than 500 ppm or entry and escape from unknown concentrations</td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td><strong>Fire Fighting</strong></td>
<td>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td><strong>Escape</strong></td>
<td>Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.</td>
</tr>
</tbody>
</table>

*Only NIOSH-approved or MSHA-approved equipment should be used.
TRICHLOROETHYLENE

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Trichloroethylene, trichloroethene, ethylene trichloride; CAS 79-01-6.
Trade Names: Algylen, Benzinol, Chlorilen, Fleck-flip, Triclene, Tric, TCE and others.
Uses: The liquid is used as a degreaser and as a solvent in dry cleaning operations.

PHYSICAL INFORMATION

Appearance: Clear, colorless liquid.
Behavior in Water: Does not mix, sinks.
Evaporation: Liquid evaporates slowly.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure limit -- 100 ppm.
NIOSH Recommended Limit: 25 ppm.
ACGIH Recommended Limit: Average 8 hour exposure limit -- 50 ppm.

Short Term Exposure:
Inhalation: Headache, sleepiness, nausea, vomiting, dizziness and coughing have been felt around 100 ppm. Unconsciousness can result at 3,000 ppm. Exposure to 8,000 ppm can cause death.
Skin: Can be absorbed through skin. May cause irritation, burning or redness.
Eyes: May cause irritation, burning or watering.
Ingestion: Can cause drunkenness, vomiting, diarrhea or abdominal pain. Unconsciousness, liver or kidney damage, vision distortion and death have been reported at large doses.

Long Term Exposure:
Contact with vapor levels near 100 ppm can cause giddiness, nervous exhaustion, increased sensitivity to alcohol including redness in the face (trichlorethylene blush), the ability to become addicted to the vapor, as well as effects of acute exposure listed above. Higher levels can alter one's heart rate. Repeated contact with hands can cause excessive dryness, cracking, burning, loss of sense of touch or temporary paralysis of fingers. Most of these effects seem to go away after exposure has stopped.

Trichloroethylene is considered a cancer suspect agent because high levels cause...
Trichloroethylene

EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Get to fresh air. Give artificial respiration or oxygen, if necessary. Keep person warm and at rest. Seek medical attention, if necessary.

Skin: Take off clothing soaked with liquid. Flush skin with plenty of water.

Eyes: Flush eyes with water for 15 minutes. Seek medical attention, if necessary.

Ingestion: Seek medical attention. Do not induce vomiting.

Note to Physician: Expired air analysis and urinary metabolites have been used to monitor exposure.

FIRE AND EXPLOSION INFORMATION

General: Not flammable or explosive at room temperatures. Ignites at 770°F (410°C), moderately flammable at high temperatures.

Explosive Limits: Upper - 41%, lower - 11%. Extinguisher: Carbon dioxide, dry chemical or foam.

REACTIVITY

Conditions to Avoid: Contact with certain hot metals (e.g., aluminum and magnesium), open flames or ultraviolet radiation can form poisonous or explosive products.

Materials to Avoid: Contact with strong alkalies can form highly poisonous and explosive products.

PROTECTIVE MEASURES

Storage and Handling: Store in sealed steel or plastic cans or dark glass bottles.

Engineering Controls: Use in well ventilated areas with no cross drafts. Sinks and showers should be available.

Protective Clothing: If direct contact is likely, wear coveralls, polyvinyl boots and gloves, and goggles or a faceshield.

Protective Equipment: At exposures above 500 ppm, wear a chemical cartridge respirator with an organic vapor cartridge, supplied-air respirator or self-contained breathing apparatus. At exposures above 1000 ppm wear any respirator appropriate for 500 ppm exposure with a full facepiece or a gas mask with an organic vapor canister.

Miscellaneous: Wash any liquid-soaked clothing before reuse. No food or smoking near liquid or vapor.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of the spill area. Put on a respirator and other protective clothing. Spread sand or other absorbent material over liquid to absorb it. Shovel into buckets, take to a safe place in the open air. Wash area of spill with soap and water. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:
The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Xylene, CAS 1330-20-7; 1,3-Dimethylbenzene, meta-xylene, CAS 108-38-3; 1,2-Dimethylbenzene, ortho-xylene, CAS 95-47-6; T,4-Dimethylbenzene, para-xylene, CAS 104-42-3.

Trade Names: p-Xylol, o-Xylol, Mixed aromatic hydrocarbons, m-Xylol and others.

Uses: Used as an intermediate in the manufacture of dyes; found in solvent mixtures, certain insecticides and aviation fuel; degreasing and cleaning agent; Raw material for terephthalic acid. Used in pharmaceutical synthesis and raw material for phthalic anhydrides.

PHYSICAL INFORMATION

Appearance: Clear, colorless liquid which may form crystals at temperatures below 57°F (14°C).

Odor: Strong; pleasant. Minimum Detectable by Odor: 20 ppm.

Behavior in Water: Xylene is not soluble in water, it will float.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure — 100 ppm.

NIOSH Recommended Limit: Average 8 hour exposure — 100 ppm.

ACGIH Recommended Limit: Average 8 hour exposure — 100 ppm.

Note: The health effects and standards for all the xylenes are similar.

Short Term Exposure:

Inhalation: Exposure to vapor can be irritating to the nose and throat. Inhalation of vapor at concentrations above 200 ppm for 3-5 minutes can lead to xylene intoxication. Symptoms include headache, dizziness and nausea. If exposure should continue central nervous system depression characterized by shallow breathing and weak pulse can occur. Levels of 230 ppm for 15 minutes may cause lightheadedness without loss of equilibrium. Reversible liver and kidney damage in man has followed exposure to sudden high concentrations of vapor. Such high levels may also give rise to lung congestion. Exposure to extremely high concentrations (10,000 ppm) of xylene vapors can lead to a strong narcotic effect with symptoms of slurred speech, stupor and coma.

Skin: Contact with vapor or liquid can cause drying and defatting which may lead to irritation.

Eyes: Vapor and liquid may be irritating to the eye and eyelids at levels of 100 ppm for 15 minutes.

Ingestion: Swallowing liquid xylene will bring about an immediate burning sensation in the mouth and throat. Irritation of the stomach and intestine can give rise to sharp stomach pains. Symptoms are the same as inhalation, except that lung congestion.
Term Exposure:

Inhalation of xylene vapor and skin contact with liquid are the two most probable routes of long term exposure. Symptoms of inhalation are dizziness, headache and nausea. Long term exposure has been associated with liver and kidney damage, intestinal tract disturbances and central nervous system depression. These effects are reversible and disappear once the chemical has been removed. Prolonged contact with skin can lead to irritation.

**EMERGENCY AND FIRST AID INSTRUCTIONS**

**Inhalation:** Move to fresh air and give artificial respiration if breathing has stopped. Seek medical attention if necessary.

**Wash with soap and water for at least 5 minutes. Seek medical attention if necessary.**

**Wash with water for at least 15 minutes. Seek medical attention.**

**Do not try to induces vomiting. Seek medical attention immediately.**

**To Physician:** May require supportive measures for pulmonary edema.

**FIRE AND EXPLOSION INFORMATION**

**General:** Liquid and vapor are both flammable. Vapor can spread to a source of ignition and flash back. Ignites at 34°F (1°C).

**Explosive Limits:** Upper = 7%, Lower = 1.1%

**Extinguisher:** Foam, dry chemical or carbon dioxide.

**REACTIVITY**

**Materials to Avoid:** Oxidizing agents such as permanganate and chlorine.

**Materials to Avoid:** Any source of ignition.

**PROTECTIVE MEASURES**

**Storage and Handling:** Protect containers against physical damage. Store, if possible, outdoors or in a detached building. If indoors, a standard flammable liquid storage room should be used.

**Engineering Controls:** Proper ventilation of storage area and work area. Sink, showers, eyewash stations should be available.

**Protective Clothing:** If contact with xylene is likely, wear rubber gloves, chemical goggles and impervious protective clothing.

**Protective Equipment:** For levels up to 500 ppm use a gas mask with an organic vapor canister, a supplied-air respirator with a full facepiece, or a self-contained breathing apparatus with a full facepiece. Up to 1,000 ppm use a chemical cartridge respirator with a full facepiece and organic vapor cartridges. Up to 10,000 ppm use a Type C supplied-air respirator with full facepiece in a positive pressure mode. For escape from a contaminated area, use a gas mask with an organic vapor canister or a self-contained breathing apparatus.

**PROCEDURES FOR SPILLS AND LEAKS**

Workers out of spill area. After putting on protective clothing and equipment, spread absorbent materials over spill area. Sweep and place absorbent into fiber carton container. For final disposal, contact your regional office of the New York State Department of Environmental Conservation.

For more information:

Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substances Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as practical.

Chemical Names: CAS 7440-66-6.

Trade Names: Blue powder, Asareo L15, C.I. Pigment Black 16, and others.

Uses: In galvanizing sheet metal; in bronze, brass, Babbit metal and German silver alloys; in casting, printing, batteries and electrical equipment; as a chemical reagent; as a nutritional trace element; and others.

Physical Information

Appearance: Silvery metal.

Odor: None.

Behavior in Water: Insoluble; material will sink.

Health Hazard Information

OSHA Standard: None established.

NIOSH Recommended Limit: None established.

ACGIH Recommended Limit: None established.

Short Term Exposure:

Note: Zinc metal is not considered very toxic but when combined with other materials such as mineral acids or oxygen, the resulting compounds can have toxic effects. See specific compounds.

Inhalation: No information found on exposure to zinc metal. However, when heated, zinc can form zinc oxide fumes which can cause "Metal Fume Fever". See zinc oxide.

Skin: No information found on exposure to zinc metal. See specific zinc compound.

Eyes: No information found on exposure to zinc metal. See specific zinc compound.

Ingestion: 42 grams (1/3 ounce) of zinc metal taken over 2 days has caused sluggishness, light-headedness, a staggering gait and difficulty in writing. See specific zinc compounds.

Long Term Exposure:

No information found on exposure to zinc metal. See specific zinc compounds.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see "Toxic Substances: How Tois Toxic" available from the New York State Department of Health.
EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: In cases of exposure to fume or dust, remove victim from contaminated area to fresh air. Give oxygen or artificial respiration as needed. Seek medical attention, if necessary.

Skin: Wash affected area with plenty of water.

Eyes: Rinse with plenty of water for 15 minutes. Hold eyelids open. Seek medical attention, if necessary.

Ingestion: If victim is conscious give water. Seek medical attention. Do NOT force an unconscious person to drink.

FIRE AND EXPLOSION INFORMATION

General: Spontaneous combustion may occur if stored in a damp place. Zinc dust forms an explosive mixture with air.

Extinguisher: Use no water. Use special mixtures of dry chemical. Wear a self-contained breathing apparatus.

REACTIVITY

Conditions to Avoid: Presence of moisture can result in spontaneous combustion. Heat or flame can cause explosion or release of toxic fumes.

Materials to Avoid: Dust can react with acids, strong alkalies, amines, chlorides, chlorates, nitrates, oxides, fluorine, sulfur, cadmium, carbon disulfide and others.

PROTECTIVE MEASURES

Storage and Handling: Store in a cool dry place, separated from acids, halogenated hydrocarbons and strong alkalies.

Engineering Controls: Adequate ventilation to keep dust levels low, sinks, showers and eyewash stations should be provided.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Safety glasses or goggles, rubber gloves.

Protective Equipment: Self-contained breathing apparatus for fire fighting.

PROCEDURES FOR SPILLS AND LEAKS

Scoop material into a suitable container. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.
HIGH DENSITY SURFACE SOIL SAMPLING GRID SAMPLES

LOW DENSITY SURFACE SOIL SAMPLING GRID SAMPLES

SITE BOUNDARY

PRELIMINARY LOCATION OF SUBSURFACE SOIL BORINGS. (A TOTAL OF BORINGS PROPOSED)

FIGURE 2-5

SURFACE SOIL SAMPLING PLAN

ROSE TOWNSHIP SITE

Michigan Department of Natural Resources
APPENDIX III

LEVELS OF PERSONNEL PROTECTION
## Table 2

### Levels of Protection

#### Level D Protection
- Tyvek or Saranex coveralls with hood (disposable)
- Inner chemical resistant gloves
- Outer chemical resistant gloves (if appropriate)
- Neoprene boots (steel toe and shank) or steel-toed work boots and disposable vinyl booties
- Escape mask (readily available on the person)
- Hardhat with optional face shield (if appropriate)
- Hooded one piece chemical resistant suit, if appropriate, for splash protection during drilling and sampling operations
- Tape boots to suit (for drilling and sampling tape gloves to suit)

#### Level C Protection
Same as Level D Protection plus the following:
- Full face piece air purifying respirator with combination particulate and organic filters

#### Level B Protection
Same as Level C Protection plus the following:
- Positive pressure self-contained breathing apparatus or positive pressure supplied air required.
- Hooded one-piece chemical suit
EXCLUSION ZONE

Decontamination
Contamination Reduction) Zone

Support Zone
(Clean Area)

Contaminated equipment drop

Clean equipment drop

Tri sodium phosphate wash

Clean water rinse

Disposable garment drop

Final Decontamination

Headquarters

F line

Not to scale

Figure 6
DECONTAMINATION LAYOUT
ROSE TOWNSHIP/DEMODE ROAD

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APPENDIX III
Levels of Personnel Protection

The level of protection will vary with various field activities. The site manager will decide the appropriate level of protection. The level for personnel protection are outlined in Table 2. The following are the various levels of protection that should be used for these known study area activities.

A. Site Survey: Since the above ground wastes have been removed except for areas of contaminated soils, the study area surveying should be conducted in Level D attire. Unless metal contaminated dust is present or HNU, photoionizing device (PID) determine that volatile organics are present, then Level C protection must be worn.

B. A minimum of 4 wind flags will be placed in location visible to all personnel on-site. All personnel activity involved in any drilling must be dressed in Level C unless levels of hydrogen cyanide are found at concentrations at or above the TLV of 10, or volatile organics above 5 ppm, then the protection level will be upgraded to Level B.

C. Personnel: All individuals leaving the Exclusion Zone will strictly follow decontamination procedures (see Figure 6). Upon exiting the Exclusion Zone, there will be a contaminated equipment drop where workers will place equipment that has been contaminated. Clean equipment will be placed at the next point. Outer garments will then be decontaminated by washing with detergent and rinsing. Disposable garments should then be removed, bagged and left for disposal out of the study area in an approved facility. Decontamination liquids will be contained, sampled and analyzed, and removed by a licensed waste hauler, if necessary, by the conclusion of the Remedial Investigation work. All personnel assisting in decontamination procedures must be in Level C protection unless otherwise specified by the site manager. If hydrogen cyanide is present, then Level B will be required unless some other level of protection is set by the site manager.

Decontamination equipment required:

- Two washtubs (boot wash and rinse)
- Two washtubs (equipment wash)
- Trisodium Phosphate
- Sheet Plastic
- High pressure hot water or steam sprayer
- Scrub brushes (to clean garments and equipment)
- Containers to hold contaminated liquids and soils
Heat Stress Casualty Prevention Plan

Due to the increase in ambient air temperatures and the effects of protective outer wear decreasing body ventilation, there exists an increase in the potential for injury, specifically, heat casualties. Site personnel will be instructed in the identification of a heat stress victim, the first-aid treatment procedures for the victim and the prevention of heat stress casualties.

A. Identification and Treatment

1. Heat Exhaustion

   a. Symptoms: Usually begins with muscular weakness, dizziness, nausea, and a staggering gait. Vomiting is frequent. The bowels may move involuntarily. The victim is very pale, his skin is clammy, and he may perspire profusely. The pulse is weak and fast, his breathing is shallow. He may faint unless he lies down. This may pass, but sometimes it remains and death could occur.

   b. First Aid: Immediately remove the victim to the Decontamination Reduction Zone in a shady or cool area with good air circulation. Remove all protective outer wear. Call a physician. Treat the victim for shock. (Make him lie down, raise his feet 6-12 inches, and keep him warm but loosen all clothing.) If the victim is conscious, it may be helpful to give him sips of a salt water solution (1 teaspoon of salt to 1 glass of water). Transport victim to a medical facility.

2. Heat Stroke

   a. Symptoms: This is the most serious of heat casualties due to the fact that the body excessively overheats. Body temperatures often are between 107°-110°F. First there is often pain in the head, dizziness, nausea, oppression, and a dryness of the skin and mouth. Unconsciousness follows quickly and death is imminent if exposure continues. The attack will usually occur suddenly.

   b. First Aid: Immediately evacuate the victim to a cool and shady area in the Decontamination Reduction Zone. Remove all protective outer wear and all personal clothing. Lay him on his back with the head and shoulders slightly elevated. It is imperative that the body temperature be lowered immediately. This can be accomplished by applying cold wet towels, ice bags, etc., to the head. Sponge off the bare skin with cool water or rubbing alcohol, if available, or even place him in a tub of cool water. The main objective is to cool him without chilling him. Give no stimulants. Transport the victim to a medical facility as soon as possible.
APPENDIX II

STUDY AREA WORK ZONE
APPENDIX II

Study Area Work Zones

The site manager will clearly lay out and identify the various study area work zones. He/She will limit equipment, operations and personnel in the areas as defined below.

A. Exclusion Zone: This includes all areas where known or potentially contaminated soils and groundwater are to be sampled or disturbed. These areas will be clearly marked and personnel advised as to their location. A minimum of Level D with some activities requiring Level C or B protective equipment is required for these areas. (see APPENDIX III)

B. Decontamination Zone (contamination Reduction Zone): This zone occurs at the interface of the Exclusion Zone and Support Zone. It provides an area of decontamination for equipment, clothing and personnel prior to entering the Support Zone.

C. Support Zone: This is the area outside the zone of significant air, soil, and surface water contamination. The functions of the Support Zone include:

1. An entry area and checkpoint for personnel, materials and equipment for study area site operations.

2. An exit area for decontaminated personnel, materials and equipment.

3. Storage area for equipment.

4. Housing for site special services.

5. Storage of first aid supplies.
B. Prevention of Heat Stress

1. One of the major causes of heat casualties is the depletion of body fluids. On the site there will be plenty of fluids available. Personnel should replace water and salts lost from sweating. Salts can be replaced by either a 0.1% salt solution, more heavily salted foods, or commercial mixes such as Gatorade. The commercial mixes are advised for personnel on low sodium diets.

2. A work schedule will be established so that the majority of the work day will be during the morning hours of the day before ambient air temperature levels reach their highs.

3. A work/rest guideline will be implemented for personnel required to wear Level B protection. This guideline is as follows:

<table>
<thead>
<tr>
<th>Ambient Temperatures</th>
<th>Maximum Wearing Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 90°F</td>
<td>1/2 hour</td>
</tr>
<tr>
<td>80°F-90°F</td>
<td>1 hour</td>
</tr>
<tr>
<td>70°F-80°F</td>
<td>2 hours</td>
</tr>
<tr>
<td>60°F-70°F</td>
<td>3 hours</td>
</tr>
<tr>
<td>50°F-60°F</td>
<td>4 hours</td>
</tr>
<tr>
<td>40°F-50°F</td>
<td>5 hours</td>
</tr>
<tr>
<td>30°F-40°F</td>
<td>6 hours</td>
</tr>
<tr>
<td>Below 30°F</td>
<td>8 hours</td>
</tr>
</tbody>
</table>

A sufficient period will be allowed for personnel to "cool down". This may require shifts of workers during operations.
APPENDIX IV

HEALTH EXAM
Personnel engaged in waste site work activities will have health monitoring examinations at least annually. These examinations should include:

Physical
Medical History
Clinical Laboratory Tests:
   SMA-12
   Complete Blood Count
   Urinalysis
   Pulmonary Function Tests
   Chest X-ray

Blood constituent levels may be monitored in staff actively working in the study area if unexpected levels of contaminants are found during the remedial investigation. Blood sampling protocol, parameters and frequency will be designed with input from MDPH. All State personnel shall receive a written medical opinion as to their capability to wear respiratory equipment prior to its use (see Figure 5).

Personnel will also receive additional medical tests if deemed necessary by physicians or MDNR safety personnel, in consultation with MDPH, following chemical exposure symptom detection.
FIGURE 5
MICHIGAN DEPARTMENT OF NATURAL RESOURCES
RESPIRATOR CERTIFICATION

Name: _______________________________   Date: __________

Division: ______________________________

In the opinion of the undersigned physician, the above employee:

[ ] May wear a respirator
[ ] May not wear a respirator.

__________________________, MD

License No. _________________________
APPENDIX V

EQUIPMENT TO BE MAINTAINED ONSITE
APPENDIX V
EQUIPMENT TO BE MAINTAINED ONSITE

1. Portable emergency eye wash and shower.
2. Twenty pound ABC type dry chemical fire extinguishers/pressure water extinguishers.
4. Emergency tools.
5. An industrial first aid kit.
7. Hand-held horn used to signal site evacuation.

Safety Practices To Be Adhered To By All On-Site Personnel:

1. 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 the exclusion or contamination reduction zone.
2. Hands and face must be thoroughly washed upon leaving the work area and before eating, drinking, or any other activities.
3. 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.
4. No excessive facial hair, which interferes with a satisfactory fit of the mask-to-face seal, is allowed for personnel required to wear respiratory protective equipment.
5. Contact with contaminated or suspected contaminated surfaces should be avoided. Whenever possible, don't walk through puddles, mud, and other discolored surfaces; kneel on ground; lean, sit, or place equipment on drums, containers, vehicles, or the ground.
6. Medicine and alcohol can exaggerate the effects from exposure to toxic chemicals. Personnel on prescribed drugs should check with a qualified physician before entering the site. Prescribed drugs should only be taken by personnel when specifically approved by a qualified physician because of the potential for absorption, inhalation, or ingestion of toxic substances. Alcoholic beverage intake should be avoided during site operations.
AIR MONITORING

An air monitoring investigation will be conducted in the vicinity of the Rose Township site to provide data describing the nature and extent of on-site air contamination and to aid in the establishment of a site safety procedure for the field investigation. Air monitoring data will also provide information useful in evaluating potential remedial measures for the site.

The objectives of the limited air quality investigation proposed for the Rose Township site are as follows:

- provide information to assess the respiratory protection requirements for on-site personnel during field activities; and

- provide information on the degradation of ambient air quality during excavations into buried waste and/or contaminated soils.

Initial air monitoring will be performed during the site reconnaissance (Task 2) with an HNU photoionization (PI) meter. This monitoring will include a site perimeter survey, a site survey, and the monitoring of specific locations on-site. Should initial air monitoring reveal total organic vapor concentrations in excess of the level specified in the site master safety plan, additional monitoring will be performed with a Photovac Organic Vapor Analyzer (OVA) to attempt identification of vapor constituents. This data will aid in the selection of respiratory protective equipment.

The site survey will occur on a regular basis during site activities to alert on-site personnel to any change of conditions. Selected respiratory protective equipment will be reviewed for adequacy as new data becomes available. Air quality monitoring will also be conducted during borehole/piezometer installation. Each borehole will be monitored on the downwind side of the borehole while being drilled. Evaluated PI readings will result in respiratory protection review. All readings will be logged on field sheets and will become a part of the data base to be used in preparing the RI report.

Furthermore, the DNR site manager or representative will be promptly notified of any results that would require a change in protection level.
APPENDIX VI

EMERGENCY ROUTES
Michigan DNR Contacts

James S. Linton  Project Manager  517-373-8448
Earle N. Latimer  Site Manager  517-373-4800
Pollution Emergency Alerting System, 24 hours  1-800-292-4706
Cathy Simon  Health Monitoring Personnel  1-517-373-2190

Emergency Notification of Department of Natural
Resources, Contact: 1-800-292-4706
or 1-517-373-7660

Emergency Routes  Travel Time Approximately 50 minutes
Distance Approximately 28 miles.

From the site to Pontiac General Hospital in Pontiac, take
DeMode Road west to Hickory Ridge Road, south (left) to State
Route 59, (turn west (M-59) (right), go to first left that
crosses median, about one block) then go east on Route 59
to Seminole south (right). Hospital on Left.

Emergency Response Protocol

All emergency telephone numbers and emergency route map to
the hospital will be posted at the headquarters near the telephone.
In the event of physical injury, the site safety officer or
any other qualified person will initiate first aid and, if
necessary, call the ambulance. If chemical exposure is encountered,
the physician will be informed, as specifically as possible,
the chemical(s) the person has been exposed to and the toxicological
properties of the chemical(s).

This safety plan was developed with the most recent and available
information. If through the site investigation additional
pertinent information to safety is made available, it will
be used to amend this plan. In addition, the site manager
may use this information to increase personnel protective
measures on the site.
APPENDIX VII

SITE EVALUATION
SITE EVACUATION

Should evacuation of the site become necessary, an alarm will be sounded at the site office trailer. The alarm will be audible in the work area.

When the evacuation alarm is sounded, all site workers will observe wind socks and proceed upwind and crosswind if necessary from the incident. All onsite workers will meet at the primary offsite meeting place located on DeMode Road, at the entrance to the site unless the wind direction is directly out of the south. If the wind is directly out of the south, then all site workers are to report to the secondary meeting point located west of the site entrance at 1201 DeMode Road.

3/21/84