

April 1979

ETHYLENE DICHLORIDE

WORK IN PROGRESS

API

<u>Program</u>	<u>Investigator</u>	<u>Organization</u>	<u>Completion Date</u>
Experimental Investigations on the Biological Effects of Dichloroethane (DCE) (EDC 1.0)	Dr. C. Maltoni	Montedison, S.p.A.	in progress
Clinical Chemistry Studies in Rats Exposed to Long-Term Inhalation with EDC (EDC 1.0)	Dr. F. Spreafico	Montedison, S.p.A.	in progress
Investigate the Pharmacodynamics of Inhaled Ethylene Dichloride in Laboratory Animals (EDC 2.0)	Dr. F. Spreafico	Mario Negri	in progress
Study of the Effects of Maternally Inhaled Ethylene Dichloride on Rat and Rabbit Embryonal and Fetal Development (EDC 3.0)	Dr. K. Olson	The Dow Chemical Company	in progress
Single Generation Reproduction Study on Inhaled Ethylene Dichloride in Rats (EDC 4.0)	Dr. K. Olson	The Dow Chemical Company	in progress

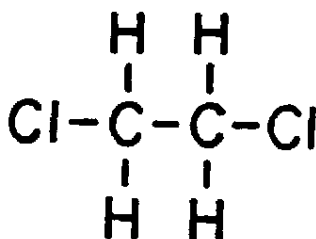
CCR 000080474

NIOSH

Current Intelligence Bulletin 25

April 19, 1978

ETHYLENE DICHLORIDE



(1,2 - Dichloroethane)



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

CCR 000080475

The Current Intelligence Bulletin is the primary product of the Current Intelligence System. The purpose of the Current Intelligence System is to promptly review, evaluate, and supplement new information received by NIOSH on occupational hazards that are either unrecognized or are greater than generally known.

As warranted by this evaluation, the information is capsulized and disseminated to NIOSH staff, other government agencies, and the occupational health community, including labor, industry, academia, and public interest groups. With respect to currently known hazard information this system also serves to advise appropriate members of the above groups of recently acquired specific knowledge which may have an impact on their programs or perception of the hazard. Above all, the Current Intelligence System is designed to protect the health of American workers and to allow them to work in the safest possible environment.

Synonyms & Identifiers

NIOSH-RTECS: KI05250

CHEMICAL ABSTRACTS SERVICE REGISTRY NUMBER: 107-06-2

CHEMICAL FORMULA: $C_2H_4Cl_2$

α , β -DICHLOROETHANE

1,2-DICHLOROETHANE

BROCID

DESTRUXOL BORER-SOL

DI-CHLOR-MULSION

1,2-DICHLOROETHANE

1,2-DICHLOROETHANE

DICHLOROETHYLENE

DUTCH LIQUID

EDC

ENT 1,656

ETHYLENE CHLORIDE

ETHYLENE DICHLORIDE

GLYCOL DICHLORIDE

sym-DICHLOROETHANE

DHEW (NIOSH) Publication No. 78-149

CURRENT INTELLIGENCE BULLETIN:
ETHYLENE DICHLORIDE (1,2-DICHLOROETHANE)

April 19, 1978

The National Institute for Occupational Safety and Health (NIOSH) recommends that as a prudent measure, ethylene dichloride (1,2-dichloroethane) be handled in the workplace as if it were a human carcinogen. This recommendation is based primarily upon an analysis of National Cancer Institute (NCI) data indicating that laboratory rats and mice fed ethylene dichloride experienced a statistically significant excess of malignant and benign tumors, as compared to controls (1).

NIOSH has prepared this Bulletin to advise you of the findings of the NCI study, other pertinent data, including findings on the mutagenic and teratogenic qualities of ethylene dichloride, and their implications for occupational health. Also included are "Suggested Guidelines for Minimizing Employee Exposure to Ethylene Dichloride." We are requesting that producers, distributors, professional associations, and unions transmit the information in this Bulletin to their customers, employees, associates, and members.

Background

The current Department of Labor, Occupational Safety and Health Administration (OSHA) standard for occupational exposure to ethylene dichloride is 50 ppm (8-hour time-weighted average). In March 1976, NIOSH recommended an exposure limit of 5 ppm (time-weighted average for up to a 10-hour workday, 40-hour workweek) (2). Neither of these levels may provide adequate protection from potential carcinogenic effects because they were selected to prevent toxic effects other than cancer. The NIOSH recommendation was based on reports of adverse effects on the nervous system and liver of workers exposed to 10-15 ppm ethylene dichloride. Exposure to higher levels was also reported to affect the cardiac and respiratory systems. We further advised nursing mothers not to work with ethylene dichloride since the chemical has been found in the milk of exposed human mothers. At the time of the recommendation, there were no reports that ethylene dichloride caused cancer in animals or man. However, we did note that information on this subject was inadequate and that the National Cancer Institute (NCI) was conducting bioassay tests on ethylene dichloride.

Production and Use

Ethylene dichloride is one of the highest volume chemicals used in the United States. It is a colorless oily liquid with a chloroform-like odor, detectable over the range of 6 to 40 ppm, with a sweet taste (3). Patty (4) concluded that a person can become adapted to the odor of ethylene dichloride at low concentrations and that its odor is probably not sufficiently striking to be considered a significant warning of hazardous chronic exposure. Ethylene dichloride (1,2-dichloroethane), which has a carbon-carbon single bond, should be distinguished from 1,2-dichloroethene which has a carbon-carbon double bond.

Between 1973 and 1976, the United States annual average production of ethylene

dichloride was approximately 10 billion pounds. During these years, most of it was used as an intermediate in the production of vinyl chloride, but it was also used in the production of other chemicals, such as 1,1,1-trichloroethane, trichloroethylene, perchloroethylene, vinylidene chloride, and ethyleneamines (5). Ethylene dichloride is a lead scavenger, and therefore appears as a component of most leaded fuels. Ethylene dichloride was also used as an extraction solvent, as a solvent for textile cleaning and metal degreasing, in certain adhesives, and as a component in fumigants for upholstery, carpets, and grain. Other miscellaneous applications include paint, varnish, and finish removers, soaps and scouring compounds, wetting and penetrating agents, organic synthesis, ore flotation, and as a dispersant for nylon, rayon, styrene-butadiene rubber and other plastics.

Potential Occupational Exposures

The National Institute for Occupational Safety and Health estimates that as many as 2 million workers may have occupational exposure to ethylene dichloride. Of these workers, an estimated 34,000 are exposed to ethylene dichloride 4 hours or more per day. These projections are based on the NIOSH National Occupational Hazards Survey (NOHS) conducted between 1972 and 1974, which encompassed some 500,000 employees at approximately 4,775 facilities. According to the survey, numerous exposures occurred in the following industries: chemical and allied products, printing and publishing, electrical equipment and supplies, wholesale and retail trade, food and kindred products, leather and leather products, and machinery.

Laboratory Animal Studies for Carcinogenicity

On March 6, 1978, the Clearinghouse on Environmental Carcinogens (NCI) reviewed and accepted the results of the bioassay of ethylene dichloride, which was performed under contract for the National Cancer Institute.

In the bioassay, technical grade 1,2-dichloroethane was tested for possible carcinogenicity in Osborne-Mendel rats and B6C3F1 mice. 1,2-Dichloroethane in corn oil was force-fed at either of two dosages, to groups of 50 male and 50 female animals of each species. Untreated and vehicle control animals were also used. The time-weighted average high and low doses of 1,2-dichloroethane in the chronic study were 95 and 47 mg/kg/day, respectively for rats of both sexes. The high and low time-weighted average doses for the male mice were 195 and 97 mg/kg/day, respectively, and 299 and 149 mg/kg/day, respectively for the female mice.

To relate some of the above information to the work environment, a 70 kg man breathing a typical 10 cu m/day (over an 8-hour work shift) of air contaminated with 50 ppm of ethylene dichloride (the current OSHA standard for exposure to ethylene dichloride) would have an inhalation exposure of about 30 mg/kg/day. Because respiration rate increases with exertion, jobs with higher exertion are likely to be associated with increased respiratory intake.

CCR 000080478

The National Cancer Institute has concluded that under the conditions of the study, 1,2-dichloroethane was carcinogenic to Osborne-Mendel rats and B6C3F1 mice. Table 1 summarizes the statistically significant tumors found in the NCI Bioassay of 1,2-dichloroethane.

TABLE 1

Statistically Significant Tumors Found in NCI Bioassay of 1,2-Dichloroethane

Species/Sex	Adverse Effect	Site
Rats/Male	Squamous-Cell Carcinomas Hemangiosarcomas Fibromas	Forestomach Circulatory System Subcutaneous Tissue
Rats/Female	Adenocarcinomas	Mammary Gland
Mice/Female	Adenocarcinomas	Mammary Gland
Mice/Female	Stromal Polyps Stromal Sarcomas	Endometrium Endometrium
Mice/Male & Female	Adenomas	Alveoli and Bronchioli

Two additional studies to assess the carcinogenic potential of ethylene dichloride are currently underway. In an ethylene dichloride inhalation study being conducted in Italy by Dr. C. Maltoni, animals will be exposed to ethylene dichloride for 2 years and observed until the end of their natural lives. No evidence of any exceptional tumor in rats or mice has been found following 100 weeks of exposure (6). Also, Dr. B. M. Goldschmidt has informed NIOSH of bioassays of 1,2-dichloroethane being conducted at the New York University Institute of Environmental Medicine. Groups of 30 female mice received skin applications of 1,2-dichloroethane for more than one year. None of the animals developed skin tumors, and autopsies did not reveal any unexpected internal lesions or tumors (7).

Other Laboratory Animal Studies

The toxic effects of ethylene dichloride exposure have been studied in a large number of animal species (2). Acute exposure to ethylene dichloride seemed to most frequently affect the cardiovascular system as evidenced by extreme lowering of blood pressure, and cardiac impairment. Other toxic effects include pulmonary edema, fatty degeneration of the liver and kidney (renal tubules) and degeneration of the adrenal cortex. Also, ethylene dichloride is reported to be a weak mutagen in bacteria and

mutagenic in fruit flies (8). In the rat, ethylene dichloride has been reported to cross the placental barrier, accumulate in the placenta and fetal tissues, and cause abnormal development of the fetus (9,10,11).

Human Toxicity

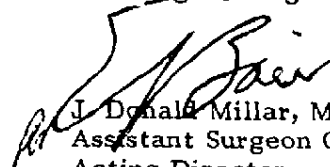
The acute effects of ethylene dichloride are similar for all routes of entry: ingestion, inhalation, and skin absorption. Acute exposures result in nausea, vomiting, dizziness, internal bleeding, bluish-purple discoloration of the mucous membranes and skin (cyanosis), rapid but weak pulse, and unconsciousness. Acute exposures can lead to death from respiratory and circulatory failure. Autopsies in such situations have revealed widespread bleeding and damage in most internal organs. Repeated long-term exposures to ethylene dichloride have resulted in neurologic changes, loss of appetite and other gastrointestinal problems, irritation of the mucous membranes, liver and kidney impairment, and death (2).

NIOSH Recommendation

The National Institute for Occupational Safety and Health is currently preparing an update to the March 1976 recommendations regarding exposure to ethylene dichloride, which will address the carcinogenic potential of this substance in the workplace. The NCI laboratory study showing ethylene dichloride to be a carcinogen in two animal species utilized forced-feeding (directly into the stomach) for the route of exposure. However, it is important to keep in mind that ethylene dichloride can and does enter the body via inhalation and through the skin, as well as orally. When evaluating the test results or potential exposure to the substance in the workplace, in addition to the route of entry into the body, the amount of ethylene dichloride which is absorbed and actually reaches the target tissue or organ is a significant issue in determining the extent or possibility of the health hazard.

Animal studies are valuable in helping identify human carcinogens. Although humans may be more sensitive or less sensitive than experimental animals to specific chemical compounds, substances that cause cancer in experimental animals must be considered to pose a potential cancer risk in man. Safe levels of exposure to carcinogens have not been demonstrated, but the probability of cancer development is lowered with decreasing exposure to carcinogens.

As an interim and prudent measure while the carcinogenicity of ethylene dichloride is being further evaluated, NIOSH recommends that occupational exposure be minimized. Exposures should be limited to as few employees as possible, while minimizing workplace exposure levels with engineering and work practice controls.


J. Donald Millar, M.D.
Assistant Surgeon General
Acting Director

REFERENCES

1. Bioassay of 1,2-Dichloroethane for Possible Carcinogenicity. DHEW Publication No. (NIH) 78-1305. U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Cancer Institute, (Camera-Ready Copy dated 1/10/78).
2. Criteria for a Recommended Standard Occupational Exposure to Ethylene Dichloride (1,2-dichloroethane). DHEW Publication No. (NIOSH) 76-139, U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, March 1976.
3. Hellman, T.M. and Small, F.H. "Characterization of the Odor Properties of 101 Petrochemicals Using Sensory Methods," Journal of the Air Pollution Control Association, 24(10):979-982, 1974.
4. Patty, F.A. Industrial Hygiene and Toxicology, Second Revised Edition, Volume II, Fawcett, D.W., Irish, D.D., eds. John Wiley & Sons, Inc., New York.
5. Stanford Research Institute. Chemical Economics Handbook. Menlo Park, California, October, 1977.
6. Letter to Director, National Institute for Occupational Safety and Health (NIOSH) from Mr. Albert C. Clark, Manufacturing Chemists Association (MCA), December 22, 1977. Letter to Dr. Arthur Gregory (NIOSH) from Ms. Lucille C. Henschel (MCA), February 28, 1978.
7. Letter to Dr. Arthur Gregory, National Institute for Occupational Safety and Health (NIOSH) from B.M. Goldschmidt, Ph.D., New York University Medical Center, Institute of Environmental Medicine, February 28, 1978.
8. Fishbein, L. "Industrial Mutagens and Potential Mutagens I. Halogenated Aliphatic Derivatives," Mutation Research, 32:267-308, 1976.
9. Vozovaya, M.A. "The Effect of Dichloroethane on the Sexual Cycle and Embryogenesis of Experimental Animals," Akusk. Ginek. (Moskow), 2:57-59, 1977.
10. Vozovaya, M.A. "The Effect of Small Concentrations of Benzene and Dichloroethane Separately and Combined on the Reproductive Function of Animals," Gig. Sanit. (Moskow), 6:100-102, 1976.
11. Vozovaya, M.A. "The Effect of Small Concentrations of Benzene, Dichloroethane Alone and Combined, on the Reproductive Function of Animals and the Development of the Progeny," Gig. Tr. Prof. Zabol. (Moskow), 7:20-23, 1975.

SUGGESTED GUIDELINES FOR MINIMIZING EMPLOYEE EXPOSURE TO ETHYLENE DICHLORIDE (1,2-DICHLOROETHANE)

NIOSH recommends that it would be prudent to handle ethylene dichloride in the workplace as if it were a human carcinogen. Exposure to ethylene dichloride should be limited to as few employees as possible, while minimizing workplace exposure levels. The area in which it is used should be restricted to only those employees essential to the process or operation.

EXPOSURE MONITORING

Initial and routine employee exposure surveys should be made by competent industrial hygiene and engineering personnel. These surveys are necessary to determine the extent of employee exposure and to ensure that controls are effective.

The NIOSH Occupational Exposure Sampling Strategy Manual, NIOSH Publication #77-173, may be helpful in developing efficient programs to monitor employee exposures to ethylene dichloride. The manual discusses determination of the need for exposure measurements, selection of appropriate employees for exposure evaluation and selection of sampling times.

Employee exposure measurements should consist of 8-hour TWA (time-weighted average) exposure estimates calculated from personal or breathing zone samples (air that would most nearly represent that inhaled by the employees). Area and source measurements may be useful to determine problem areas, processes, and operations.

MINIMIZING EMPLOYEE EXPOSURE

There are four basic methods of limiting employee exposure to ethylene dichloride. None of these is a simple industrial hygiene or management decision and careful planning and thought should be used prior to implementation of any of these.

o Product Substitution

The substitution of an alternative material with a lower potential health risk is one method. However, extreme care must be used when selecting possible substitutes. Alternatives to ethylene dichloride should be fully evaluated with regard to possible human effects. Unless the toxic effects of the alternative have been thoroughly evaluated a seemingly safe replacement, possibly only after years of use, may be found to induce serious health effects.

o Contaminant Controls

The most effective control of ethylene dichloride, where feasible, is at the source of contamination by enclosure of the operation and/or local exhaust ventilation.

If feasible, the process or operation should be enclosed with a slight vacuum so that any leakage will result in the flow of external air into the enclosure.

The next most effective means of control would be a well designed local exhaust ventilation system that physically encloses the process as much as possible, with sufficient capture velocity to keep the contaminant from entering the work atmosphere.

To ensure that ventilation equipment is working properly, effectiveness (e.g., air velocity, static pressure, or air volume) should be checked at least every three months. System effectiveness should be checked soon after any change in production, process, or control which might result in significant increases in airborne exposures to ethylene dichloride.

o Employee Isolation

A third alternative is the isolation of employees. It frequently involves the use of automated equipment operated by personnel observing from a closed control booth or room. The control room is maintained at a greater air pressure than that surrounding the process equipment so that air flow is out of, rather than into, the room. This type of control will not protect those employees that must do process checks, adjustments, maintenance, & related operations.

o Personal Protective Equipment

The least preferred method is the use of personal protective equipment. This equipment, which may include respirators, goggles, gloves, etc., should not be used as the only means to prevent or minimize exposure during routine operations.

Exposure to ethylene dichloride should not be controlled with the use of respirators except:

- During the time period necessary to install or implement engineering or work practice controls; or
- In work situations in which engineering and work practice controls are technically not feasible; or
- For maintenance; or
- For operations which require entry into tanks or closed vessels; or
- In emergencies.

Only respirators approved by the National Institute for Occupational Safety and

Health (NIOSH) should be used. Refer to NIOSH Certified Equipment, December 15, 1975, NIOSH publication #76-145 and Cumulative Supplement June 1977, NIOSH Certified Equipment, NIOSH publication #77-195. The use of facesal coverlets or socks with any respirator voids NIOSH approvals.

Quantitative facesal fit test equipment (such as sodium chloride, dioctyl phthalate, or equivalent) should be used. Refer to A Guide to Industrial Respiratory Protection, NIOSH publication #76-189 for Guidelines on appropriate respiratory protection programs..

In addition, proper maintenance procedures, good housekeeping in the work area and education of employees concerning the nature of the hazard, its control and personal hygiene are all aspects of a good control program.

CUMULATIVE LIST OF NIOSH CURRENT INTELLIGENCE BULLETINS

* 1.	Chloroprene	- January 20, 1975
* 2.	Trichloroethylene (TCE)	- June 6, 1975
* 3.	Ethylene Dibromide (EDB)	- July 7, 1975
* 4.	Chrome Pigments	- June 24, 1975
		- October 7, 1975
		- October 8, 1976
* 5.	Asbestos	- August 8, 1975
* 6.	Hexamethylphosphoric Triamide (HMPA)	- October 24, 1975
* 7.	Polychlorinated Biphenyls (PCBs)	- November 3, 1975
		- August 20, 1976
	8. 4,4-Diaminodiphenylmethane (DDM)	- January 30, 1976
* 9.	Chloroform	- March 15, 1976
10.	Radon Daughters	- May 11, 1976
11.	Dimethylcarbamoyl Chloride (DMCC)	
	Revised	- July 7, 1976
12.	Diethylcarbamoyl Chloride (DECC)	- July 7, 1976
13.	Explosive Azide Hazard	- August 16, 1976
14.	Inorganic Arsenic - Respiratory Protection	- September 27, 1976
* 15.	Nitrosamines in Cutting Fluids	- October 6, 1976
* 16.	Metabolic Precursors of a Known Human Carcinogen, Beta-Naphthylamine	- December 17, 1976
* 17.	2-Nitropropane	- April 25, 1977
* 18.	Acrylonitrile	- July 1, 1977
* 19.	2,4-Diaminoanisole	- January 13, 1978
* 20.	Tetrachloroethylene (Perchloroethylene)	- January 20, 1978
21.	Trimellitic Anhydride (TMA)	- February 3, 1978
* 22.	Ethylene Thiourea (ETU)	- April 11, 1978
* 23.	Ethylene Dibromide and Disulfiram Toxic Interaction	- April 11, 1978
* 24.	Direct Black 38, Direct Blue 6, and Direct Brown 95 Benzidine Derived Dyes	- April 17, 1978
* 25.	Ethylene Dichloride (1,2-Dichloroethane)	- April 19, 1978

NOTE: Bulletins #1 through #18 have been reprinted as a NIOSH publication, #78-127, for the convenience of those that desire a complete series of Current Intelligence Bulletins. Distribution of this publication and single copies of Bulletins #19 and later are available from NIOSH Publications Dissemination, Division of Technical Services, 4676 Columbia Parkway, Cincinnati, Ohio 45226.

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for Occupational Exposure To**Ethylene Dichloride (1,2-Dichloroethane)**

A complete criteria document for occupational exposure to ethylene dichloride (1,2-dichloroethane) has been prepared by the National Institute for Occupational Safety and Health (NIOSH). NIOSH recommends that occupational exposure to ethylene dichloride be controlled so that workers are not exposed in excess of 5 ppm (20 mg/cubic meter) determined as a time-weighted average for up to a 10-hour workday, 40-hour workweek. NIOSH also recommends that peak exposures not exceed 15 ppm (60 mg/cubic meter) as determined by a sampling period of 15 minutes. Furthermore, NIOSH recommends that nursing mothers not be exposed to ethylene dichloride since ethylene dichloride is readily absorbed into the mothers' milk.

Liquid ethylene dichloride is absorbed through the skin, and because spills are extremely hazardous, NIOSH recommends other preventative measures wherever ethylene dichloride is used. These measures include labeling of containers, informing employees of the hazards, use of protective clothing, and provision of showers and eyewash facilities.

About 75 percent of the approximately 8 billion pounds of ethylene dichloride produced in the United States is used to make vinyl chloride. Much of the remainder is used in anti-knock mixtures of leaded fuels, in fumigant-insecticides, in the formulation of some degreaser compounds, and in rubber cements. NIOSH estimated that 18,000 workers are potentially exposed to ethylene dichloride.

Little is known about the metabolism of ethylene dichloride, but the available animal data, as well as the signs and symptoms of acute human poisoning, indicate that ethylene dichloride is metabolized to more toxic substances. The metabolites may include 2-chloroethanol, chloroacetaldehyde, and monochloroacetic acid.

Fatalities have not been reported when the exposure concentrations were below 75 ppm. Signs and symptoms of acute poisoning include headache, dizziness, lassitude, nausea, vomiting, and abdominal pain. These signs and symptoms have not been reported when the exposure concentrations were below 25 ppm, but chronic cardiac, hepatic, and neurologic effects have been found.

Reports of occupational exposures that were without effect were not found in the literature, but evaluation of the available information suggests that adherence to the recommended airborne limits coupled with control of source exposure by adherence to recommended work practices should prevent the toxic effects that have been reported.

NIOSH recommends that workers exposed to ethylene dichloride at half or more of the recommended standard have comprehensive preplacement and annual medical examinations giving particular attention to cardiovascular, pulmonary, neurologic, liver, and kidney functions. Engineering controls should be used whenever feasible to maintain ethylene dichloride concentrations below the prescribed limit, and respirators should only be used in certain nonroutine or emergency situations.

The recommended standard is part of a continuing series of criteria documents developed by NIOSH in accordance with the Occupational Safety and Health Act of 1970. The document was transmitted to the U.S. Department of Labor on March 4, 1976, for review and consideration in the standard setting process. The criteria document was reviewed by six consultants, two professional societies, and Government agencies having interest and responsibility for occupational safety and health. In addition, consideration was given to two responses obtained from solicitation in the Federal Register. The proposed standard is considered appropriate and no additional information that would affect the recommended standard is available.

The following is the first chapter of the criteria document. It contains the NIOSH recommendations for controlling worker exposure to ethylene dichloride (1,2-dichloroethane).



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

CCR 000080487

Single copies of complete criteria document are available from:
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dichloride-resistant materials shall be used. Suitable eye protection shall be in accordance with 29 CFR 1910.133.

Section 5 — Informing Employees of Hazards from Ethylene Dichloride

All new and present employees in any ethylene dichloride area shall be kept informed of the hazards, relevant symptoms, effects of overexposure, and proper conditions and precautions concerning safe use and handling of ethylene dichloride.

A continuing educational program shall be instituted to ensure that all workers have current knowledge of job hazards, proper maintenance procedures, and cleanup methods, and that they know how to correctly use respiratory protective equipment and protective clothing.

The information explaining the hazards of working with ethylene dichloride shall be kept on file and readily accessible to the worker at all places of employment where ethylene dichloride is manufactured, used, transported, or stored.

Information as required shall be recorded on US Department of Labor Form OSHA-20, "Material Safety Data Sheet," or similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 — Work Practices

(a) Handling and Storage

(1) Storage containers, piping, and valves shall be periodically inspected for leakage.

(2) Storage facilities shall be designed to contain spills and prevent contamination of workroom air.

(3) Processes and storage facilities shall not be located near open flames or high-temperature operations, unless precautions are taken to prevent fire and explosion hazards and exposure to pyrolysis products.

(4) Where ethylene dichloride is transferred from one metal container to another, the 2 vessels shall be grounded or electrically interconnected by bonding. The use of mechanical equipment likely to give off sparks should be avoided.

(5) Where ethylene dichloride is used as a fumigant, strict adherence to label requirements for application and personal protection shall be followed. In addition, standards for pesticide use by agricultural workers can be found in 40 CFR 170.

(b) Contaminant Controls

(1) Suitable engineering controls designed to limit exposure to ethylene dichloride to that prescribed in subsection (a) of Section 1 shall be utilized. Ventilation systems shall be designed to prevent the accumulation or recirculation of ethylene dichloride in the workroom and to effectively remove ethylene dichloride from the breathing zones of workers. Ventilation systems shall be subjected to regular preventive

maintenance and cleaning to ensure maximum effectiveness, which shall be verified by periodic airflow measurements.

(2) Portable exhaust ventilation or suitable general ventilation shall be provided for operations that require the spray application of ethylene dichloride such as in fumigation operations.

(3) Buildings in which ethylene dichloride is used where it could form an explosive air mixture shall be explosion-proof. Explosion vents are available and effective on windows, roof and wall panels, and skylights as a safeguard against destruction of buildings and equipment in which flammable vapors may accumulate. Stair enclosures shall also be fire-resistant and shall have self-closing fire doors.

(4) Forced draft ventilation systems shall be equipped with remote manual controls and designed to turn off automatically in the event of a fire in the building.

(c) Equipment Maintenance and Emergency Procedures

(1) Ethylene dichloride hazard areas

A hazard area that workers may enter shall be considered as any space with physical characteristics and sources of ethylene dichloride that could result in concentrations of ethylene dichloride in excess of the environmental limit. Exits shall be plainly marked. Emergency exit doors shall be conveniently located and shall open into areas which will remain free of contamination in an emergency. At least 2 separate means of exit shall be provided from each room or building in which ethylene dichloride is stored or handled in quantities that could create a hazard.

(2) Confined spaces

(A) Entry into confined spaces or into other areas where there may be limited egress shall be controlled by a permit system. Permits shall be signed by an authorized representative of the employer certifying that preparation of the confined space, precautionary measures, personal protective equipment, and procedures to be used are all adequate.

(B) Tanks, pits, tank cars, process vessels, tunnels, sewers, grain storage bins, or other confined spaces which have contained ethylene dichloride shall be thoroughly ventilated to assure an adequate supply of oxygen, tested for ethylene dichloride and other contaminants and inspected prior to each entry. Ventilation shall be maintained while workers are in the space.

(C) Inadvertent infiltration of ethylene dichloride into the confined space while work is in progress inside shall be prevented by disconnecting and blanking off ethylene dichloride supply lines.

(D) Personnel entering confined spaces shall be furnished with appropriate personal protective equipment and protected by a lifeline tended by

another worker outside the space, who shall also be equipped for entry with approved respiratory, eye, and skin protection, lifeline, and have contact with a third party.

(E) Written operating instructions and emergency medical procedures shall be formulated and posted in conspicuous locations where accidental exposure to concentrations of ethylene dichloride which exceed the environmental limit may occur. These instructions and procedures shall be printed both in English and in the predominant language of non-English-speaking workers, if any. Special instructions shall be given to illiterate workers.

(d) Showers and Eye Wash Fountains

Showers and eye wash facilities shall be provided and so located as to be readily accessible to workers in all areas where skin or eye splash with ethylene dichloride is likely. If ethylene dichloride is splashed on the skin, contaminated clothing shall be promptly removed and the skin washed with soap and water. If liquid ethylene dichloride contacts the eyes, they shall be thoroughly irrigated with clean water, following which medical assistance shall be promptly provided. Such incidents shall be reported to the immediate supervisor by the affected employee or by a fellow worker.

Section 7 — Monitoring and Recordkeeping

(a) Where it has been determined that the environmental concentrations do not result in TWA workday exposures above one-half the TWA environmental limit, environmental monitoring shall not be required. However, records which form the basis for concluding that the exposures are at or below one-half the limit shall be maintained and exposure surveys shall be made when any process change indicates the need for reevaluation or at the discretion of the compliance officer.

(b) Where exposure concentrations have not been determined, they shall be determined within 6 months of the promulgation of a standard incorporating these recommendations.

(c) Where it has been determined that environmental concentrations result in TWA workday exposures above one-half the limit, employers shall maintain records of environmental exposures to ethylene dichloride based upon the following sampling and recording schedules:

(1) Samples shall be collected at least quarterly in accordance with Appendix I for the evaluation of the work environment with respect to the recommended limit.

(2) Environmental samples shall be taken when a new process is installed or when process changes are made which may cause an increase in environmental concentrations. Increased production, relocation of existing operations, or other functions which can increase concentrations shall require resampling.

(3) In all monitoring, samples shall be collected which are representative of breathing-zone exposures characteristic of each job or specific operation in each work area. Sufficient numbers of samples shall be collected to express the variability of exposure for the work situation and to estimate TWA workday exposure for the work situation and to estimate TWA workday exposures for every employee.

(4) The minimum number of representative TWA exposure determinations for an operation or process shall be based on variation in exposures and production schedules considering the number of workers exposed as suggested in Table I-2, or as otherwise indicated by a professional industrial hygienist.

TABLE I-2
SAMPLING SCHEDULE

Number of Employees Exposed	Number of TWA Determinations
1-20	50% of the number of workers
21-100	10 plus 25% of the excess over 20 workers
More than 100	30 plus 5% of the excess over 100 workers

(d) When exposure levels are found to be greater than those prescribed in Section 1(a), environmental concentrations shall be reduced by suitable engineering controls. Exposures shall be monitored at least weekly until the effectiveness of the controls is established.

(e) All records of sampling and of pertinent medical examinations shall be maintained for at least 20 years after the individual's employment is terminated. Records shall indicate the type of personal protective devices, if any, in use at the time of sampling. Each employee shall have access to information on his own environmental exposure.