NIOSH

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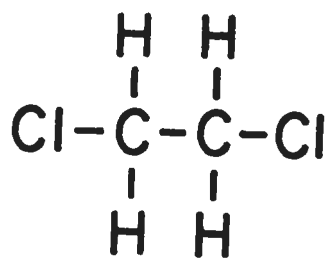
# ETHYLENE DICHLORIDE



( 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

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-BICHLOROETHANE
BROCIDE
DESTRUXOL BORER-SOL
DI-CHLOR-MULSION
1,2-DICHLORETHANE
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 Insitute (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-dichloroeth<u>a</u>ne), which has a carbon-carbon single bond, should be distinguished from 1,2-dichloroeth<u>e</u>ne 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.

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<br>Hemangiosarcomas<br>Fibromas | Forestomach<br>Circulatory System<br>Subcutaneous Tissue |
| Rats/Female | Adenocarcinomas | Mammary Gland |
| Mice/Female | Adenocarcinomas | Mammary Gland |
| Mice/Female | Stromal Polyps<br>Stromal Sarcomas | Endometrium<br>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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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.

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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.

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9. Vozovaya, M.A. "The Effect of Dichloroethane on the Sexual Cycle and Embryogenesis of Experimental Animals," Akusk. Ginekol. (Moskow), 2:57-59, 1977.

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## 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 employe [illegible] ess 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 faceseal coverlets or socks with any respirator voids NIOSH approvals.

Quantitative faceseal 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<br>- October 7, 1975<br>- October 8, 1976 |
| * | 5. | Asbestos | - August 8, 1975 |
| * | 6. | Hexamethylphosphoric Triamide (HMPA) | - October 24, 1975 |
| * | 7. | Polychlorinated Biphenyls (PCBs) | - November 3, 1975<br>- 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 BenzidineDerived Dyes | - April 17, 1978 |
| * | 25. | Ethylene Dichloride (1,2-Dichloroethane) | - April 19, 1978 |

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*Cancer related alerts

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