

NIOSH REVISED RECOMMENDATIONS  
FOR AN OCCUPATIONAL EXPOSURE STANDARD FOR  
ETHYLENE DICHLORIDE  
(1,2-dichloroethane)

INTRODUCTION

In 1975, a criteria document containing a recommended standard for occupational exposure to ethylene dichloride (1,2-dichloroethane) was prepared by the National Institute for Occupational Safety and Health (NIOSH) and transmitted to the Department of Labor for consideration in promulgation of Federal regulations (1). In that document, NIOSH recommended that the present Federal occupational health standard of 50 parts per million (ppm), determined as an 8-hour time-weighted average (TWA), be reduced to a TWA of 5 ppm for a 10-hour workshift, 40-hour workweek. NIOSH based its recommendations on a wide range of potentially serious health effects involving the nervous, respiratory, hepatic, and cardiovascular systems. NIOSH also expressed concern regarding the potential carcinogenicity of one possible metabolite of ethylene dichloride and noted the carcinogenic study being conducted by the National Cancer Institute. This recently completed study has demonstrated that ethylene dichloride is carcinogenic in rats and mice (2).

NIOSH recommends, on the basis of this study and on the basis of studies demonstrating mutagenicity (3-5), that ethylene dichloride be controlled as an occupational carcinogen and that the previous recommended standard be revised downward from 5 ppm (20 mg/cu m), to 1

ppm (4 mg/cu m) determined as a TWA exposure for up to a 10-hour workshift. NIOSH further recommends a ceiling concentration of 2 ppm (8 mg/cu m) as determined over a 15-minute sampling period. The present Federal standard (PEL) of 50 ppm (200 mg/cu m) measured as a TWA, includes a ceiling of 100 ppm, and a maximal allowable peak above the ceiling of 200 ppm allowed for not more than 5 minutes during any 3-hour period (6).

Because it is not possible at present to establish a safe exposure level for a carcinogen, NIOSH recommends restricting exposure to very low levels that can be reliably measured in the workplace. Procedures for sampling and analysis of workroom air are provided in Appendices I and II of the NIOSH criteria document on ethylene dichloride (1). Based on the sampling and analytical method recommended in the criteria document, the lowest detectable level of ethylene dichloride in air that can be measured is 1 ppm. The recommended standard is readily measurable by techniques that are valid, reproducible, and available to industry and government agencies (7-9).

In addition to the potential for causing cancer in humans, exposure to ethylene dichloride may result in disorders of the skin, eye, lung, liver, kidney, and heart. (1). Compliance with all sections of this NIOSH recommended standard should substantially reduce the risk of ethylene dichloride-induced cancer as well as prevent non-carcinogenic adverse effects of occupational exposure to ethylene dichloride.

NIOSH estimates on the basis of a national survey (10) that approximately 2 million workers in 148,165 workplaces are potentially

exposed to ethylene dichloride; some 200,000 of these workers are estimated to receive exposure continuously in the workplace. The compound is used in such diverse operations as: A raw material for producing vinyl chloride and numerous other structurally related chlorinated chemicals, a constituent of antiknock compounds for gasoline, a basic component of thiokol A (a polysulfide rubber), a grain and seed fumigant, and a commonly-used extractant/solvent for research and development laboratories. A more complete listing of industries utilizing ethylene dichloride is given in Supplement I.

Although the major use of EDC is in the manufacture of vinyl chloride, an outstanding potential for exposure occurs during the pouring of containers of ethylene dichloride into open vats where it is subsequently used for fumigation of grains. Emphasis, therefore should be placed on prohibiting the occupational use of ethylene dichloride as a solvent or diluent in all open-type operations. Furthermore, product substitution should be a paramount consideration wherever ethylene dichloride is identified or its presence suspected, and it should be replaced wherever feasible with less harmful substitutes. The recommended standard would apply to the processing, manufacture, and use of ethylene dichloride and products containing ethylene dichloride.

## I. BASIS FOR A REVISED ETHYLENE DICHLORIDE STANDARD

No epidemiologic studies that were designed to investigate the carcinogenicity of ethylene dichloride in humans have been found in the literature. The seven epidemiologic studies referenced in the criteria document refer to physiological alterations and morbidity (1).

Studies at the National Cancer Institute have been completed on an animal bioassay of ethylene dichloride (EDC) given by gastric intubation. The results are summarized in Table I.

There is a statistically significant positive association between the dosage of ethylene dichloride and the incidence of squamous-cell carcinomas of the forestomach and hemangiosarcomas of the circulatory system in male rats. In female rats, there was a statistically significant increased incidence of adenocarcinomas of the mammary gland. Ethylene dichloride was carcinogenic in mice also, causing mammary adenocarcinomas and endometrial tumors in female mice, as well as producing lung adenomas in mice of both sexes. There was a dose-response relationship for total tumors in both mice and rats, as well as a dose-response relationship for most specific types of tumors. Table I depicts the relative incidences of tumors seen in controls and at the two dose levels administered (1).

The Cancer Clearing House noted in their meeting of March 6 & 7, 1978, after accepting the results, "The potential carcinogenic risk that this compound poses to humans was emphasized "(11).

Other investigations, as yet unpublished, may provide negative results on the carcinogenic potential of ethylene dichloride. The

Manufacturing Chemists Association (MCA) in a communication to NIOSH has reported on a study on ethylene dichloride in Italy by Maltoni (12). Rats and mice were exposed to 150 ppm ethylene dichloride in air. Referring to tumor incidence in rats, Maltoni stated "No relevant changes in the incidence of the tumours normally occurring in the bred (sic) of rats used have been observed, following the treatment, apart from a moderate overall increase in benign mammary tumours ( fibroma and fibroadenomas) in treated rats when compared to controls, however, without a dose-response relationship, within exposed groups." This moderate overall increase was 46/90 at 150 ppm, 41/90 at 50 ppm, 29/90 at 10 ppm, 40/90 at 5 ppm, and 30/90 in the matched controls. The control animals (not kept in chambers) corresponding to the experimentals had an incidence of 39/90. The status report concluded that "the presented data may be considered almost conclusive." In this study the highest concentration to which rats were exposed was 150 ppm. While increases in tumor incidences were not significantly different from controls at this level, increased incidences did occur, and higher levels of exposure may result in still greater incidences of tumors. At the present time, NIOSH considers the evidence for a carcinogenic potential of ethylene dichloride via inhalation to be inconclusive.

In addition, Dr. B.M. Goldschmitt in a personal communication to NIOSH reported that a study at the Institute of Environmental Medicine at New York University showed no increased incidence of tumors following application of ethylene dichloride to the skin of mice (13). When tested as an initiating agent for the tumor promoter phorbol myristate acetate "for more than one year, (the combined treatment) yielded one

animal (in 30) with one papilloma." This study was not originally intended to test the carcinogenicity of ethylene dichloride per se when applied to the skin. Greater numbers of experimental animals and greater quantities of ethylene dichloride applied to the skin would be necessary before any definitive conclusions could be made. NIOSH therefore considers the carcinogenic potential of ethylene dichloride via the dermal route to be undetermined at this time.

Consistant observations of the mutagenicity of ethylene dichloride continue to be reported (3-5). It is reported as both a "moderate mutagen" alone and a "potent mutagen" when applied together with liver enzymes (4). While the relation of mutagenesis to carcinogenicity is not firmly established, the consistant positive mutagenicity findings support a conclusion that ethylene dichloride be considered a carcinogen.

Vozovanya (14,15) reported that in pregnant rats exposed to 15 mg/cu m ethylene dichloride in air, preimplantation embryonic deaths were 5 times higher than controls. There were hematomas in the region of the head, neck and upper extremities of the fetuses, and total embryonic mortality was increased. Deformities were neither reported, nor discussed.

TABLE I  
A COMPARISON OF THE INCIDENCE OF VARIOUS TUMORS  
IN ANIMALS GIVEN ETHYLENE DICHLORIDE  
(Low Dose: 50 mg per Kg PO; High Dose 100 mg per Kg PO)  
(PO = per os, delivered to the animal by intragastric intubation)

| Rats - male                       | Pooled<br>Vehicle<br>Control | Matched<br>Vehicle<br>Control | Dose<br>in mg/kg<br>50 100 |       |
|-----------------------------------|------------------------------|-------------------------------|----------------------------|-------|
| Hemangiosarcomas                  | 1/60                         | 0/20                          | 9/50                       | 7/50  |
| Fibroma of<br>Subcutaneous tissue | 0/60                         | 0/20                          | 5/50                       | 6/50  |
| Squamous cell<br>carcinoma        | 0/60                         | 0/10                          | 3/50                       | 9/50  |
| Rats - female                     | Pooled<br>Vehicle<br>Control | Matched<br>Vehicle<br>Control | Dose<br>in mg/kg<br>50 100 |       |
| Mammary carcinoma                 | 1/59                         | 0/20                          | 1/50                       | 18/50 |
| Hemangiosarcoma                   | 0/59                         | 0/20                          | 4/50                       | 4/50  |
| Mammary carcinoma<br>or adenoma   | 6/59                         | 0/20                          | 15/50                      | 24/50 |
| Mice - males                      | Pooled<br>Vehicle<br>Control | Matched<br>Vehicle<br>Control | Dose<br>in mg/kg<br>50 100 |       |
| Lung adenomas                     | 0/59                         | 0/19                          | 1/47                       | 15/48 |
| Hepatocellular<br>Carcinomas      | 4/59                         | 1/19                          | 6/47                       | 12/48 |
| Mice - females                    | Pooled<br>Vehicle<br>Control | Matched<br>Vehicle<br>Control | Dose<br>in mg/kg<br>50 100 |       |
| Lung adenomas                     | 2/60                         | 1/20                          | 7/50                       | 15/48 |
| Mammary carcinoma                 | 0/60                         | 0/20                          | 9/50                       | 7/48  |
| Stromal polyp or<br>sarcoma       | 0/60                         | 0/20                          | 5/49                       | 5/47  |

Summary and Conclusion:

NIOSH considers the evidence of carcinogenicity of ethylene dichloride reported by the National Cancer Institute to be conclusive in two mammalian species (the rat and the mouse). Since ethylene dichloride causes progressive, malignant disease of various organs in two species of animals, NIOSH recommends that ethylene dichloride be considered carcinogenic in man. Therefore, because it is not presently possible to establish an exposure level at which ethylene dichloride may be regarded to be without risk, NIOSH recommends that exposure to ethylene dichloride be kept as low as feasible. The use of ethylene dichloride as a solvent, diluent, or fumigant in open operations should be prohibited. Product substitution should be a paramount consideration, and wherever ethylene dichloride is identified or its presence suspected, it should be replaced by a less harmful substitute.

NIOSH recommends a sampling and analytical method for ethylene dichloride in air (1, 7-9) that employs adsorption of ethylene dichloride on charcoal followed by carbon disulfide desorption, and gas chromatographic measurement. One part per million represents the lowest level at which a reliable estimate of ethylene dichloride concentration can be determined at this time.

## II. REVISED RECOMMENDATIONS FOR AN ETHYLENE DICHLORIDE STANDARD

NIOSH recommends that occupational exposure to ethylene dichloride be controlled by adherence to the following sections. The recommended standard is designed to protect the health and provide for the safety of employees for up to a 10-hour workshift, 40-hour workweek, over a working lifetime. Compliance with all sections of the recommended standard should, at a minimum, substantially reduce the risk of ethylene dichloride-induced cancer and prevent other adverse effects of exposure to ethylene dichloride in the workplace. The standard is measurable by techniques that are reproducible and available to industry and government agencies. The employer should regard the recommended workplace environmental limit as a maximum limit for exposure and should make every effort to keep the exposure as low as is technically feasible. The criteria and standard will be reviewed and revised as necessary.

Ethylene dichloride is widely used as a grain and seed fumigant. There are 85 registered fumigants in which one of the main ingredients is ethylene dichloride. It is also used in analytical chemistry procedures. Animals exposed to ethylene dichloride have developed cancers at various sites, and results of bacterial tests demonstrate that ethylene dichloride is mutagenic. Ethylene dichloride is readily absorbed through the skin, the lung, and the gastrointestinal tract (1).

The term "ethylene dichloride" refers to all physical forms of the compound and its solutions. "Occupational exposure to ethylene

dichloride" is defined as work in any area in which ethylene dichloride is produced, stored, used, packaged, or distributed. If ethylene dichloride is handled or stored only in intact, sealed containers (eg, during shipment), adherence to the following sections are not required, except for Sections 3, 5(a), 6(g), and 8(a).

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure to ethylene dichloride shall be controlled so that employees are not exposed at a concentration in excess of one part per million (1 ppm) (4 milligrams per cubic meter) in air as determined by a personal air sample collected at a rate of flow between 25 and 200 ml/minute. A ceiling concentration of 2 ppm (8 mg/cu m), as determined over a 15-minute sampling period, is also recommended.

(b) Sampling and Analysis

Procedures for the collection and analysis of environmental samples shall be as provided in Appendices I and II of the criteria document or by any methods shown to be at least equivalent in precision, accuracy, and sensitivity to the methods specified.

Section 2 - Medical

Medical surveillance shall be made available as outlined below to all employees occupationally exposed to ethylene dichloride.

(a) Preplacement medical examinations shall include at least:

(1) Comprehensive medical and work histories with special emphasis directed towards the respiratory, cardiovascular, hepatic and renal functions.

(2) Comprehensive physical examination.

(3) A judgment of the worker's ability to use positive pressure respirators.

(b) Periodic examinations shall be made available at least annually to employees occupationally exposed to ethylene dichloride. These examinations shall include at least:

(1) Interim medical and work histories.

(2) Comprehensive physical examination

(c) Pertinent medical records shall be maintained for all employees occupationally exposed to ethylene dichloride. Such records shall be

kept for at least 30 years after the last occupational exposure to ethylene dichloride. Records of environmental exposures applicable to an employee shall be included in the employee's medical records. These records shall be made available to the designated medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee.

### Section 3 - Labeling and Posting

All warning signs shall be printed both in English and in the predominant language of non-English-reading employees. Workers who cannot read the language used on labels or warning signs shall receive information regarding hazardous areas and shall be informed of the instructions printed on labels and signs.

All containers of ethylene dichloride shall be labeled and all areas where ethylene dichloride is stored, handled, used, produced, or distributed shall be posted in accordance with the following subsections.

(a) Containers of ethylene dichloride shall bear the following label in addition to, or in combination with, labels required by other statutes, regulations, or ordinances:

ETHYLENE DICHLORIDE

DANGER

CANCER SUSPECT AGENT

AVOID SKIN CONTACT

FLAMMABLE

May generate toxic gases on contact

with open flame, hot surfaces, or

other heat-producing conditions.

Keep containers closed when not in use.

Use only with adequate ventilation.

Avoid breathing of vapor.

Handle only with gloves resistant to ethylene dichloride.

(b) The following warning sign shall be posted in readily visible locations at or near entrances to areas in which ethylene dichloride is stored, handled, used, produced, or distributed:

WARNING--HAZARDOUS AREA

ETHYLENE DICHLORIDE

CANCER SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

#### Section 4 - Personal Protective Equipment and Clothing

Employers shall use engineering controls and safe work practices to keep exposure to ethylene dichloride as low as possible and to minimize skin contact. When necessary, these shall be supplemented by the use of personal protective equipment. All employees entering the regulated area shall be equipped with clean work clothing (long-sleeved shirts, trousers, and footwear) and with the necessary protective equipment. Full-body protection with appropriate head covering and air supply shall be used in weighing and charging operations in which there is occupational exposure to ethylene dichloride. At no time shall protective equipment be stored in the regulated area.

(a) Respirators may be used only:

(1) During the time necessary to install and test the required engineering controls.

(2) During nonroutine operations or maintenance and repair activities in which brief exposure to ethylene dichloride may occur.

(b) Respirators permitted or required by paragraph (a) of this section shall be supplied-air or self-contained, positive-pressure respirators with full facepiece and shall comply with the standards jointly approved by NIOSH and the Mine Safety and Health Administration as specified in 30 CFR 11. All respiratory protective devices should be worn with full-body clothing resistant to penetration by ethylene

required

and repair  
may occur.

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dichloride. Employers shall provide respiratory protection for employees and shall establish and enforce a respiratory protection program meeting the requirements of 29 CFR 1910.134 and shall ensure that employees use the respiratory protective equipment when necessary.

(c) Employers shall ensure that respirators are properly cleaned and maintained. They shall also ensure that employees know the location of respirators assigned to them, how to use them, and how to test respirators for leaks, proper operation, and proper fit.

(d) Respirators shall be easily accessible. If respirators for more than one purpose are present, employees shall be taught to recognize the proper one.

#### Section 5 - Informing Employees of Hazards from Ethylene Dichloride

(a) Employees who work in areas in which ethylene dichloride is stored, handled, used, produced, or distributed shall be informed at the beginning of their assignment and at least annually thereafter of the hazards of exposure to ethylene dichloride, including the information that ethylene dichloride is believed capable of causing cancer, that it can enter the body by skin absorption, ingestion or inhalation, and that it may cause liver and kidney damage. Employees shall also be informed of the value of continued periodic medical examinations. Information

shall also be provided on the specific nature of the operation that could result in exposure and on how to recognize and evaluate conditions and situations that may result in the release of ethylene dichloride. The employer shall also inform the employees about cleanup, decontamination, and emergency procedures and their role in these activities. Employers shall post this information in the workplace and shall keep it on file, readily accessible to employees.

(b) Employers shall institute a continuing education program, conducted at least annually by persons qualified by experience or training, for employees whose jobs may involve occupational exposure to ethylene dichloride to ensure that all such employees have current knowledge of job hazards; relevant maintenance, cleanup, and decontamination methods; and proper respirator use. The instruction program shall include a description of the environmental and medical surveillance procedures and of the advantages to the employee of participating in these procedures.

(c) Required information shall be recorded on a "Material Safety Data Sheet" or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor, and kept on file, readily accessible to employees at all places of employment where there is occupational exposure to ethylene dichloride.

## Section 6 - Work Practices

### (a) Emergency Procedures

For all work areas in which emergencies involving ethylene dichloride may occur, employers shall ensure that employees are properly trained and follow the procedures specified below and any others appropriate for the specific operation or process.

(1) All employees involved in the emergency who may have had skin contact with ethylene dichloride shall wash affected parts promptly and thoroughly.

(2) Persons essential to emergency operations shall have the approved protective clothing and respirators, as specified in Section 4, readily available.

(3) Procedures shall be prepared for maintenance or cleanup and decontamination of areas where leaks or discharges of ethylene dichloride have occurred. Employees not essential to emergency operations shall be evacuated from the affected areas during emergencies. Perimeters of these areas shall be delineated, posted, and secured.

(4) Only personnel properly trained in emergency procedures and protected against the attendant hazards shall clean up and

decontaminate spills and control and repair leaks. After cleanup and decontamination, protective clothing and equipment shall be decontaminated and removed and the employee required to shower.

(5) Emergency telephone numbers shall be prominently posted.

(b) Engineering Controls

Engineering controls shall be used to limit the inhalation of, and to minimize skin contact with, ethylene dichloride by controlling the amount of ethylene dichloride that is emitted into the air. The most effective control measure is enclosure of unit operations and processes. For small operations, glove boxes or laboratory hoods may constitute sufficient enclosure. Local exhaust ventilation may also be effective when used at the source of ethylene dichloride emission.

Ventilation systems shall be inspected for corrosion, subjected to regular preventive maintenance, and cleaned at least every 6 months to ensure their effectiveness. The effectiveness of the system shall be verified by airflow measurement at least annually, and a log showing the results of annual inspections shall be kept. Exhaust ventilation systems shall discharge to the outside air through an appropriate filtering device and shall conform to applicable local, state, and Federal regulations. Contaminated exhaust air shall not be recirculated or discharged to other work areas, either regulated or unregulated.

Enclosures, exhaust hoods, and ductwork shall have pressure-failure alarms and shall be kept in good repair so that design airflows are maintained. Airflow at each hood shall be measured at least quarterly, but monthly measurements are recommended. Continuous airflow indicators, such as water or oil manometers properly mounted at the juncture of fume hood and duct throat (marked to indicate acceptable airflow), are recommended. A log showing design airflow and the results of quarterly inspections shall be kept and may be used in place of the annual inspection log of the ventilation system.

(c) Regulated Areas

Regulated areas shall be established and maintained where ethylene dichloride is manufactured, used, processed, or repackaged. Access to these areas shall be limited to authorized persons. An entry roster shall be kept of employees entering regulated areas. Toilets shall be located in regulated areas and shall be separate from other toilet facilities.

(1) Access to the regulated area shall be limited to employees having assigned duties there.

(2) A daily entry roster shall be kept of all employees entering the regulated area and of their length of stay.

(3) Employees working in regulated areas shall wash their face, neck, hands, and forearms each time they leave the regulated area. Washing facilities shall be provided at each exit. Employees working in regulated areas shall wash their hands and forearms before using the toilet.

(4) Employees engaged in operations in which ethylene dichloride is transferred, charged, or discharged, or which involve using a laboratory-type hood, opening a closed system, or repackaging, shall be provided with gloves and aprons or coveralls or with full-body protective suits resistant to penetration by ethylene dichloride.

(5) As a backup precaution, employees using glove boxes to handle ethylene dichloride shall wash their hands and arms on completion of the assigned task.

(6) When employees use protective clothing and equipment, they shall remove it and leave it at the exit before they leave the regulated area; the employees shall then wash their hands, forearms, face, and neck to remove accumulated ethylene dichloride before they enter nonregulated areas.

(d) Clean Work Clothing Room

A clean work clothing room shall be established and maintained that is free of ethylene dichloride contamination and that contains locker facilities.

(1) Shower facilities shall separate the clean work clothing room from the regulated area.

(2) The clean work clothing room shall be kept under positive pressure relative to the regulated area.

(3) Signs meeting the requirements of Section 3 shall be posted at the doorway separating the clean work clothing room and regulated area. Instructions informing employees of the procedures for entering and leaving the regulated area shall also be posted.

(4) Employees assigned to the regulated area shall change into clean work clothing (long-sleeved shirts, trousers, and footwear) each workshift before entering the regulated area. Any necessary protective equipment shall also be put on at the time of entry to the regulated area.

(5) At the end of each workshift, protective clothing, work clothing, and protective equipment shall be removed and placed in clearly labeled containers located in the regulated area. The employee

shall shower and shampoo before entering the clean work clothing room to put on street clothing.

▼ (e) Decontamination

Good housekeeping practices shall be observed to prevent contamination of areas and equipment with ethylene dichloride. The regulated area shall be washed thoroughly at the end of each shift to prevent such contamination.

Spills of ethylene dichloride or solutions containing ethylene dichloride shall be removed from work areas by vacuum cleaning with a vacuum cleaner designed for that purpose. No blowing by compressed air, or any evaporative method that increases the concentration of airborne ethylene dichloride, shall be allowed. After cleanup, monitoring for residual ethylene dichloride shall be carried out to insure that airborne concentrations are below the prescribed environmental limit.

(f) Laundering

The employer shall provide for the daily decontamination and laundering of used work clothing. Clothing should be washed with soap or other detergent and water. Precautions shall be taken to protect personnel who handle and launder soiled clothing. These employees shall be advised of the hazards of, and means of preventing, exposure to ethylene dichloride. If an outside laundry facility is used, the launderers shall be advised of the hazards and proper procedures involved in handling contaminated work clothing. Contaminated clothing

that is to be transported to an outside laundry facility shall be placed in sealed containers.

(g) Storage

Storage areas shall be isolated, well ventilated, and fire-resistant. Containers of ethylene dichloride shall be tightly closed and stored safely away from strong oxidizing materials and corrosive liquids and gases, heat, explosives, and gases under pressure to minimize the possibility of accidental breakage or spills.

(h) Maintenance

Lines and fittings that may carry ethylene dichloride shall be made of materials resistant to penetration of ethylene dichloride and shall be inspected frequently for corrosion and leaks. All ethylene dichloride equipment, including valves, fittings, and connections, shall be checked for tightness and kept in good working order. Such inspections shall be made immediately after new connections are made and after ethylene dichloride is introduced. Repairs and adjustments shall be made promptly.

(i) Entry into Confined Spaces

Entry into confined spaces, such as tanks, pits, and process vessels that have contained ethylene dichloride, shall be controlled by

a permit system. Permits shall be signed by an authorized employer representative, certifying that preparation of the confined space, precautionary measures, and personal protective equipment are adequate and that prescribed procedures will be followed.

(1) All lines shall be disconnected or blocked while a vessel is being cleaned. All valves or pumps leading to and from the vessel shall be closed down.

(2) The vessel shall have all liquid ethylene dichloride removed and be purged completely with air.

(3) The vessel shall then be checked by trained personnel for fire or explosion hazard, airborne ethylene dichloride, possible oxygen deficiency, and concentrations of other likely contaminants, to assure that no danger exists.

(4) Each employee entering the vessel shall be equipped with appropriate respiratory protection, as specified in Section 4 of this chapter, as well as a harness and a lifeline. At least one other person equipped with appropriate respiratory protection, harness, and lifeline shall watch at all times from the outside. Mechanical ventilation shall be provided continuously when workers are inside the vessel.

(j) Disposal

Waste material contaminated with ethylene dichloride and containers of ethylene dichloride shall be disposed of in a manner not hazardous to employees. The disposal method shall conform to applicable local, state, and Federal regulations and shall not constitute a hazard to the surrounding population or environment. Waste water contaminated with ethylene dichloride shall be flushed to holding basins for decontamination.

Section 7 - Sanitation

(a) The pertinent requirements for plant sanitation, stated in 29 CFR 1910.141, shall be complied with. The subsections (a), (c), (d), (e), and (g) are especially relevant to ethylene dichloride.

(b) Washing facilities, conveniently located and near the exit, shall be provided to employees in the regulated area. Locker room facilities, including showers, shall be located outside the regulated area.

(c) Preparing, storing, dispensing (including that done through vending machines), or eating food shall be prohibited in regulated areas.

(d) Smoking shall be prohibited in regulated areas.

#### Section 8 - Monitoring and Recordkeeping Requirements

##### (a) Industrial Hygiene Surveys

Employers shall conduct an industrial hygiene survey in any facility where ethylene dichloride is stored, produced, processed, or otherwise handled. These surveys shall be used to establish those areas in a facility where occupational exposure to ethylene dichloride occurs. If an employer concludes that there is no occupational exposure to ethylene dichloride in that area, the records shall show the basis for this conclusion. Surveys shall be repeated at least annually and within 14 days after any process change likely to result in occupational exposure to ethylene dichloride.

##### (b) Personal Monitoring

If it has been determined that occupational exposure to ethylene dichloride has occurred, the employer shall institute environmental monitoring.

(1) A program of personal monitoring shall be instituted to identify and measure, or permit calculation of, the exposure of each employee. Source and area monitoring may be used to supplement personal monitoring.

(2) In all personal monitoring, samples representative of exposure in the breathing zone of the employee shall be collected.

(3) For each ethylene dichloride determination, a sufficient number of samples shall be taken to characterize the employee's work and production schedules, location, or duties. Changes in production schedules shall be considered in deciding when samples are to be collected.

(4) Each operation in each regulated area shall be sampled at least once every 6 months while ethylene dichloride is produced or handled. For intermittent operations, ie, those lasting less than 6 months, at least one monitoring regimen shall be conducted during each operation period, and monitoring should coincide with the periods of maximum potential exposure to ethylene dichloride.

If an employee is found to be exposed to ethylene dichloride at concentrations exceeding the recommended occupational exposure limit, the exposure of that employee shall be measured at least once every week, control measures shall be initiated, and the employee shall be

notified of the exposure and of the control measures being implemented. Such monitoring shall continue until two consecutive determinations, at least 1 week apart, indicate that control measures are effective in that the employee's exposure no longer exceeds the recommended occupational exposure limit; routine semiannual monitoring may then be resumed.

(c) Recordkeeping

Records of environmental monitoring and other pertinent records shall be kept for at least 30 years after the employee's last occupational exposure to the ethylene dichloride. Records of environmental monitoring shall include an identification of the employee being monitored, duties and job locations within the worksite, time and dates of sampling and analysis, sampling and analytical methods used and available evidence of their precision and accuracy, the number, duration, and results of samples taken, environmental concentrations determined from these samples, and the type of personal protective equipment used by the employee. Entry rosters of authorized persons who enter regulated areas shall also be retained for at least 30 years. Environmental monitoring records and entry rosters shall be made available to designated representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare. Employees shall have access to data on their environmental exposures. On request, medical records shall be made available to the

designated medical representatives of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, of the employer, and of the employee or former employee.

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Supplement I  
INDUSTRIES UTILIZING ETHYLENE DICHLORIDE IN THEIR OPERATIONS  
(Manufacturing, processing or compounding)

Adhesives formulators  
Asphalt processing  
Bakelite processing  
Bitumen processing  
Camphor refining  
Cosmetics manufacture  
Cellulose acetate dispersion  
Cellulose ester dispersion  
Dry cleaning - patented  
Degreasing operations  
    textiles industry  
    petroleum industry  
    electronics industry  
Extractant:  
    soybean oil  
    fish protein  
    caffeine  
    dyes  
    camphor  
Fumigant - grain and seeds  
Gasoline:  
    TEL precursor  
    lead scavenger  
    antiknock agent  
    blending

Milk preservation  
Manufacture:  
    vinyl chloride  
    methyl chloroform  
    trichloroethylene  
    perchloroethylene  
    vinylidene chloride  
    ethylene amines  
Ore processing  
Paint solvation and stripping  
Pesticide processing  
Pest extermination  
Petroleum refining  
Pharmaceuticals  
Photography  
Resins:  
    bakelite  
    thiokoles  
Rubber  
Textiles:  
    nylon  
    viscose rayon  
Toxicological analysis  
Varnish diluent  
Water softening  
Xerography