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PROPERTIES AND ESSENTIAL INFORMATION

FOR

SAFE HANDLING AND USE

OF

VINYL CHLORIDE

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Section 4 HEALTH HAZARDS - MEDICAL MANAGEMENT, FIRST AID AND
PROTECTIVE EQUIPMENT

4.1 Health Hazards

- 4.1.1 Vinyl chloride monomer is believed to be a carcinogen to man. Exposure of three animal species to vinyl chloride has caused a higher frequency of angiosarcoma, as well as other respiratory and digestive tumors than in the control groups. Workers in the manufacture of polyvinyl chloride resin have shown a higher incidence of angiosarcoma than anticipated after long exposure at relatively high concentrations. The long-term effects of short-term and intermittent high concentration exposure have not been studied in animals and man.

Because of the evidence of carcinogenicity, the Occupational Safety and Health Administration and the Environmental Protection Agency have issued regulations that limit the emission of vinyl chloride to the air and the exposure of people to such emissions.

Workers in the PVC industry, primarily reactor cleaners, have been found to have acroosteolytic changes in certain bones, particularly those of the distal phalanges of the fingers. This is largely reversible and has been associated only with high levels of exposure which have been experienced in the past. Certain skin changes suggesting scleroderma have been noted in some patients with occupational acroosteolysis.

Combustion and pyrolysis products of monomeric or polymerized vinyl chloride include hydrogen chloride and other highly irritating gases. Exposure to gases may cause severe irritation of the mucous linings of the respiratory tract and pulmonary edema and chemical pneumonitis may occur.

Vinyl chloride monomer in gaseous form has no distinctive warning odor in low concentrations nor is it irritating. High concentrations of vinyl chloride has a narcotic effect on the central nervous system and can produce anesthesia at high concentrations. Hazards may be related to impaired judgment or functional ability under these circumstances. The threshold of odor for vinyl chloride varies with purity of VCM and amount of exposure. A two-thousand ppm threshold of odor level has been observed.

4.1.2 Acute Toxicity

Levels on the order of 6,000 ppm for five minutes exposure were required to produce minimal symptoms

4.1 Health Hazards (continued)

4.1.2 Acute Toxicity (continued)

resembling mild alcohol intoxication in humans. Levels of approximately 16,000 ppm for the same length of time will produce varying degrees of intoxication, with lightheadedness, some nausea and a dulling of visual and auditory responses in most humans. Higher levels produce unconsciousness.

4.1.3 Chronic Toxicity

Long-term exposure of experimental animals to VCM at concentrations of fifty ppm or greater has produced angiosarcoma of the liver and other evidence of the induction of malignant neoplasms. The incidence of hepatic angiosarcoma among workers exposed to vinyl chloride monomer has been in excess of the predicted incidence based upon control populations. The incidence appears to be dose related in that the disease is most frequent among groups that were exposed to relatively high levels of VCM.

4.2 Medical Management

4.2.1 Physical Examinations

The Occupational Safety and Health Administration Standard for (29CFR §1910.1017) Vinyl Chloride requires that all employees exposed to a vinyl chloride concentration of 0.5 ppm or more without regard to the use of respirators be provided a program of medical surveillance. This program performed or under the supervision of a licensed physician as stated in the regulation is as follows:

(1) The the time of initial assignment, or upon institution of medical surveillance;

(i) A general physical examination shall be performed, with specific attention to detecting enlargement of liver, spleen or kidneys, or dysfunction in these organs, and for abnormalities in skin, connective tissues and the pulmonary system (See Appendix A).

(ii) A medical history shall be taken, including the following topics:

- (A) Alcohol intake;
- (B) Past history of hepatitis;
- (C) Work history and past exposure to potential hepatotoxic agents, including drugs and chemicals;

4.2 Medical Management (continued)

- 4.2.1 (D) Past history of blood transfusions, and
(E) Past history of hospitalizations.

(iii) A serum specimen shall be obtained and determinations made of:

- (A) Total bilirubin;
- (B) Alkaline phosphatase;
- (C) Serum glutamic oxalacetic transaminase (SGOT);
- (D) Serum glutamic pyruvic transaminase (SGPT); and
- (E) Gamma Glutamyl Transpeptidase.

(2) Examinations provided in accordance with this paragraph shall be performed at least:

(i) Every six months for each employee who has been employed in vinyl chloride or polyvinyl chloride manufacturing for ten years or longer; and

(ii) Annually for all other employees.

(3) Each employee exposed to an emergency shall be afforded appropriate medical surveillance.

(4) A statement of each employee's suitability for continued exposure to vinyl chloride including use of protective equipment and respirators, shall be obtained from the examining physician promptly after any examination. A copy of the physician's statement shall be provided each employee.

(5) If any employee's health would be materially impaired by continued exposure, such employee shall be withdrawn from possible contact with vinyl chloride.

(6) Laboratory analyses for all biological specimens included in medical examinations shall be performed in laboratories licensed under 42 CFR Part 74.

(7) If the examining physician determines that alternative medical examinations to those required by paragraph (1) of this section will provide at least equal assurance of detecting medical conditions pertinent to the exposure to vinyl chloride, the employer may accept such alternative examinations as meeting the requirements of paragraph (1) of this section, if the employer obtains a statement from the examining physician setting forth the alternative examinations and the rationale for substitution. This statement shall be available upon request for examination and copying to authorized representatives of the Assistant Secretary of Labor for OSHA and the Regional OSHA Director.

4.2 Medical Management (continued)

4.2.1 Physical Examinations (continued)

Appendix A - Supplementary Medical Information

When required tests under paragraph (1) of this section show abnormalities, the tests should be repeated as soon as practicable, preferably within three to four weeks. If tests remain abnormal, consideration should be given to withdrawal of the employee from contact with vinyl chloride, while a more comprehensive examination is made. Additional tests which may be useful:

- (A) For kidney dysfunction: Urine examination for albumin, red blood cells and exfoliative abnormal cells.
- (B) Pulmonary system: Forced vital capacity, forced expiratory volume at one second, and chest roentgenogram (posterior-anterior 14 x 17 inches).
- (C) Additional serum tests: Lactic acid dehydrogenase, lactic acid dehydrogenase isoenzyme, protein determination and protein electrophoresis.
- (D) For a more comprehensive examination on repeated abnormal serum tests: Hepatitis B antigen and liver scanning.

Records of such medical surveillance shall be available to the Assistant Secretary of Labor for OSHA and the OSHA Regional Director. Medical records shall be maintained for the duration of the employment of each employee of each employee plus twenty years or thirty years, whichever is longer.

4.2.2 Suggestions to Physicians

Treatment for vinyl chloride intoxication is symptomatic; no special procedures are required. In acute overexposures the primary effect is central nervous system depression. In chronic exposure the liver is the principal target with secondary effects possibly in the kidneys and lungs.

Note to Physicians: Avoid use of epinephrine or related drugs in treating acute overexposure cases since vinyl chloride may sensitize the heart to the arrhythmic action of these drugs.

When breathing has ceased due to vinyl chloride narcosis, promptly initiate assisted respiration (e.g., mouth-to-mouth, mechanical resuscitation). Oxygen should be administered. Active ventilation is important to the maintenance of adequate tissue oxygenation and the removal of vinyl chloride to the exhaled air.

4.2 Medical Management (continued)

4.2.2 Suggestions to Physicians (continued)

Oxygen Administration

Oxygen has been found useful in the treatment of inhalation exposures of many chemicals, especially those capable of causing either immediate or delayed harmful effects in the lungs.

In most exposures, administration of 100% oxygen at atmospheric pressures has been found to be adequate. This is best accomplished by use of a face mask having a reservoir bag of the non-rebreathing type. Inhalation of 100% oxygen should not exceed one hour of continuous treatment. After each hour, therapy may be interrupted. It may be reinstituted as the clinical condition indicates.

Some believe that superior results are obtained when exposures to lung irritants are treated with oxygen under and exhalation pressure not exceed 4cm water. Masks providing for such exhalation pressures are available. A single treatment may suffice for minor exposures to irritants. It is believed by some observers that oxygen under pressure is useful as an aid in the prevention of pulmonary edema after breathing irritants.

In the event of an exposure causing symptoms or in case of a history of severe exposure, the patient may be treated with oxygen under 4cm exhalation pressure for one-half hour periods out of every hour. Treatment may be continued in this way until symptoms subside or other clinical indications for interruptions appear.

Caution! It may not be advisable to administer oxygen under positive pressure in the presence of impending or existing cardiovascular failure.

4.3 First Aid

4.3.1 General

First aid should be started at once in the case of acute intoxication with vinyl chloride or in the case of contact with liquid vinyl chloride. Refer all over-exposed patients to a physician and give a detailed account of the accident (OSHA §1910.1017). Each employee exposed to an emergency shall be afforded appropriate medical surveillance.

4.3 First Aid

4.3.2 Contact with Skin

Vinyl chloride in liquid form is a skin irritant and can cause frostbite. All clothing that has become contaminated with vinyl chloride including shoes should be removed immediately and not worn again until properly decontaminated. All affected body areas should be washed thoroughly with warm water and soap. The individual should be referred to a physician promptly.

4.3.3 Contact with the Eyes

If liquid vinyl chloride has entered the eyes, they should be washed promptly with copious quantities of water for at least fifteen minutes. The eyelids should be held apart during washing to ensure contact of the water with all the surface tissues of the eye and lids. Prompt medical attention should be obtained.

4.3.4 Taken Internally

The gaseous nature of vinyl chloride makes the ingestion of significant quantities unlikely. Consult a physician in cases of suspected ingestion.

4.3.5 Inhalation

A worker who has been overcome by vinyl chloride must be carried at once into an uncontaminated atmosphere and if respiration has been slowed or stopped, effective artificial respiration must be initiated immediately. If oxygen inhalation apparatus is available, oxygen should be administered but only by a person authorized for such duty by a physician. The patient should be kept comfortably warm but not hot.

Stimulants will rarely be necessary where adequate oxygenation is maintained. Any such drugs for shock treatment should be given only by the attending physician. Never attempt to give anything by mouth to an unconscious patient.

Exposed persons showing signs of vinyl chloride intoxication should be led to an uncontaminated atmosphere promptly to prevent injury by falling, etc. All exposed persons are to be referred to a physician promptly after exposure.

4.4 Personal Protective Equipment

4.4.1 Availability and Use

Personal protective equipment is not an adequate substitute for good safe working conditions, adequate ventilation and intelligent conduct on the part of employees working with vinyl chloride. It is, however, in some instances the only practical means of protecting the worker, particularly in emergency situations.

The OSHA Standard for Vinyl Chloride specifically requires the use of engineering and work practice controls to reduce employee exposure to vinyl chloride to the permissible level or to the extent feasible. Where such controls are not sufficient to reduce exposure to the permissible exposure limits, a written program shall be established and implemented to reduce employee exposure to the permissible limits or to the greatest extent feasible.

4.4.2 Protective Clothing

Clothing and gloves made of rubber or impervious material should be worn to protect the body skin from accidental contact with liquid vinyl chloride where applicable.

Protective garments are required for employees who are engaged in hazardous operations such as cleaning polyvinyl chloride residue on vessel walls. These garments shall be selected for the operation and possible exposure conditions when liquid vinyl chloride is not involved.

All protective garments shall be provided clean and dry for each use.

4.4.3 Foot Protection

Footwear with built-in steel toe caps are recommended for all industrial operations. For added protection against chemical contact and liquid vinyl chloride, safety footwear or overshoes worn over leather shoes are recommended. It is important to thoroughly clean or discard contaminated footwear.

4.4.4 Eye Protection

Spectacle-type safety glasses meeting ANSI standard Z87.1 with metal or plastic frames are recommended as minimum protection against eye injuries from flying particles.

4.4 Personal Protective Equipment (continued)

4.4.4 Eye Protection (continued)

When there is danger of splashing or material is under pressure, splash goggles and/or plastic shields (full length, eight-inch minimum) with forehead protection should be worn where complete face protection is desirable.

Where liquid vinyl chloride is involved or there is likelihood of exposure to vinyl chloride at concentrations exceeding the permissible exposure limit, appropriate respiratory protection is required by OSHA. Use of a full-face piece respirator provides adequate eye protection without supplementary devices.

4.4.5 Respiratory Protection

Where employees are provided or are required to wear respiratory protective devices a respiratory protection program meeting the requirements of OSHA §1910.134 shall be established and maintained. Respirators selected for vinyl chloride shall be as follows:

<u>Atmospheric Concentration of Vinyl Chloride</u>	<u>Required Apparatus</u>
(i) Unknown, or above 3,600 ppm. . .	Open-circuit, self-contained breathing apparatus, pressure demand type, with full face-piece.
(ii) Not over 3,600 ppm	(A) Combination type C supplied air respirator, pressure demand type, with full or half face-piece and auxiliary self-contained air supply; or (B) Combination type C, supplied air respirator continuous flow type, with full or half face-piece, and auxiliary self-contained air supply.
(iii) Not over 1,000 ppm	Type C, supplied air respirator continuous flow type with full or half facepiece, helmet or hood.
(iv) Not over 100 ppm	(A) Combination type C supplied air respirator demand type, with full facepiece and auxiliary self-contained air supply; or

4.4 Personal Protective Equipment (continued)

4.4.5 Respiratory Protection (continued)

<u>Atmospheric Concentration of Vinyl Chloride</u>	<u>Required Apparatus</u>
(iv) Not over 100 ppm (continued) . . .	(B) Open-circuit, self-contained breathing apparatus with full facepiece, in demand mode; or (C) Type C supplied air respirator, demand type, with full facepiece.
(v) Not over 25 ppm	(A) A powered air-purifying respirator with hood, helmet, full or half facepiece, and a canister which provides a service life of at least four hours for concentrations of vinyl chloride up to 25 ppm; or (B) Gas mask, front-or back-mounted canister which provides a service life of at least four hours for concentrations of vinyl chloride up to 25 ppm.
(vi) Not over 10 ppm	(A) Combination type C supplied-air respirator, demand type, with half facepiece and auxiliary self-contained air supply; or (B) Type C supplied-air respirator, demand type, with half facepiece; or (C) Any chemical cartridge respirator with an organic vapor cartridge which provides a service life of at least one hour for concentrations of vinyl chloride up to 10 ppm.

Respirators shall be selected from among those jointly approved by NIOSH and MESA under the provisions of 30CFR Part 11.

Employee entry into unknown concentrations of vinyl chloride or concentrations greater than 36,000 ppm may be made only for life rescue. Entry into concentrations ranging from 3,600 to

4.4 Personal Protective Equipment (continued)

4.4.5 Respiratory Protection (continued)

36,000 may be made only for life rescue, firefighting or securing equipment so as to prevent a greater hazard.

When air purifying respirators are in use a continuous monitoring and alarm system must be provided when vinyl chloride concentrations may reasonably be expected to exceed the maximum allowable concentration for the devices in use. Such a system shall be used to alert employees that the vinyl chloride concentration exceeds that allowable for the respirator in use.

Where air purifying canisters or cartridges are used they shall be replaced prior to the expiration of their service life or at the end of the work shift in which they were used, whichever occurs first.

4.4.6 Head Protection

Hard hats are recommended for protection from falling objects, overhead liquid leaks and chemical splashes.

7.3 Ventilation (continued)

- 7.3.1 Many companies also provide emergency ventilation rates of thirty air changes per hour controlled by automatic analyzers in the work space air.

Pressurized control rooms or buildings with ventilation air intakes located upwind or some distance from sources of contamination can be used to provide a "safe" area for operating personnel where respirators need not be worn.

Good ventilation is a valuable tool in achieving the required one ppm or lower concentration in the work space air, but it is effective only when used in conjunction with good equipment and process design and proper equipment maintenance. In the design of a good mechanical ventilation system, consideration should be given to employee comfort and to control of the system; i.e. under what conditions should it operate normally, when should it be off, when should emergency speed be used and should control be automatic or manual.

7.3.2 Air Analysis-Monitoring

Analysis of the air for vinyl chloride in the work area is required by the EPA Standard (40 CFR 61.60F) as a means of detecting and measuring emissions to the air. The standard requires a system which obtains air samples from one or more points on a continuous sequential basis and analyzes the samples with gas chromatography or by alternative methods. The OSHA standard (29 CFR 1910.1017) requires that when employees are wearing air purifying respirators a continuous monitoring and alarm system be in use if there is a likelihood of exceeding the vinyl chloride concentration allowable for the respirator in use. In addition, these analyzers are invaluable in providing data for work in meeting the OSHA permissible exposure limits.

Flammable gas detectors are also used to indicate danger from fire or explosion and may activate water deluge as well as mechanical ventilation systems.

Automatic analyzers are complicated pieces of equipment and should be checked and maintained to meet the EPA standard requirements as a minimum.

The OSHA Standard also requires monitoring employee exposures to vinyl chloride on a specific basis. Sampling and analysis may be done in any fashion so long as acceptable levels of accuracy are achieved. This type of monitoring requires the consultation with a trained industrial hygienist.

7.2 Equipment Design (continued)

7.2.2 Special Equipment and Design

The design of vinyl chloride piping and equipment is highly specialized because of the reactive, flammable and toxic properties of the material. Prior to the start of any plant or equipment design the Occupational Safety and Health Administration Standard for Vinyl Chloride (29 CFR §1910.1017) and the Environmental Protection Agency National Emission Standard for Vinyl Chloride (40 CFR 61f) as well as any other pertinent regulations should be thoroughly understood. The EPA Standard in particular requires specific equipment items. The technical problems of designing equipment, providing adequate ventilation and formulating operating procedures which ensure maximum safety and economy can be handled best by experienced engineers and safety and fire protection specialists.

7.2.3 In handling of vinyl chloride or the operation of any type of vinyl chloride system, all valves, pipelines, vents, safety devices, etc. should be located that they can be readily inspected and repaired. Consideration should be given to redundant facilities in critical areas. All handling and storage equipment should be located away from any source of sparks, flames, heated surfaces and other sources of ignition. The use of excess flow valves, valves with fusible links and remotely operated valves should be considered on large tanks in the case of fires or major leaks near these vessels. Bottom connections are to be avoided if practical.

7.2.4 Safety requires that equipment be used and maintained as recommended by the manufacturer or within design limits such as the ASME Pressure Vessel Code. All process equipment including safety devices should have regularly scheduled testing and inspection.

7.3 Ventilation

7.3.1 Good ventilation is essential in rooms or confined areas where vinyl chloride is handled to prevent the unsafe accumulation of toxic or explosive concentrations. Consideration should also be given to emergency ventilation to remove dangerous concentrations resulting from leaks and/or equipment failures. Good practice indicates that a normal ventilation system should yield at least fifteen air changes per hour for enclosed processing areas.

7.4 Electrical Equipment

- 7.4.1 Vinyl chloride is normally handled in closed systems and all work areas should be ventilated and controlled to low concentrations of vinyl chloride. Flammable concentrations may exist only occasionally. Under normal condition, electrical equipment approved for Class I Division 2 locations may be used.

The selection of electrical equipment for a plant requires skilled evaluation by a competent process engineer as well as an electrical engineer. All equipment and wiring should be purchased and installed to meet the appropriate sections of the National Electric Code.

- 7.4.2 Separate power supply to lights, analyzers and automatic control systems is provided by many companies in their plants. These separate power supplies are often backed up by auxiliary generators or batteries for critical control items.

- 7.4.3 Static electricity is generated when vinyl chloride or polyvinyl chloride flows through or is discharged from a pipe. To drain off static charges and avoid spark discharges, a continuous path from the point of generation to ground should be provided. This is best accomplished by electrically interconnecting all vessels and piping (bonding), by grounding all vessels and piping or by a combination of bonding and grounding.

Bonds or grounds for static electricity protection may be of any conductor size and any ground that is adequate for power or lightning protection is more than adequate for grounding static electricity. Ground wiring should be of sufficient size to provide reasonable protection against physical wear. Periodic checks of continuity to ground should be made. Systems using non-conductors such as glass, plastic and ceramic piping or coatings should be carefully checked for continuity. Some types of Teflon lined plug valves have required electrical bonds between the plug and the body to reduce sparking.

For a more complete discussion of static electricity see NFPA #77.