Gil Hanks

Chemical Safety Data Sheet SD-56

PROPERTIES AND ESSENTIAL INFORMATION

FOR

SAFE HANDLING AND USE

OF

VINYL CHLORIDE

ADOPTED 1954

Chemicals in any form can be safely stored, handled or used if the physical, chemical and hazardous properties are fully understood and the necessary precautions, including the use of proper safeguards and personal protective equipment, are observed.

Manufacturing Chemists' Association, Inc.

1625 Eye Street, N. W., Washington 6, D. C.

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CHEMICAL SAFETY DATA SHEET

VINYL CHLORIDE

SUMMARY

Vinyl chloride is a highly volatile extremely FLAMMABLE compressed gas which is ordinarily handled in liquefied form under pressure. It has a mild anesthetic action in concentrations above 500 ppm. and its vapors are irritating to the eyes.

Precautions necessary in handling the material are detailed in the body of the Safety Data Sheet. Key points to consider for safe handling include:

1. Keep away from heat, sparks and open flame.
2. Provide adequate ventilation.
3. Ground equipment and containers before discharging to reduce danger of ignition from static sparks.
4. In discharging do not heat containers above 50°C. (122°F.). No heat should be applied to tank cars.
5. All equipment should be of steel and have a designed working pressure of at least 100-150 psi.
6. In the event of accidental leaks, spills or whenever excessive vapor concentrations may be encountered only personnel equipped with approved respiratory protection should be permitted in the contaminated area.
7. Chemical safety goggles should be worn when discharging containers or tank cars or whenever there is a danger of the liquid or saturated vapor coming in contact with the eyes.
8. Waste disposal should be away from any source of ignition. Dilute phenolic residues before discharging to sewer.

In case of fire use carbon dioxide or dry chemical extinguishing equipment. In the event of contact with the liquid remove contaminated clothing immediately. For eyes flush immediately with large quantities of water for at least 15 minutes while medical attention is being sought.

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Chemical Safety Data Sheet

VINYL CHLORIDE

Adopted February, 1954

1. NAME

Chemical Names: Vinyl Chloride
Chloroethylene
Chloroethene
Common Name: Vinyl Chloride
Formula: CH_2CHCl

2. PROPERTIES

2.1 **Grade:**

Technical with inhibitor. (Purity of sample 99.42%)

2.2 **Important Physical and Chemical Properties:***

Boiling Point	—13.8°C. (+7°F.)
Color	Colorless or water white
Corrosivity	Noncorrosive at normal atmospheric temperatures when dry (moisture free). In contact with water at elevated temperatures vinyl chloride accelerates corrosion of iron or steel.
Explosive Limits (Percent by Volume in Air)	Lower 4%; Upper 22%
Flash Point	—78°C. (—108.4°F.), Open-Cup
Hygroscopicity	No
Critical Pressure	52.7 Atmospheres
Critical Temperature	158.4°C. (317°F.)
Deliquescence	No
Ignition Temperature, Autogenous	472.22°C. (882°F.) (Vapors above —60°F.)
Light Sensitivity	Not a factor in handling inhibited vinyl chloride
Melting Point (Freezing Point)	—153.71°C. (—245°F.)
Molecular Weight	62.50
Odor	Sweet smelling gas
Physical State	Gas at ordinary temperature and pressure. Liquid under pressure in cylinders or pressure vessels at room temperature.
Reactivity	Polymerizes readily in presence of air, sunlight, oxygen or heat. This behavior is due to the presence of a double bond. Otherwise vinyl chloride is quite stable.
Specific Gravity	.9121 @ 20°/20°C. (Water = 1.00)
Vapor Density	2.15 (Air = 1.00)
Vapor Pressure	2580 mm. of mercury 20°C. (68°F.)

*Many of the data recorded under this paragraph were determined in the research laboratory of one of the large producers of vinyl chloride and are based on a technical grade material having a purity of 99.42%. Materials from other sources may vary in accordance with the nature of the impurities or the character of the inhibitor present.

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2.3 Hazardous Properties

2.3.1 *HEALTH HAZARDS* (See 8. Health Hazards and Their Control)

Aside from the risk of fire and explosion, vinyl chloride presents no other very serious problem in general handling. The presently accepted upper limit of safety as a health hazard is 500 ppm.

2.3.2 *FIRE HAZARD*

Vinyl chloride vapors form flammable mixtures with air at all temperatures above —78°C. (—108.4°F.)

3. USUAL SHIPPING CONTAINERS

3.1 Type and Size

3.1.1 Approved ICC cylinders and tank cars designed to carry liquid gases under pressure and equipped with safety relief devices.

3.1.2 All parts of valve and safety devices in contact with contents of containers must be of metal or other material, suitably treated if necessary, which will not cause formation of any acetylides. A good practice is to dismantle all valves for inspection before each loading. Approved cylinders include ICC-4B300, ICC-4BA300, ICC-3A300, and ICC-3AA300. *Cylinders with brazed seams are not permitted.*

3.1.3 Some types of tank cars are ICC-106A-500, ICC-106A500X, ICC-105A300 and ICC-105A300W. Maximum permitted filling density is 84% for cylinders and for Class ICC-106A cars and for Class ICC-105A cars 87%.

3.1.4 Filling density is defined as the per cent ratio of the weight of chemical in the tank to the weight of water that the tank or cylinder will hold.

3.1.5 ICC Regulations require that vinyl chloride must be inhibited for the purpose of transportation (See 6.2.3).

3.2 Label or Identification

3.2.1 Each container of vinyl chloride (including tank cars) should carry an identifying label or stencil.

3.2.2 The Manufacturing Chemists' Association recommends the following in addition to, or in combination with, any label warnings or other statements required by statutes, regulations, or ordinances:

VINYL CHLORIDE

DANGER! EXTREMELY FLAMMABLE

Keep away from heat, sparks, and open flame.

Keep container closed.

Use with adequate ventilation.

Avoid prolonged breathing of vapor.

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3.2.3 Each shipping container must bear the ICC red label for FLAMMABLE compressed gases.

3.2.4 Tank cars and railroad cars carrying one or more containers of vinyl chloride must bear the ICC DANGEROUS placard.

3.3 Disposal and Return Precautions

3.3.1 Small containers (ICC-4B300 and ICC-4BA300, without brazed seams, ICC-3A300, ICC-3AA300) should be drained free of liquid vinyl chloride and the valves closed tightly before they are returned to the supplier. No air should be permitted to enter the container (See 4.3).

3.3.2 In addition, the following precautions must be taken:

3.3.2.1 *Return of Small Containers*

The cylinder valve protection cap or outlet cap must be securely replaced. The lower portion of the ICC shipping tag, if attached to the cylinder, must be removed. In other cases, applicable to ICC Regulations, compliance is essential. Bill of lading should give the cylinder identification number (which appears on the shoulder of cylinder) for each cylinder shipped, show name of consignee and indicate that the cylinders are empty (See 3.3.5).

Full or partly emptied cylinders should not be returned without permission of the supplier. Such cylinders must be shipped as full cylinders and correspondingly labeled and tagged (See 3.2). All empty cylinders should be returned promptly.

3.3.3 Tank cars (ICC-106A500, ICC-106A-500X, ICC-105A300, and ICC-105A300W) should be drained free of liquid vinyl chloride, the valves should be securely closed and the valve plugs replaced. No air should be permitted to enter the vessel. The inert gas used for the unloading procedures (See 4.4 Tank Cars) should be left in the vessel at a pressure not to exceed the service pressure for which the car is authorized.

3.3.4 In addition, the following precautions must be taken:

3.3.4.1 *Return of Tank Cars*

As soon as a tank car is completely unloaded, all valves must be made tight, the unloading connections must be removed and all closures made tight, except that heater coil inlet and outlet pipes (if any) must be left open for drainage. Heater coils must never be used in unloading vinyl chloride. Empty tank cars should be returned as promptly as possible, in accordance with instructions received from shipper.

3.3.5 Follow ICC Regulations regarding the replacement of closures, condition and labeling of empty containers; condition of empty cars and placard requirements before returning to shipper. The ICC DANGEROUS placards on sides and ends of tank cars must be removed, or reversed (if in metal placard holders) by the party discharging the tank car. The empty car must be offered to the receiving carrier either without placards, or preferably with four (4) DANGEROUS-EMPTY placards.

4. UNLOADING AND EMPTYING

4.1 Health Hazards (See 8. Health Hazards and Their Control)

4.1.1 Aside from the risk of fire and explosion, vinyl chloride presents no other very serious problem in general handling. The presently accepted upper limit of safety as a health hazard is 500 ppm.

4.2 Fire and Explosion Hazards

4.2.1 Vinyl chloride should always be handled with full recognition of its flammability. Precautions should be taken both to keep the material enclosed and to eliminate sources of ignition. Reliance must be placed upon the elimination of all sources of ignition and on the provision of sufficient ventilation to keep escaping vapors at nonflammable levels (See 6.2).

4.3 Cylinders

4.3.1 Precautions generally applied to use of cylinders (ICC-4B300 and ICC-4BA300, without brazed seams, ICC-3A300, ICC-3A-A300) for flammable liquefied gases should be used.

4.3.2 A water bath heated to a maximum of 50°C. (122°F.) may be used to empty cylinders by means of the vapor pressure of the vinyl chloride.

4.3.3 Check valves must be installed in feed lines from the cylinder to prevent the reactants from entering the cylinder.

4.3.4 When the cylinder is empty, the valve should be securely closed. Air should not be allowed to enter the container.

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4.3.5 Valve protective caps should be kept in place on cylinders except when the cylinders are connected for discharge.

4.3.6 Cylinders must not be filled except by or with the consent of the owner, and then only in accordance with the Regulations of the Interstate Commerce Commission.

4.3.7 No attempt should ever be made to mix gases or liquids in a cylinder.

4.4 Tank Cars

4.4.1 Applicable instructions for unloading tank cars containing flammable liquids are set forth in MCA Manual Sheet TC-4. (Also see ICC Regulations, Sec. 74.560 to 74.563 inclusive, for unloading tank cars.)

4.4.2 Shipper's instructions should always be followed and all caution markings on both sides of tank and dome should be read and observed.

4.4.3 In the event of a tank car fitting failure or leak, the shipper should be telephoned or wired immediately for instructions (See 6.3).

4.4.4 Tank cars should be electrically grounded to dissipate static or induced lightning charges.

4.4.5 No heat should be applied to the tank car. An inert gas line or compressed vinyl chloride gas line should be attached to vent connection of the tank car to provide a pressure for transfer of the liquid vinyl chloride from tank car to receiving tank.

Cylinder nitrogen (inert gas) is often used as the pressuring medium in the event vinyl chloride gas is not available. Larger installations may have a suction line connected from the storage tank to a compressor which discharges compressed vinyl chloride gas to vent connection on tank car. The pressure on the car should never exceed the service pressure at which the safety valve is set to operate.

4.4.6 Some tank cars in vinyl chloride service are equipped with excess flow check valves. A too rapid opening of the discharge valves will cause the check valves to close. If this should occur, the outlet valve should be closed until the pressure is equalized and the excess flow valve opens.

4.4.7 Positive vinyl chloride or inert gas pressure should be left in car. No air should be allowed to enter car (See 3.3.3).

5. STORAGE

5.1 Hazards (See 8. Health Hazards and Their Control)

5.1.1 Aside from the risk of fire and explosion, vinyl chloride presents no other very serious problem in general handling. The presently accepted upper limit of safety as a health hazard is 500 ppm.

5.1.2 Vinyl chloride should always be handled with full recognition of its flammability. Precautions should be taken both to keep the material enclosed and to eliminate sources of ignition. If there should be any unavoidable leaks, reliance must be placed upon the elimination of all sources of ignition and on the provision of sufficient ventilation to keep escaping vapors at nonflammable levels (See 6.2).

5.1.3 *CORROSION*

Vinyl chloride is noncorrosive at normal atmospheric temperatures when dry (moisture free). In contact with water at elevated temperatures vinyl chloride accelerates corrosion of iron or steel.

5.1.4 *VOLATILITY*

Vinyl chloride is very volatile and is a gas at normal atmospheric conditions. Containers used for handling vinyl chloride at atmospheric temperature are always under pressure.

5.1.5 *TEMPERATURE REQUIREMENTS*

Inhibited vinyl chloride may be stored at normal atmospheric conditions in suitable pressure vessel.

Uninhibited vinyl chloride may be stored either under refrigeration or at normal atmospheric temperature in the absence of air or sunlight but only for a duration of a few days. If for longer periods, regular checks should be made for the presence of polymers.

5.2 Conditions of Storage

5.2.1 *TYPE OF CONSTRUCTION*

All piping (including instrument leads), storage tanks, relief devices and equipment employed to handle vinyl chloride should be of steel and designed to have a working pressure of at least 100-150 psi with a safety factor conforming to the A.S.M.E. code for unfired pressure vessels or any code applying to locale of planned storage. Shut-off valves and control

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valves should be of steel or a suitable alloy not bearing copper, designed for working pressures of 150 psi or over. All-welded construction is preferred to riveted construction. It is recommended wherever possible that all liquid inlet lines enter the bottom or extend to the bottom of the vessel. This guards against the accumulation of static electricity. All equipment should be properly grounded with resistance to ground never exceeding 25 ohms. An efficient water spray system should be installed or made available. Adequate diking and drainage should be provided under tank area to confine and dispose of the liquid in case of vessel rupture. Any cylinders used to store vinyl chloride must meet ICC Specifications.

5.2.2 *ISOLATION*

Storage areas should be selected in accordance with local codes or authorities having jurisdiction. (Assistance may be obtained from such organizations as National Board of Fire Underwriters, Factory Insurance Association, Associated Factory Mutual Fire Insurance Companies.) For highly volatile and flammable material, storage should be located outside of buildings. Cylinders containing vinyl chloride should be stored always in a vertical position, outside of buildings, and in an isolated and well ventilated area. It is preferable to store cylinders in the open, but provision should be made to shield them from the direct rays of the sun and prevent accumulation of dirt, snow, water, or ice on valves or safety devices.

5.2.3 *COMPATIBLE AND DANGEROUSLY REACTIVE MATERIALS*

Tanks in vinyl chloride service should be used only for the storage of vinyl chloride (See 6.8). Before vinyl chloride is placed in a tank, the vessel should be purged with an inert gas until free of air. Vinyl chloride is generally noncorrosive at normal atmospheric temperatures when dry (moisture free). However, mild to appreciable corrosion has been noted even at ordinary temperature. This may be due to the presence of impurities. In contact with water at elevated temperatures vinyl chloride accelerates corrosion of iron or steel. Acetylene as an impurity in vinyl chloride may form an explosive compound (acetylide) when exposed to copper or possibly copper alloys.

5.2.4 *VAPOR-PROOF OR EXPLOSION-PROOF REQUIREMENTS*

All electrical equipment, motors, lights, and flashlights used in an area in which vinyl chloride is stored or handled should conform to the National Electrical Code (Class I, Division II for storage; and Class I, Division I for use).

5.2.5 *VENTING REQUIREMENTS*

An adequate system for normal and emergency venting should be installed. All vent lines should extend to a safe area free of any source of ignition. The point of outlet should be equipped with an approved flame arrestor. Relief valves should be installed in pairs, parallel, using transflow valving to facilitate periodic testing and repairing.

5.2.6 *VENTILATION*

All storage areas should be provided with continuous ventilation. Pits, depressions and basements should be avoided.

5.2.7 *PROTECTION FROM ELECTRICAL STORMS*

Storage tanks for vinyl chloride should be protected from electrical storms and induced static electricity by grounding of all equipment.

5.2.8 *PROTECTION FROM INTERNAL EXPLOSIVE MIXTURES*

Storage tanks and other vessels should be maintained under positive pressure utilizing an inert gas when necessary or vapor pressure of the vinyl chloride. Vessels should be provided with bottom inlets under the liquid, or dip pipe extending from the top of the vessel to within inches of the bottom of the vessel to protect against a static discharge.

6. HANDLING

6.1 Health Hazards (See 8. Health Hazards and Their Control)

6.1.1 Aside from the risk of fire and explosion, vinyl chloride presents no other very serious problem in general handling. The presently accepted upper limit of safety as a health hazard is 500 ppm.

6.2 Fire, Explosion, and Polymerization Hazards

6.2.1 *FIRE HAZARDS*

Vinyl chloride should always be handled with full recognition of its volatility and its flammability. In general, precautions should be taken both to keep the material enclosed and to eliminate all sources of ignition. In small

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laboratory operations, where vinyl chloride vapors may escape, reliance must be placed upon the elimination of sources of ignition and the provision of sufficient ventilation to keep escaping vapors at non-flammable levels. Vinyl chloride vapors can form flammable mixtures with air at all temperatures above —78°C. (—108.4°F.).

Fires involving large quantities of liquid are difficult to extinguish since vinyl chloride is not miscible with water and is lighter than water (will float on top of water). Most small fires can be extinguished with carbon dioxide or dry chemical agents if properly applied. Adequate fire extinguishing equipment of carbon dioxide or dry chemical type, fixed and portable, should be provided. Water spray is also satisfactory for extinguishing fires. Diking and drainage should be provided for confining and disposing of the liquid in case of tank rupture or spills. Precautions should be taken to guard against vinyl chloride entering general sewer system (See 6.3).

In event of a fire no unauthorized person should be permitted to enter an unventilated area until the space has been thoroughly sprayed with water to remove gases such as hydrogen chloride, phosgene, carbon monoxide, etc. generated from the fire.

6.2.2 *EXPLOSION HAZARDS*

Vinyl chloride is a gas at normal atmospheric temperature and pressure. The gas will burn very readily in proper mixtures of air or oxygen. The explosive limits are: lower 4.0%, upper 22.0% by volume in air. An explosion hazard can exist when drawing samples or venting to the atmosphere. Open flames, local hot spots, friction, any spark producing equipment, and static electricity are to be avoided when handling this material.

6.2.3 *POLYMERIZATION HAZARDS*

Vinyl chloride does not form peroxides by autoxidation as readily as many other monomers. Aside from polymerization, vinyl chloride is chemically quite stable (See 2.2 Reactivity). Vinyl chloride can be satisfactorily stored without an inhibitor for short periods if it is kept in steel tanks under refrigeration or at normal atmospheric temperature in the absence of air and sunlight. For shipping purposes inhibitors are employed. Inhibitors, like phenol, when present have hazards of their own, being very toxic (See 7.5).

6.3 Spills and Leakage

6.3.1 Frequent inspections of equipment and vessels containing vinyl chloride should be made to detect or prevent leaks.

6.3.2 If spills or leaks occur, all sources of ignition if required to be present in the area and adjacent areas must be shut off immediately. Only necessary and properly protected personnel should remain in the area (See 6.5).

6.3.3 Spills, unless very large, usually evaporate rather rapidly and do little damage, but ample ventilation should be provided to prevent the formation of toxic and explosive mixtures. Spills should be guarded and controlled immediately. All openings in sewer system should be trapped for segregation and extinguishment. All sources of ignition should be removed (See 6.2.1).

6.3.4 If possible, increased forced ventilation should be provided. Inhalation of vapors should be avoided (See 8).

6.3. Leaking cylinders in any enclosure should be removed to an isolated, well-ventilated area and the contents transferred to other suitable containers (See 4.3 and 5.2.2).

6.3.6 The detection of leaks in equipment of vinyl chloride can best be accomplished by the use of a flammable gas indicator, or by inspection for the presence of vapors and frosting on the surfaces of the equipment.

6.3.7 In the event of a tank car leakage, utilize necessary personal protective equipment and make emergency repairs, if possible. The supplier should be telephoned or wired immediately for specific instructions. Guard against the fire hazard or explosion hazard (See 6.2).

6.3.8 Clothing contaminated with vinyl chloride should be removed immediately and the body washed thoroughly to remove any material which may have penetrated to the skin. Clothing should be washed before reuse. If necessary shoes should be replaced with new ones. Disposal of the contaminated shoes is recommended if the spilled vinyl chloride contained a toxic inhibitor, like phenol.

6.4 Employee Education and Training

6.4.1 Safety in handling vinyl chloride and other hazardous chemicals depends upon the effectiveness of employee education, training, and the safety instructions incorporated into job instruction manuals.

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6.4.2 The education and training of employees to work safely and to use the personal protective equipment or other safeguards provided for them is a responsibility of supervision.

6.4.3 Employee education and training should emphasize the need of handling vinyl chloride according to the methods outlined in this data sheet.

6.4.4 Before being placed on the job, new or transferred employees should be thoroughly instructed and questioned in respect to the proper handling of vinyl chloride. Employees on the job should be reinstructed periodically.

6.4.5 Each employee should know the location, purpose, use and maintenance of personal protective equipment and be thoroughly trained in when and how to use the equipment (See 6.5).

6.4.6 Each employee should know the location of safety showers, eye baths, bubbler drinking fountains, faucets or fire extinguishing equipment.

6.4.7 Only reliable, properly trained employees should be given the responsibility of operating valves which control the flow of vinyl chloride to and from storage tanks, tank cars, and cylinders, or drawing samples and venting to the atmosphere.

6.4.8 Employees should be trained to report to the proper authority all suspected leaks or equipment failures and any signs of illness in personnel.

6.4.9 Each employee should know what to do in case of an emergency, in rendering first aid measures, and should realize the necessity for prompt administration of artificial resuscitation when overcome by vinyl chloride vapors (See 8.4.2.1).

6.5 Personal Protective Equipment

6.5.1 *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. Such equipment may protect the individual wearing it while others in the area may be exposed to danger. The correct usage of personal protective equipment requires the education of the worker in the proper employment of the equipment available to him (See 6.4). Under conditions which are sufficiently hazardous to require protective equipment, the use of it should be supervised. In all cases, the type of protective equipment selected should depend upon the nature and degree of the hazards existing.

The following personal protective equipment should always be used for the purposes mentioned and as specified in Section 8. Health Hazards and Their Control, and in other sections of this data sheet:

6.5.2 *EYE PROTECTION*

6.5.2.1 *Chemical Safety Goggles:* cup-type or rubber-framed goggles, equipped with approved impact resistant glass or plastic lenses, should be worn whenever there is danger of the vinyl chloride (in liquid or saturated vapor form) coming in contact with eyes. Goggles should be carefully fitted by adjusting the nose piece and head band to ensure maximum protection and comfort.

6.5.2.2 *Spectacle-type Safety Goggles:* metal or plastic rim safety spectacles with perforated side shields which can be obtained with prescription safety lenses or suitable all plastic safety goggles may be used where continuous eye protection is desirable. These types, however, should not be used where complete eye protection against chemicals is needed.

6.5.2.3 *Face Shields:* plastic shields (full length, eight inch minimum) with forehead protection may be worn in lieu of, or in addition to, chemical safety goggles where complete face protection is desirable. Chemical safety goggles should always be worn as added protection where there is danger of vinyl chloride striking the eyes from underneath or around the sides of the face shield.

6.5.2.4 Each employee should know the location of safety showers, eye baths, and bubbler drinking fountains for flushing the eyes.

6.5.3 *RESPIRATORY PROTECTION*

Respiratory protective equipment must be carefully maintained, inspected, cleaned, and sterilized at regular intervals, and always before use by another person. Personnel wearing such equipment must be carefully instructed as to its operation and limitations.

6.5.3.1 *Air or Oxygen Supplied Masks*

6.5.3.1.1 Air or oxygen supplied masks, equipped with full face pieces and approved by the U. S. Bureau of Mines for this purpose, should be used under the following conditions,

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and the manufacturer's instructions must be carefully followed:

(a) In emergencies, when the vapor concentration is not definitely known.

(b) When the harmful vapor concentration is over 2 per cent by volume.

(c) When the oxygen content of the air may be less than 16 per cent by volume.

(d) When the exposure period is to be over 30 minutes duration.

(e) In tank and equipment cleaning and repair work under conditions outlined in (a), (b), (c) and (d).

6.5.3.1.2 *Types Generally Available Include:*

(a) *Air-Line Masks* supplied by plant compressed air are suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply. Such masks should be used only in conjunction with a suitable reducing or demand-type valve, excess pressure relief valve, and filter. The compressed air should be checked frequently to make certain that harmful gases from the decomposition of the lubricating oil used in the compressor, or impure air supply, are not present.

(b) *Positive Pressure Hose Masks* supplied by externally lubricated blowers are usually preferred to the air-line type. Since these masks also depend on a remote air supply, they should be used only where conditions will permit safe escape in the event of air supply failure. Care must be taken to locate the blower air source in an area which is free of air contaminants.

(c) *Self-contained Breathing Apparatus* which permits the wearer to carry a supply of oxygen or air compressed in the cylinder, and the self-generating type which produces oxygen chemically, allow for greater mobility. The length of time a self-contained breathing apparatus provides protection varies according to the amount of air or oxygen supply carried. In tank work, where small manholes are encountered. a self-contained breathing apparatus is usually unsuitable because of its bulk.

6.5.3.2 *Industrial Canister Type Gas Masks* equipped with full face pieces and approved by the U. S. Bureau of Mines, fitted with the proper canister for absorbing vinyl chloride vapor (or gas), will afford protection against concentrations not exceeding 2 per cent by volume when used in accordance with the manufacturer's instructions. The oxygen content of the air must be not less than 16 per cent by volume. The masks should be used for relatively short exposure periods only, i.e., less than 30 minutes. They may not be suitable for use in an emergency since, at that time, the actual vapor concentration is unknown and it may be very high. The wearer must be warned to leave the contaminated area immediately on detecting the odor of vinyl chloride. This is an indication that the mask is not functioning properly or that the vapor concentration is too high.

NOTE: Where carbon monoxide may be encountered in addition to vinyl chloride, the mask should be equipped with an "All Purpose Canister" and a "Timing Device" as approved by the U. S. Bureau of Mines.

6.5.3.3 *Chemical Cartridge Respirators* approved by the U. S. Bureau of Mines may be used to avoid inhaling agreeable but harmless concentrations of vinyl chloride vapor. These respirators, however, are not recommended for protection where toxic quantities of an air contaminator may be encountered.

6.5.4 *HEAD PROTECTION*

6.5.4.1 Safety or "hard" hats will provide protection against accidental liquid leaks, falling tools, and other objects.

.5.4.2 Brimmed felt hats may be substituted for a safety hat where danger of falling objects is remote.

6.5.5 *FOOT PROTECTION*

High leather or synthetic rubber safety shoes with built-in steel toe caps are recommended where there is danger of heavy objects falling on workman's foot. Liquid vinyl chloride penetrates leather, and shoes wet with vinyl chloride should be replaced.

6.5.6 *BODY, SKIN AND HAND PROTECTION*

6.5.6.1 Any work gloves, clothing or wearing apparel which becomes contaminated with vinyl chloride should be removed immediately, and the body should be thoroughly washed. All contaminated work gloves, clothing or wearing apparel should be thoroughly washed, and dried before reuse. For care of contaminated shoes see 6.5.5.

6.5.6.2 When cleaning, inspecting, or repairing tanks, safety equipment such as safety

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belts, rescue harness, lifeline, clothing and gas masks should be worn as required by the specific nature of the work and the hazards involved.

6.5.6.3 Frequent inspections and necessary repairs should be made to all personal protective equipment so that it is always ready to give proper protection to the wearer.

6.5.6.4 Facilities for personal cleanliness should be provided and time allowed for thorough washing before lunch and at the end of the work day.

6.6 Engineering Controls

6.6.1 Selection of a site or location for apparatus or equipment to ship, handle, store or manufacture vinyl chloride should be made by the direction of chemical engineers or mechanical engineers fully aware of the hazards encountered in dealing with vinyl chloride (See 5.2.2).

6.6.2 Processes should be designed so that the operating personnel will not be exposed to direct contact with vinyl chloride or its vapor. The technical problems of designing equipment, providing adequate ventilation, and formulating operational procedures which promise maximum security and economy, can be handled best by engineers or other competent personnel. The manufacturers of vinyl chloride, and of the equipment in which it is to be used, are always prepared to help with these problems (See 5.2.1).

6.6.3 In the handling of vinyl chloride or operation of any type of vinyl chloride system, all valves, pipe lines, vents, safety devices, etc., should be so located that they can be readily inspected and repaired. They should always be in proper order and condition before the operation is started. All handling and storage equipment should be located away from any source of sparks, flames, heated surfaces and all sources of ignition which might cause fires or explosions. All charging and discharging pipes should enter through, or extend to, the bottom of all containers to minimize vaporization of the liquid and possible generation of static electricity.

6.6.4 It is essential for safety that equipment will be used and maintained as recommended by the manufacturer and that a periodic test schedule of the equipment, including safety devices, should be followed. All vent lines should extend outdoors to an area free of any source of ignition for discharge.

6.6.5 All electrical installations should conform with the National Electrical Code. All equipment should be properly grounded to prevent accumulation of static.

6.7 Ventilation

6.7.1 If the workroom or operating area is separate from vinyl chloride storage or processing equipment, general ventilation is adequate. For emergencies, however, the area should be provided with mechanical exhaust ventilation to maintain concentrations below flammable limits.

6.7.2 In the processing or storage area, if outside location is impracticable, special emergency equipment for ventilation is necessary under abnormal conditions, such as leaks or spills.

6.7.3 Six or more changes of air per hour are considered adequate for buildings housing storage or processing equipment for flammable liquids, vapors, or gases under pressure.

6.7.4 Buildings of substantial construction should have at least one square foot of door, window, or nonrigid roof area for each 35 cubic feet of volume to prevent serious structural damage in the event of explosion within the building.

6.7.5 The most important consideration in ventilation is to ensure an adequate air flow away from the work area.

6.7.6 All ventilating systems should be inspected periodically and maintained in a safe and efficient working condition.

6.7.7 Under abnormal conditions, such as when leaks or spills occur, all available ventilation should be used.

6.8 Tank and Equipment Cleaning and Repairs

6.8.1 The hazardous nature of tank or vessel inspections, cleaning, and repairs requires that the foreman and crew be selected, trained, and drilled carefully. They should be fully familiar with the hazards and safeguards necessary for the safe performance of the work. Use only spark-resistant tools.

6.8.2 Wherever possible, vessels should be cleaned from the outside, using cleanout manholes or openings provided for this purpose.

6.8.3 First consideration in vessel entry work requires the vessel be properly isolated

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from any process equipment, pipe lines, or apparatus. These process lines, pipe lines, and apparatus should be disconnected, preferably by removing a complete small section and providing a blank flange on the open end to protect against human error and unsuspected leaks. Valves and plug cocks in the process lines, pipe lines, or apparatus should not be relied upon to prevent leakage into vessel being cleaned.

6.8.4 Electrical switches should be locked in the "OFF" position and tagged with a warning that they are not to be opened. Where possible, the fuses should be pulled. Drive belts should be removed and all other precautions taken to ensure against the accidental starting of agitating equipment or other moving parts inside the vessel or adjacent to the entrance.

6.8.5 Before entering a tank, it should be empty, purged, and tested for flammable residues. Caution should be exercised in checking for trapped vapors in any semi-solid or solid residues. In purging a vessel, an inert gas (carbon dioxide or nitrogen) is recommended. The inert gas must be displaced before allowing entry into a vessel. When air is used for purging a vessel, there is a period when an explosive mixture is present (mixture contains by volume between 4-22% gas). For this reason it is best to avoid the use of air in removing flammable vapors.

6.8.6 Warning signs should be placed indicating nature of hazard present during preparation of vessel for entry or repair.

6.8.7 Before entering a vessel and during the course of the work, tests should be made by a qualified person to determine that no further purging or washing is necessary, that no oxygen deficiency exists, and that no harmful gas or vapor is present.

6.8.8 Special ventilation and a continuous fresh air purging of vessel is recommended during the entire time men are cleaning, inspecting, or repairing vessel.

6.8.9 Proper personal protective equipment such as a safety belt, rescue harness, lifeline, or mask as required should be worn by anyone entering a vessel after preparation for inspection, and or repairs (See 6.5).

6.8.10 An attendant should be stationed outside the vessel in such a position as to keep workmen within the vessel under constant observation. He should serve as the lifeline tender and be ready at all times to summon help or other required aid. He should never abandon the lifeline while workmen are in the vessel.

6.8.11 A self-contained breathing apparatus or an air-supplied mask should be located immediately adjacent to vessel repair area for any emergency situation during vessel entry work. In addition a lifeline and safety harness should be on hand.

6.8.12 The portable electric lights and power tools should be in good condition, grounded and approved by competent persons for use in exposures of this nature.

6.8.13 Before reuse, the vessel should be purged free of air by using an inert gas such as carbon dioxide or nitrogen.

6.9 Repackaging

6.9.1 Only clean, ICC Specification cylinders or tank cars should be used (See 3.1).

6.9.2 Adequate ventilation should be provided and all sources of ignition removed from transfer area.

6.9.3 Proper personal protective equipment should be used (See 6.5). Transferring vinyl chloride from cylinders by the use of an uncontrolled heating method is not recommended because it is unsafe, wasteful, and time consuming. Temperatures of over 50°C. (122°F.) should not be applied to any part of a cylinder containing compressed gas. Excessive heating weakens the structural characteristics of the metal and may seriously damage the cylinder. Low melting safety devices may reach the fusing point by the application of excessive heat to a cylinder. Never apply direct flame to a cylinder. A definite fire hazard is created. For recommended practice to transfer contents of a cylinder see 4.3.

6.9.4 For recommended practice to transfer contents of tank car see 4.4.

6.9.5 The appropriate labels should be applied to the filled cylinders or tank cars (See 3.2).

7. WASTE DISPOSAL

7.1 All Federal, State, and local regulations regarding health and pollution should be observed. Disposal of waste material, however, depends to a great extent upon surroundings and weather conditions.

7.2 When it becomes necessary to dispose of vinyl chloride as such, it is preferable to do so as a vapor, venting to an area free of any source of ignition (See 5.2.5 and 5.2.6).

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7.3 When a waste disposal problem arises as a result of a major spill or equipment rupture, only properly protected and qualified personnel should remain in the area (See 6.3 and 6.5).

7.4 Waste mixtures containing vinyl chloride should not be allowed to enter drains or sewers as serious explosion in such systems may result (See 6.3).

7.5 Removal of inhibitor, such as phenol in form of sodium phenolate, should be done by dilution to approximately 1% solution (See SD-4, Part 7. Waste Disposal).

8. HEALTH HAZARDS AND THEIR CONTROL

8.1 Hazards

8.1.1 *GENERAL*

Aside from the risk of fire or explosion, vinyl chloride presents no other very serious problem in general handling. The presently accepted maximum allowable concentration is 500 ppm.

8.1.2 *SYSTEMIC EFFECTS*

In concentrations well above 500 ppm. vinyl chloride acts as a mild general anesthetic.

8.1.3 *LOCAL EFFECTS*

In contact with the skin vinyl chloride *is irritating.* Prolonged contact will result in refrigeration and freezing.

8.2 Prevention and Control

Vinyl chloride is not a serious industrial hazard provided precautions are taken to avoid leaks or spills which might provide a fire or explosion hazard. Where serious leaks or spills do occur, the workmen present in the area should be evacuated, and persons returning to the area to repair or clean up equipment should be provided with appropriate gas masks, self-contained oxygen units, or air supplied hoods.

8.2.1 *EMPLOYEE EDUCATION* (See 6.4 Employee Education and Training)

Employees working in areas where vinyl chloride is handled or stored should be thoroughly and repeatedly warned of the anesthetic properties of vinyl chloride gas and instructed as to what to do if anesthetic effects are detected in themselves or in others (See 8.4.2.1).

Emphasis in training should be placed on:

1. *The use of artificial respiration in cases where breathing has stopped because of deep anesthesia.*
2. *The necessity of immediate removal of contaminated clothing and shoes in case of liquid spills.*
3. *Repeated washing of the eyes with copious amounts of water in case of liquid splashes.*

8.2.2 *VENTILATION*

Work areas where vinyl chloride is handled or stored should be provided with adequate ventilation. The concentration of vinyl chloride should be kept below the upper safe limit of 500 ppm. at all times.

8.3 Personal Protective Equipment

8.3.1 No personal protective equipment is an adequate substitute for safe working conditions and intelligent conduct on the part of employees who work with vinyl chloride. Furthermore, the correct usage of personal protective equipment requires education of the worker in the proper employment of the materials available to him. Under conditions which are sufficiently hazardous to require personal protective equipment, the use of it should be supervised.

8.3.2 Employees who may be subject to severe exposure to vinyl chloride, as in tank and equipment cleaning and repairs, in decontaminating extensive areas after large spillage, or in cases of failure of piping or equipment, should be provided, when indicated, with proper eye, respiratory, skin, and mucous membrane protection as follows:

(a) Suitable gas tight safety goggles.

(b) Rescue harness and life line for those entering tank or enclosed storage space (See 6.7).

(c) Hose masks with hose inlet in a vapor-free atmosphere, air line masks with proper reducing valve and filter, suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply, or self-contained breathing equipment with stored oxygen or air (such equipment allows greater mobility but usually requires more highly trained men).

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8.3.3 Facilities for washing eyes and skin with large quantities of water should be readily available (See 6.5.2.4).

8.4 First Aid and Medical Care

8.4.1 *GENERAL PRINCIPLES*

8.4.1.1 As in exposure to any odorless or mildly scented anesthetic gas, a recognition of the presenting symptoms and signs in oneself and in others is very important. The anesthetic properties of vinyl chloride are mild in degree and slow in developing. Detection of symptoms except in very high concentrations permits ample warning and sufficient time for escape from the environment provided the warning is heeded and escape is possible.

8.4.1.2 As in any skin contact with irritating or harmful materials, speed in removing the contaminant from the skin is of primary importance. Vinyl chloride is very volatile and simple exposure to air will usually effect adequate removal. Clothing, shoes, bandages, or other articles by which vinyl chloride might be held in contact with the skin should be immediately removed to decrease the freezing effect.

8.4.2 *SPECIFIC ACTIONS*

8.4.2.1 *Inhalation*

Continued exposure to atmospheres containing vinyl chloride in concentrations of 1000 ppm. or over will slowly produce evidences of mild anesthesia: (1) a sensation of drowsiness and inability to concentrate, (2) a blurring of vision—at first readily cleared by conscious effort—later controlled only with difficulty or not at all, (3) staggering gait, (4) sensation of numbness or tingling in feet or hands or both.

These symptoms may be readily detected by the employee himself if he has been alerted to the possibility of their arising from overexposure to vinyl chloride. They may also be noted in fellow employees. When such symptoms arise, they are definite warning of a hazardous exposure to vinyl chloride, and all personnel should be immediately evacuated from the area until the leak or spill has been located and corrected and until complete recovery from all symptoms has occurred.

Because of the mildness and slow development of symptoms, it is very unlikely that any workman will be overcome to the point where he will require help in escaping the environment or medical care following exposure. Any person with evidence of intoxication from vinyl chloride should be put at rest, either seated or lying, in an uncontaminated atmosphere.

If trapped in an area of high concentration where escape is impossible, deep anesthesia can result. If such an exposure has occurred, the patient should be placed in bed, preferably with the head slightly lowered and with no pillows. If respirations have ceased, artificial respiration will be required. In any case, medical attention should be obtained immediately.

8.4.2.2 *Contact with Skin*

Liquid vinyl chloride is a primary irritant to intact skin. If sufficient quantities remain long enough in contact with the skin, the rapid evaporation may result in freezing or "frost bite". Consequently, anything which tends to hold vinyl chloride in contact with the skin, such as clothing, shoes, or bandages, increases the risk of freezing.

If spills occur, all contaminated clothing should be removed immediately and the contaminated area washed copiously in running water. If mild irritation has occurred, no further treatment may be required. If inflammation is severe, loose dressings of petroleum jelly should be applied and the patient placed in the care of a physician.

If freezing has occurred, the area should be loosely covered with a clean, preferably sterile, gauze or towel and placed in the care of a physician.

8.4.2.3 *Contact with Eyes*

Vinyl chloride which has gotten into the eyes should be washed out immediately with copious amounts of flowing water. Water at room temperature will produce less pain than very cold water, but in an emergency a drinking fountain is a satisfactory source of water. The washing should continue for at least 15 minutes. If injury is apparent in the tissues of the eye after 15 minutes of irrigation, the washing should be continued for another 15 minutes. In all cases except of very minor irritation, the patient should be placed in the care of an ophthalmologist immediately.

The medical information in this publication has been supplied by the Medical Advisory Committee of the Manufacturing Chemists' Association, Inc.

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