OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CHLORODIFLUOROMETHANE

INTRODUCTION

This guideline summarizes pertinent information about chlorodifluoromethane for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

- **Formula**

  $CHClF_2$

- **Synonyms**

  Algeon 22; CFC 22; difluorochloromethane; difluoromonochloromethane; Dymel 22; Fluorocarbon-22; Freon 22; Genetron 22; monochlorodifluoromethane; refrigerant 22; Ucon 22

- **Identifiers**

  1. CAS No.: 75-45-6
  2. RTECS No.: PA6390000
  3. DOT UN: 1018 12
  4. DOT label: Nonflammable gas

- **Appearance and odor**

  Chlorodifluoromethane is a colorless, odorless, nonflammable gas; however, it may be shipped as a liquefied gas under pressure or reduced temperature.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

  1. Molecular weight: 86.47
  2. Boiling point (760 mm Hg): -40.8°C (-41.4°F)
  3. Specific gravity (water = 1): 1.49 at -69°C (-92.2°F)
  4. Vapor density (air = 1 at boiling point of chlorodifluoromethane): 2.98
  5. Melting point: -146°C (-230.8°F)
  6. Vapor pressure at 21°C (70°F): 7,121.2 mm Hg
  7. Solubility: Very soluble in water; soluble in ether, acetone, and chloroform
  8. Evaporation rate: Not applicable

- **Reactivity**

  1. Conditions contributing to instability: None reported
  2. Incompatibilities: Contact of chlorodifluoromethane at high temperatures with alkalies or alkaline earth

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metals such as aluminum, sodium, potassium, or zinc causes thermal decomposition.

3. Hazardous decomposition products: Toxic gases (such as fluorine, chlorine, phosgene, and carbonyl halides) may be released in a fire involving chlorodifluoromethane.

4. Special precautions: Corrosion can occur when magnesium alloys or aluminum containing more than 2% magnesium is used with fluorocarbon systems in which water may be present.

Flammability

The National Fire Protection Association has not assigned a flammability rating to chlorodifluoromethane; this substance is not combustible.

1. Flash point: Not applicable

2. Autoignition temperature: Not applicable

3. Flammable limits in air: Not applicable

4. Extinguishant: Use an extinguishant that is suitable for the materials involved in the surrounding fire.

Fires involving chlorodifluoromethane should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Containers of chlorodifluoromethane may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Personnel should withdraw immediately if they hear a rising sound from a venting safety device or if a container becomes discolored as a result of fire. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving chlorodifluoromethane. Structural firefighters' protective clothing may provide limited protection against fires involving chlorodifluoromethane.

EXPOSURE LIMITS

OSHA PEL

The Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure limit (PEL) for chlorodifluoromethane [29 CFR 1910.1000, Table Z-1].

- **NIOSH REL**

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 1,000 ppm (3,500 mg/m^3) as a TWA for up to a 10-hr workday and a 40-hr workweek and 1,250 ppm (4,375 mg/m^3) as a short-term exposure limit (STEL). A STEL is a 15-min TWA exposure limit that should not be exceeded at any time during a workday [NIOSH 1992].

- **ACGIH TLV**

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned chlorodifluoromethane a threshold limit value (TLV) of 1,000 ppm (3,540 mg/m^3) as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1993].

- **Rationale for limits**

The ACGIH limit is based on the risk of cardiac sensitization, asphyxiation, and central nervous system effects associated with exposure to chlorodifluoromethane.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Exposure to chlorodifluoromethane can occur through inhalation and eye or skin contact.

- **Summary of toxicology**

1. *Effects on Animals:* In animals, chlorodifluoromethane causes depression of the central nervous system, cardiac arrhythmias, and asphyxiation. The LC_{50} in the rat is 35 parts per hundred (pph) (350,000 ppm) for a 15-min exposure; acutely poisoned animals exhibited altered sleep times, stumbling, and respiratory depression before death [NIOSH 1989]. Mice exposed for 2-hr periods showed a maximum tolerated concentration of 320,000 ppm, and a minimum fatal level of 370,000 ppm [ACGIH 1991]. Rats and guinea pigs exposed by inhalation to airborne concentrations of 75,000 to 100,000 ppm chlorodifluoromethane for 2-hr showed excitation and/or changes in equilibrium; narcosis occurred at 200,000 ppm and death occurred at 300,000 and

400,000 ppm [ACGIH 1991]. Dogs exposed to a 50,000-ppm concentration of chlorodifluoromethane developed cardiac sensitization; exposure to 25,000 ppm did not cause this effect [ACGIH 1991]. The minimum concentration capable of altering the reflex response in rabbits varied between 11,000 and 20,000 ppm [ACGIH 1991]. In 2-hr exposures to guinea pigs, the highest concentration tested (200,000 ppm) did not cause death, while 50,000 ppm produced mild clinical changes, and minimal effects were noted at 25,000 ppm [ACGIH 1991]. In a 4-week study in which rats, guinea pigs, dogs, and cats were exposed to a 50,000-ppm concentration of chlorodifluoromethane for twenty 3.5-hr episodes, no clinical, biochemical, or pathological effects were observed [ACGIH 1991]. Rats, mice, and rabbits were exposed for 6 hr/day, 6 days/week for 10 months to 14,000 ppm chlorodifluoromethane. In another experiment, rats and mice were exposed to 2,000 ppm of this substance for the same period. No effects were noted in animals exposed at the lower concentration, but at 14,000 ppm, alterations occurred in body weight, physiological endurance, and hematological characteristics; pathological changes were noted in the lungs, central nervous system, heart, liver, kidneys, and spleen [ACGIH 1991]. In one inhalation bioassay in rats, males exposed to the highest concentration administered showed only a marginal increase in the incidence of subcutaneous fibrosarcomas and Zymbal-gland tumors, and negative results were obtained for females [IARC 1987]. Based on this study, the International Agency for Research on Cancer (IARC) has concluded that the evidence for chlorodifluoromethane's carcinogenicity in animals is limited [IARC 1987].

2. *Effects on Humans:* In humans, chlorodifluoromethane can affect the heart; at very high concentrations, it is an asphyxiant. A study of hospital personnel exposed to 300 ppm chlorodifluoromethane during tissue freezing procedures revealed a 3.5-fold increase in the incidence of palpitations in exposed individuals over the incidence in nonexposed hospital personnel [Clayton and Clayton 1981; Hathaway et al. 1991]. An epidemiologic study involving workers exposed to chlorofluorocarbons, including chlorodifluoromethane, showed no increased mortality due to heart, circulatory, or malignant disorders [Hathaway et al. 1991]. A small study of 539 refrigeration workers exposed to a mixture of chlorofluorocarbons, including chlorodifluoromethane, for at least 6 months and followed for up to 30 years was inconclusive, leading IARC to conclude that the evidence for the carcinogenicity of this substance in humans is inadequate [IARC 1987].

- **Signs and symptoms of exposure**

1. *Acute exposure:* Chlorodifluoromethane may cause dizziness, disorientation, incoordination, narcosis, nausea, vomiting, heart palpitations (irregular heart beat), tightness in the chest, and difficult breathing. Direct tissue contact with liquid chlorodifluoromethane may cause frostbite.

2. *Chronic exposure:* Continued low-level exposure to chlorodifluoromethane may cause an irregular heartbeat.

- **Emergency procedures**

WARNING!

Seek immediate medical attention for severely affected victims or for victims with signs and symptoms of frostbite, toxicity, or irritation!

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* If tissue is frozen, seek medical attention ***immediately***. If tissue is not frozen, ***immediately and thoroughly*** flush the eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids. If irritation, pain, swelling, lacrimation, or photophobia develops, get medical attention as soon as possible.

2. *Skin exposure:* If tissue is frozen, seek medical attention ***immediately***; do not rub the affected areas or flush them with water. If tissue is not frozen, immediately and thoroughly wash contaminated skin with soap and water.

3. *Inhalation exposure*: Move the victim to fresh air ***immediately***.

   If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Rescue:* Remove an incapacitated worker from fur-

ther exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve chlorodifluoromethane and may result in worker exposures to this substance:

—Formulation of aerosol propellants (former use)

—Use as a component of fluorocarbon resins (such as tetrafluoroethylene polymers) and as a low-temperature solvent

—Use in central air conditioning systems and heat pumps

—Use in cylinder packing and shipping and tank car filling

The following methods are effective in controlling worker exposures to chlorodifluoromethane, depending on the feasibility of implementation:

—Process enclosure

—Local exhaust ventilation

—General dilution ventilation

—Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. Industrial ventilation—a manual of recommended practice. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. Industrial ventilation—a self study companion. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. Design of industrial ventilation systems. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. Engineering design for control of workplace hazards. New York, NY: McGraw-Hill.

5. Plog BA [1988]. Fundamentals of industrial hygiene. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

- **Preplacement medical evaluation**

  Before a worker is placed in a job with a potential for exposure to chlorodifluoromethane, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the cardiovascular system.

  A preplacement medical evaluation is recommended to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to chlorodifluoromethane at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and

other findings consistent with diseases of the cardiovascular system.

- **Periodic medical examinations and biological monitoring**

  Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to chlorodifluoromethane exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of chlorodifluoromethane on the cardiovascular system. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

  Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for chlorodifluoromethane.

- **Medical examinations recommended at the time of job transfer or termination**

  The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

A worker's exposure to airborne chlorodifluoromethane is determined by using a charcoal tube (100/50 mg sections, 20/40 mesh). Samples are collected at a recommended flow rate of 0.05 liter/min or less until a maximum air volume of 1 liter is collected. The sample is then treated with carbon disulfide to extract the chlorodifluoromethane. Analysis is conducted by gas chromatography using a flame ionization detector. This method is described in the OSHA Computerized Information System [OSHA 1989] and in the *OSHA Chemical Information Manual* [OSHA 1991].

PERSONAL HYGIENE

If liquid chlorodifluoromethane contacts the skin, workers should flush the affected areas immediately with plenty of tepid water for 15 min, and then wash with soap and water.

Clothing contaminated with liquid chlorodifluoromethane should be removed immediately, and provisions should be made for safely removing this chemical from these articles.

A worker who handles cylinders of liquid chlorodifluoromethane should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, or applying cosmetics.

Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where chlorodifluoromethane is handled, processed, or stored.

STORAGE

Chlorodifluoromethane should be stored in a cool, dry, well-ventilated area in closed, pressurized, steel containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of chlorodifluoromethane should be protected from physical damage and should be stored separately from alkaline earth metals (such as sodium, aluminum, or potassium), heat, sparks, and open flame.

SPILLS AND LEAKS

In the event of a spill or leak involving chlorodifluoromethane, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material; stop the leak if it is possible to do so without risk.
2. Notify safety personnel.
3. Remove all sources of heat and ignition.
4. Ventilate the area of the spill or leak.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

  Chlorodifluoromethane is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

- **Reportable quantity requirements for hazardous releases**

  Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the National Response Center of an accidental release of chlorodifluoromethane; there is no reportable quantity for this substance.

- **Community right-to-know requirements**

  Employers are not required by Section 313 of SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of chlorodifluoromethane emitted or released from their facility annually.

- **Hazardous waste management requirements**

  EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although chlorodifluoromethane is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [42 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

  Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

- **Conditions for respirator use**

  Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of chlorodifluoromethane exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

  Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective gloves and clothing should be worn to prevent any skin contact with liquid chlorodifluoromethane. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. The following materials have been tested against chlorodifluoromethane and have demonstrated resistance: Natural rubber and neoprene. Nitrile, polyvinylchloride, and styrene-butadiene rubber have demonstrated poor resistance to permeation by chlorodifluoromethane.

If liquid chlorodifluoromethane is dissolved in water or an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which liquid chlorodifluoromethane might contact the eyes. Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with liquid chlorodifluoromethane. Contact lenses should not be worn if the potential exists for chlorodifluoromethane exposure.

REFERENCES CITED

ACGIH [1991]. Documentation of the threshold limit values and biological exposure indices. 6th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

ACGIH [1993]. 1993-1994 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

Clayton G, Clayton F [1981]. Patty's industrial hygiene and toxicology. 3rd rev. ed. New York, NY: John Wiley & Sons.

CFR. Code of Federal regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Hathaway GJ, Proctor NH, Hughes JP, Fischman ML [1991]. Proctor and Hughes' chemical hazards of the workplace. 3rd ed. New York, NY: Van Nostrand Reinhold.

IARC [1987]. IARC monographs on the evaluation of carcinogenic risk of chemicals to humans. Suppl. 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NIOSH [1987a]. NIOSH guide to industrial respiratory protection. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-116.

NIOSH [1987b]. NIOSH respirator decision logic. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-108.

NIOSH [1989]. Registry of toxic effects of chemical substances database: chlorodifluoromethane. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Standards Development and Technology Transfer, Technical Information Branch.

NIOSH [1992]. NIOSH recommendations for occupational safety and health: compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.

OSHA [1989]. Computerized information system. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.

OSHA [1991]. Chemical information manual. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.