OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CHLOROPENTAFLUOROETHANE

INTRODUCTION

This guideline summarizes pertinent information about chloropentafluoroethane 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 Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether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**

  $CClF_2CF_3$

- **Synonyms**

  F-115; Fluorocarbon-115; Freon 115; Genetron 115; Halocarbon 115; monochloropentafluoroethane

- **Identifiers**

  1. CAS No.: 76-15-3
  2. RTECS No.: KH7877500
  3. DOT UN: 1020 12
  4. DOT label: Nonflammable gas

- **Appearance and odor**

  Chloropentafluoroethane is a colorless, odorless, nonflammable gas; it is shipped as a liquefied gas under its own vapor pressure.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

  1. Molecular weight: 154.47
  2. Boiling point (760 mm Hg): -39.1°C (-38.4°F)
  3. Specific gravity: 5.5 at 20°C (68°F)
  4. Vapor density: Not applicable
  5. Melting point: -106°C (-222.8°F)
  6. Vapor pressure at 21.1°C (69.8°F): 6,034.4 mm Hg
  7. Solubility: Insoluble in water; soluble in alcohol and ether
  8. Evaporation rate: Not applicable

- **Reactivity**

  1. Conditions contributing to instability: None reported
  2. Incompatibilities: Contact of chloropentafluoroethane at high temperatures with alkalies or alka-

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line earth metals such as powdered aluminum, potassium or zinc causes thermal decomposition.

3. Hazardous decomposition products: Toxic gases and vapors (such as hydrochloric or hydrofluoric acid, phosgene, fluorides, and chlorides) may be released in a fire involving chloropentafluoroethane.

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 for chloropentafluoroethane; this substance is a nonflammable gas.

1. Flash point: Not applicable

2. Autoignition temperature: Not applicable

3. Flammable limits in air: Not applicable

4. Extinguishant: Use dry chemical or carbon dioxide to fight fires involving chloropentafluoroethane.

Fires involving chloropentafluoroethane 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 chloropentafluoroethane 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. If a tank car or truck is involved in a fire, personnel should isolate an area of a half mile in all directions. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving chloropentafluoroethane. Structural firefighters' protective clothing may provide limited protection against fires involving chloropentafluoroethane.

EXPOSURE LIMITS

- **OSHA PEL**

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

- **NIOSH PEL**

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 1,000 ppm (6,320 mg/m^3) as a TWA for up to a 10-hr workday and a 40-hr workweek [NIOSH 1992].

- **ACGIH TLV**

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned chloropentafluoroethane a threshold limit value (TLV) of 1,000 ppm (6,320 mg/m^3) as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1993].

- **Rationale for limits**

The NIOSH limit is based on the risk of cardiac, skin, CNS, and respiratory effects associated with exposure to chloropentafluoroethane [NIOSH 1992].

HEALTH HAZARD INFORMATION

- **Routes of exposure**

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

- **Summary of toxicology**

1. *Effects on Animals:* In animals, chloropentafluoroethane affects the heart and respiratory system at very high doses. Early studies in experimental animals showed that inhalation of a chloropentafluoroethane concentration of approximately 200,000 ppm caused confusion, pulmonary irritation, tremors, and, occasionally, coma [NLM 1992]. At a concen-

tration of 190,000 ppm, chloropentafluoroethane caused cessation of respiration (apnea) in rats exposed from 4 to 26 min [NLM 1992]. Rats exposed at 800,000 ppm plus 20% oxygen for 4 hr showed no clinical effects of histopathology. Rats and guinea pigs exposed at 600,000 ppm chloropentafluoroethane in oxygen for 2 hr and guinea pigs exposed at 200,000 ppm chloropentafluoroethane in air for varying intervals up to 2 hr showed no adverse clinical signs [ACGIH 1991]. Studies with anesthetized dogs, rats, and monkeys showed that, under certain conditions, exposures of 100,000 to 200,000 ppm of chloropentafluoroethane may increase blood pressure, accelerate heart rate, cause myocardial depression, or change pulmonary mechanics [ACGIH 1991]. Species differences in sensitivity are great. Monkeys do not show respiratory or circulatory effects when exposed to a 200,000 ppm concentration of chloropentafluoroethane; dogs show no respiratory depression when exposed to 200,000 ppm but do show bronchoconstriction, decreased compliance, sensitization of the heart to epinephrine, tachycardia, myocardial depression, and hypotension when inhaling 100,000 to 250,000 ppm chloropentafluoroethane; rats show bronchospasm, decreased compliance, and respiratory stimulation after inhalation of 100,000 ppm chloropentafluoroethane [Clayton and Clayton 1981; NLM 1992]. Rats, mice, rabbits, and dogs which received 90 exposures, 6 hr daily to 100,000 ppm chloropentafluoroethane showed no adverse effects, and rats, guinea pigs, dogs, and cats exposed to 200,000 ppm chloropentafluoroethane for 3.5 hr/day, 5 days/week for 4 weeks also showed no adverse effects after the cessation of exposure [ACGIH 1991].

2. *Effects on Humans:* In humans, chloropentafluoroethane can affect the heart, central nervous system, and skin. The neurological effects of chlorofluorocarbon exposure were evaluated in 27 refrigeration repair workers and 14 age-matched control workers from a local union of plumbers, pipefitters, and insulation workers. Personal air samples taken on two worker-participants over the course of a typical workshift showed average exposures of 1.4 ppm chlorodifluoromethane and 2.2 ppm chloropentafluoroethane. No peripheral neuropathy was seen among the study subjects, and there was no significant difference in mean nerve conduction velocities between study and reference subjects; however, lightheadedness and palpitations were reported significantly more often by refrigeration repair workers than by controls [NLM 1992]. The defatting effects of fluorocarbons such as chloropentafluoroethane, when in prolonged or repeated contact with the skin, may cause dermatologic problems, and contact of the skin with liquefied chloropentafluoroethane may cause frostbite [Clayton and Clayton 1981; Braker and Mossman 1980].

- **Signs and symptoms of exposure**

1. *Acute exposure:* The signs and symptoms of acute overexposure to chloropentafluoroethane include difficult breathing, dizziness, disorientation, incoordination, narcosis, and nausea or vomiting. Exposure to very high concentrations of this substance may affect the heart, causing irregular heartbeat, which could cause death. Contact of the skin with the evaporating liquid may cause frostbite.

2. *Chronic exposure:* The signs and symptoms of chronic exposure of the skin to chloropentafluoroethane include defatting and dermatitis.

- **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 further 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 chloropentafluoroethane and may result in worker exposures to this substance:

—Use as a refrigerant in home appliances, mobile air conditioning units, and retail food refrigeration systems and chillers

—Use as a chemical intermediate

The following methods are effective in controlling worker exposures to chloropentafluoroethane, 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 chloropentafluoroethane, 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 skin, cardiovascular system, and respiratory system. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

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 chloropentafluoroethane 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 skin, cardiovascular system, or respiratory 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 chloropentafluoroethane exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of chloropentafluoroethane on the skin, cardiovascular system, or respiratory 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 chloropentafluoroethane.

- **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 chloropentafluoroethane 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 until a recommended air volume of 2.5 liters is collected. Analysis is conducted by gas chromatography using a flame ionization detector. This method is described in the OSHA Laboratory In-House Methods File [OSHA 1989].

PERSONAL HYGIENE

If liquid chloropentafluoroethane contacts the skin, watch for the development of frostbite. If frostbite occurs, the affected part should be wrapped in woolen material and should then be immersed in warm water until medical help is obtained.

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

A worker who handles chloropentafluoroethane should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, or using toilet facilities.

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

STORAGE

Chloropentafluoroethane should be stored in a cool, dry, well-ventilated area in tightly sealed, pressurized containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of chloropentafluoroethane should be protected from physical damage and should be stored separately from metals, including aluminum, zinc, and beryllium, heat, sparks, and open flame.

LEAKS

In the event of a leak involving chloropentafluoroethane, 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 leak:

1. 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 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**

  Chloropentafluoroethane 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 chloropentafluoroethane; 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 chloropentafluoroethane 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 chloropentafluoroethane is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 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 the 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 chloropentafluoroethane 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 about the selection and use of respirators and about 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 chloropentafluoroethane. 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. No reports have been published on the resistance of various protective clothing materials to chloropentafluoroethane permeation; however, the following materials have been tested against chemically similar materials (Freon 113) and have withstood permeation for periods greater than 8 hr: nitrile rubber and Teflon® . Since specific test data are not available for chloropentafluoroethane, the information provided here should be considered as a guideline only. If permeability data are not readily available, protective clothing manufacturers should be requested to provide information on the best chemical protective clothing for workers to wear when they are exposed to chloropentafluoroethane.

Safety glasses, goggles, or face shields should be worn during operations in which liquid chloropentafluoroethane 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 chloropentafluoroethane. Contact lenses should not be worn if the potential exists for chloropentafluoroethane 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.

ATS [1987]. Standardization of spirometry—1987 update. American Thoracic Society. Am Rev Respir Dis 136:1285 1296.

Braker W, Mossman AL [1980]. Matheson gas data book. 6th ed. Secaucus, NJ: Matheson Gas Products, Inc.

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.

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 [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.

NLM [1992]. The hazardous substances data bank: chloropentafluoroethane. Bethesda, MD: National Library of Medicine.

OSHA [1989]. OSHA laboratory in-house methods file. Salt Lake City, UT: U.S. Department of Labor, Occupational Safety and Health Administration, OSHA Analytical Laboratory.