

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CYCLOPENTANE

INTRODUCTION

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 Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether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



• Synonyms

Pentamethylene

• Identifiers

1. CAS No.: 287-92-3
2. RTECS No.: GY2390000
3. DOT UN: 1146 27
4. DOT label: Flammable liquid

• Appearance and odor

Cyclopentane is a flammable, mobile, colorless liquid with a mild, sweet odor.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 70.13
2. Boiling point (760 mm Hg): 49.3°C (120.7°F)
3. Specific gravity (water = 1): 0.75 at 20°C (68°F)
4. Vapor density (air = 1 at boiling point of cyclopentane): 2.42
5. Melting point: -94°C (-137.2°F)
6. Vapor pressure at 31°C (87.8°F): 400 mm Hg
7. Solubility: Insoluble in water; soluble in alcohol, ether, acetone, benzene, petroleum ether, carbon tetrachloride.
8. Evaporation rate: Data not available

• Reactivity

1. Conditions contributing to instability: Heat, sparks, and open flame

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Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Education and Information Division

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2. **Incompatibilities:** Contact of cyclopentane with strong oxidizing agents (such as chlorine, bromine, or fluorine) may cause a reaction.
3. **Hazardous decomposition products:** Toxic gases (such as carbon monoxide and carbon dioxide) may be released in a fire involving cyclopentane.
4. **Special precautions:** None reported

Flammability

The National Fire Protection Association has assigned a flammability rating of 3 (severe fire hazard) to cyclopentane.

1. **Flash point:** -37°C (-35°F) (closed cup)
2. **Autoignition temperature:** 361°C (682°F)
3. **Flammable limits in air (% by volume):** Lower, 1.1; upper, 8.7
4. **Extinguishant:** Use dry chemical, standard foam, or carbon dioxide to fight fires involving cyclopentane. Water may be ineffective, but it may be used to cool fire-exposed containers. If a leak or spill has not ignited, water spray may be used to disperse vapors and to protect persons attempting to stop the leak.

Fires involving cyclopentane 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. Vapor explosion and poison hazards may occur indoors, outdoors, or in sewers. Vapors may travel to a source of ignition and flash back. Containers of cyclopentane 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. Dikes should be used to contain fire-control water for later disposal. 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 cyclopentane. Structural firefighters' protective clothing may provide limited protection against fires involving cyclopentane.

EXPOSURE LIMITS

• OSHA PEL

The Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure limit (PEL) for cyclopentane [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 600 ppm (1,720 mg/m³) as a TWA for up to a 10-hr workday and a 40-hr workweek for cyclopentane [NIOSH 1992].

• ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned cyclopentane a threshold limit value (TLV) of 600 ppm (1,720 mg/m³) as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1991].

• Rationale for limits

The NIOSH limit is based on the risk of CNS depression and skin irritation associated with cyclopentane exposure. The ACGIH limit is based on the risk of narcotic effects associated with exposure to cyclopentane.

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to cyclopentane can occur through inhalation, ingestion, and eye or skin contact.

• Summary of toxicology

1. **Effects on Animals:** Cyclopentane is a central nervous system depressant in animals. Application of cyclopentane to the skin of guinea pigs caused redness and dryness [Clayton and Clayton 1981]. The minimal narcotic concentration in mice is 38.3 ppm; this level of exposure may also cause loss of reflexes and death. The margin of safety between the minimal narcotic dose and the lethal dose is thus very small [Clayton and Clayton 1981]. Exposure to a cyclopentane concentration of 112 to 1,139 ppm for 6 hours/day for 3 weeks caused no effects in male and

female rats; however, exposure to 8,110 ppm for 6 hours/day for 12 weeks caused a decrease in the rate of body weight gain in female rats [Clayton and Clayton 1981].

2. *Effects on Humans:* Cyclopentane is a central nervous system depressant in humans. Because the industrial use of pure cyclopentane is limited and the commercial reagents and solvents that contain cyclopentane also contain other hydrocarbons, there are few toxicologic data on the effects of exposure to the pure substance [ACGIH 1991]. Prolonged contact of this substance with the skin may produce dryness and cracking [NJDH 1989]. Exposure to a 10 to 15 ppm concentration of cyclopentane for an unspecified period is reported to have been tolerated by volunteers [Clayton and Clayton 1981]. The central nervous system effects of exposure to cyclopentane include lightheadedness, dizziness, excitement, incoordination, nausea, vomiting, loss of consciousness, and, if exposure is severe, death due to respiratory failure [Sittig 1985]. One hundred twenty-two Italian shoe factory workers exposed for unspecified periods to unidentified concentrations of glue solvents that contained both cyclopentane and n-hexane developed polyneuropathy; however, the extent to which these polyneuropathies were attributable to cyclopentane exposure is unclear [ACGIH 1991].

• Signs and symptoms of exposure

1. *Acute exposure:* The signs and symptoms of acute exposure to cyclopentane may include lightheadedness, dizziness, excitement, incoordination, nausea, vomiting, stupor, loss of consciousness, and death. Contact with cyclopentane can irritate the skin and eyes.
2. *Chronic exposure:* The signs and symptoms of chronic exposure to cyclopentane include dryness and cracking of the skin. Although cyclopentane has not been adequately evaluated for the possibility of brain and nerve damage following repeated exposures, other solvents and petroleum-based chemicals have been shown to cause such damage, including: reduced memory and concentration, fatigue, sleep disturbances, and reduced coordination.

• Emergency procedures

WARNING!

Seek immediate medical attention for severely affected victims or for victims with signs and symptoms of 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:* Irritation may result from exposure to concentrated solutions, vapors, mists, or aerosols of cyclopentane. *Immediately and thoroughly* flush the eyes with large amounts of water, occasionally lifting the upper and lower eyelids.
2. *Skin exposure:* Irritation may result. *Immediately* remove contaminated clothing 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. *Ingestion exposure:* Take the following steps if cyclopentane or any material containing it is ingested:
 - Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.
 - Have the victim drink a glass (8 oz) of fluid such as water.
 - Induce vomiting by giving syrup of ipecac as directed on the package. If ipecac is unavailable, have the victim touch the back of the throat with a finger until productive vomiting ceases.
 - Do *not* force an unconscious or convulsing person to drink fluid or to vomit.

5. *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 cyclopentane and lead to worker exposures to this substance:

- Use in cracking of aromatics
- Use as an intermediate in the production of various chemicals and pharmaceuticals, including analgesics, sedatives, hypnotics, antitumor agents, prostaglandins, depressants, and insecticides
- Use as a component of solvents used for cellulose ethers, motor fuels, and as an azeotropic distillation agent
- Use in the production of cyclopentadiene
- Use as a laboratory chemical

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

- Process enclosure
- Local exhaust ventilation
- General dilution ventilation
- Personal protective equipment

Good sources of information on 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 cyclopentane, the examining physician 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 central nervous 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 cyclopentane at or below the prescribed exposure limit. The examining physician 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 central nervous 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 cyclopentane exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of cyclopentane on the skin and central nervous 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 cyclopentane.

- **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 to determine the worker's medical status at the end of his or her employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

Determination of a worker's exposure to airborne cyclopentane is made using a charcoal tube (100/50 mg sections, 20/40 mesh). Samples are collected at a maximum flow rate of 0.2 liter/min until a maximum air volume of 5 liters is collected. The sample is then treated with carbon disulfide to extract the cyclopentane. Analysis is conducted by gas chromatography using a flame ionization detector. This method is described in the OSHA Laboratory In-House Methods File [OSHA 1991].

PERSONAL HYGIENE

If cyclopentane contacts the skin, workers should wash the affected areas with soap and water.

Clothing contaminated with cyclopentane should be removed immediately, and provisions should be made for the safe removal of the chemical from the clothing. Persons laundering the clothes should be informed of the hazardous properties of cyclopentane.

A worker who handles cyclopentane 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 cyclopentane or a solution containing cyclopentane is handled, processed, or stored.

STORAGE

Cyclopentane should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Storage areas must meet OSHA requirements for Class IB flammable liquids. Outside or detached storage is preferred; inside storage should be in a standard flammable liquids storage room. Containers of cyclopentane should be protected from physical damage and should be stored separately from strong oxidizing agents (such as chlorine, bromine, and fluorine), heat, sparks, and open flame. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Only nonsparking tools may be used to handle cyclopentane. To prevent static sparks, containers should be grounded and bonded for transfers. Because containers that formerly contained cyclopentane may still hold product residues, they should be handled appropriately.

SPILLS AND LEAKS

In the event of a spill or leak involving cyclopentane, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed. 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.
5. For small liquid spills, take up with sand or other noncombustible absorbent material and place into closed containers for later disposal.
6. For large liquid spills, build dikes far ahead of the spill to contain the cyclopentane for later reclamation or disposal.

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**

Cyclopentane 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 cyclopentane; 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 cyclopentane 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 cyclopentane 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 any 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 cyclopentane 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 knowl-

edgeable 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 clothing should be worn to prevent any skin contact with cyclopentane. 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. Butyl rubber and natural rubber have been tested against permeation by cyclopentane and have breakthrough times of less than one hour; therefore, they are not recommended for use with cyclopentane. No other reports were found on the resistance of additional protective clothing materials to cyclopentane permeation. 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 cyclopentane.

If cyclopentane is dissolved in 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 cyclopentane might contact the eyes (e.g., through splashes of solution). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with cyclopentane. Contact lenses should not be worn if the potential exists for cyclopentane exposure.

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