1,1-Dimethylhydrazine
CAS No. 57-14-7

Reasonably anticipated to be a human carcinogen
First listed in the Fourth Annual Report on Carcinogens (1985)
Also known as unsymmetrical dimethyldrazine or UDMH

\[
\begin{align*}
\text{H}_2\text{N} & \quad \text{N} \\
\text{CH}_3 & \quad \text{CH}_3
\end{align*}
\]

Carcinogenicity
1,1-Dimethylhydrazine is reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals
Oral exposure of mice to 1,1-dimethylhydrazine caused tumors at several different tissue sites. Following administration of 1,1-dimethylhydrazine in drinking water, high incidences of blood-vessel cancer (angiosarcoma) in various organs were observed in mice of both sexes; tumors of the kidneys, lungs, and liver also were observed. Administration of 1,1-dimethylhydrazine by stomach tube increased the incidence of lung tumors and the number of tumors per animal in female mice (IARC 1974).

Since 1,1-dimethylhydrazine was listed in the Fourth Annual Report on Carcinogens, additional studies in experimental animals have been identified. 1,1-Dimethylhydrazine administered by subcutaneous injection increased the incidence of benign and malignant peripheral nerve sheath tumors (neurofibrosarcoma and melanotic and unpigmented schwannoma) in hamsters of both sexes (IARC 1999).

Cancer Studies in Humans
No epidemiological studies were identified that evaluated the relationship between human cancer and exposure specifically to 1,1-dimethylhydrazine.

Properties
1,1-Dimethylhydrazine exists at room temperature as a clear, colorless liquid with a fishy odor. It is miscible with water, ether, hydrocarbons, and dimethylformamide and is very soluble in methanol and dimethyl sulfoxide. It is stable under normal temperatures and less liquid with a fishy odor. It is miscible with water, ether, hydrocarbons, and dimethylformamide and is very soluble in methanol and dimethyl sulfoxide. It is stable under normal temperatures and

\[\text{H}_2\text{N} \quad \text{N} \quad \text{CH}_3 \quad \text{CH}_3\]

Water solubility 1,600 g/L
Vapor pressure 167 mm Hg at 25°C

\[\text{Dissociation constant (pK}_a\text{)} = 7.21 \text{ at 25°C}\]

Source: HSDB 2009.

Use
1,1-Dimethylhydrazine is used primarily as a component of jet and rocket fuels. Other uses include as an intermediate for chemical synthesis, as a stabilizer for organic peroxide fuel additives, as an absorbent for acid gases, as a plant growth control agent, and in photography (ATSDR 1997, IARC 1999, HSDB 2009).

Production
Production of 1,1-dimethylhydrazine was first reported to the U.S. Tariff Commission in 1956 (IARC 1974). Production was 45 metric tons (99,000 lb) in 1977 and 4.5 metric tons (9,900 lb) in 1982 (ATSDR 1997, HSDB 2009). In 2009, 1,1-dimethylhydrazine was produced by four manufacturers worldwide, including one in the United States (SRI 2009), and was available from 17 suppliers, including 9 U.S. suppliers (ChemSources 2009). Reports filed under the U.S. Environmental Protection Agency’s Toxic Substances Control Act Inventory Update Rule indicated that U.S. production plus imports of 1,1-dimethylhydrazine totaled 500,000 to 1 million pounds in 1986, 1990, and 1994 and 10,000 to 500,000 lb in 1998 and 2002 (EPA 2004).

Exposure
The primary routes of potential human exposure to 1,1-dimethylhydrazine are inhalation, ingestion, and dermal contact (HSDB 2009). The general population potentially could be exposed by ingestion of residues present on foods treated with 1,1-dimethylhydrazine. In the past, humans have been exposed to 1,1-dimethylhydrazine following ingestion of fruits sprayed with the plant growth regulator Alar (diaminodize). 1,1-Dimethylhydrazine was identified as a hydrolysis product of diaminozide in processed fruit. Diaminozide is no longer registered for use on food plants in the United States (ATSDR 1997). 1,1-Dimethylhydrazine has been detected in tobacco products (at concentrations of up to 147 ng/g); therefore, people who chew tobacco may be exposed to small amounts of 1,1-dimethylhydrazine (Schmelz et al. 1977). However, it has been detected in cigarette mainstream smoke (Diekmann et al. 2002). The potential for exposure to 1,1-dimethylhydrazine may be higher for people who live near military installations where the chemical is used as an aerospace propellant or for people who live near hazardous-waste sites contaminated with hydrazines. In the mid 1970s, 1,1-dimethylhydrazine was measured in the air near Rocky Mountain Arsenal at levels of up to 1.7 ppm (4.1 mg/m³) (limit of detection = 0.001 ppm [0.002 mg/m³]) (HSDB 2009). In 1997, 1,1-dimethylhydrazine was identified as a contaminant at three hazardous-waste sites on EPA’s National Priorities List.

Environmental exposure to 1,1-dimethylhydrazine is expected to be very low, because it degrades rapidly in the environment (HSDB 2009). Between 1988 and 2007, the largest environmental release of 1,1-dimethylhydrazine reported by EPA’s Toxics Release Inventory occurred in 1988, when 13,188 lb was released, predominantly to on-site landfills or surface impoundments and to air. Since 1988, the largest releases have been 2,320 lb in 1989 and 1,468 lb in 2001. The smallest reported release occurred in 2007, when one U.S. facility released 15 lb of 1,1-dimethylhydrazine, including 5 lb to air and 10 lb to an off-site hazardous-waste landfill (TRI 2009). If released to air, 1,1-dimethylhydrazine will exist entirely in the vapor phase and will react quickly with ozone, with a half-life of about 16.5 minutes, or with hydroxyl radicals, with an estimated half-life of 6 days. 1,1-Dimethylhydrazine has not been detected in environmental samples of water or soil (HSDB 2009).

Workers may potentially be exposed to 1,1-dimethylhydrazine during its production, transportation, use as a chemical intermediate, or application to control the growth of crops and vegetation, especially if proper protective equipment is not used (ATSDR 1997). Greenhouse workers who use diaminozide on non-food plants may be exposed to small amounts of 1,1-dimethylhydrazine (ATSDR 1997). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 2,917 workers (in the Chemicals and Allied
Products industry potentially were exposed to 1,1-dimethylhydrazine (NIOSH 1990).

**Regulations**

**Department of Transportation (DOT)**
1,1-Dimethylhydrazine is considered a hazardous material and marine pollutant, and special requirements have been set for marking, labeling, and transporting this material.

**Environmental Protection Agency (EPA)**

*Clean Air Act*
National Emission Standards for Hazardous Air Pollutants: Listed as a hazardous air pollutant.
New Source Performance Standards: Manufacture or use of 1,1-dimethylhydrazine is subject to certain provisions for the control of volatile organic compound emissions.
Prevention of Accidental Release: Threshold quantity (TQ) = 15,000 lb.

*Comprehensive Environmental Response, Compensation, and Liability Act*
Reportable quantity (RQ) = 10 lb.

*Emergency Planning and Community Right-To-Know Act*
Toxics Release Inventory: Listed substance subject to reporting requirements.
Reportable quantity (RQ) = 10 lb.
Threshold planning quantity (TPQ) = 1,000 lb.

*Resource Conservation and Recovery Act*
Listed Hazardous Waste: Waste codes for which the listing is based wholly or partly on the presence of 1,1-dimethylhydrazine = U098, K107, K108, K109, K110.
Listed as a hazardous constituent of waste.

**Occupational Safety and Health Administration (OSHA, Dept. of Labor)**
While this section accurately identifies OSHA's legally enforceable PELs for this substance in 2018, specific PELs may not reflect the more current studies and may not adequately protect workers.
Permissible exposure limit (PEL) = 0.5 ppm (1 mg/m³).
Potential for dermal absorption.

**Guidelines**

*American Conference of Governmental Industrial Hygienists (ACGIH)*
Threshold limit value – time-weighted average (TLV-TWA) = 0.01 ppm.
Potential for dermal absorption.

*National Institute for Occupational Safety and Health (NIOSH, CDC, HHS)*
Ceiling recommended exposure limit = 0.06 ppm (0.15 mg/m³) (2-h exposure).
Immediately dangerous to life and health (IDLH) limit = 15 ppm.
Listed as a potential occupational carcinogen.

**References**