

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** 1,1-DIMETHYLHYDRAZINE ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for 1,1-DIMETHYLHYDRAZINE

The basic text of this document contains the draft technical standard approved by the Joint Review Committee of the NIOSH/OSHA Standards Completion Program and the supporting documentation for the substance 1,1-DIMETHYLHYDRAZINE.

The SCP draft technical standards are recommendations to the Department of Labor for its consideration in rulemaking and have no legal status until final rules have been promulgated by that agency. This draft standard is provided for your information only.

The References and Sources, Respirator Table Documentation and Use/Exposure and Control Documentation are the working documents used by the various SCP working groups during the development of the draft technical standard and serve as the technical foundation for the standard. The classification for each substance and the regulatory statements were derived following a decision logic established for the various sections of the standard.

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(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of 1,1-dimethylhydrazine not in excess of 0.5 parts per million (ppm) (1 milligram per cubic meter, (mg/M3)) averaged over an eight-hour work shift (time weighted average), as stated in § 1910.1000, Table Z-1.

(2) "Action level" means one half of the permissible exposure for 1,1-dimethylhydrazine.

(b) Exposure determination and measurement. (1) Each employer who has a place of employment in which 1,1-dimethylhydrazine is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of 1,1-dimethylhydrazine at or above the action level. The determination shall be made each time there is a change in production, process, or control measures which could result in an increase in airborne concentrations of 1,1-dimethylhydrazine.

(2) A written record of the determination shall be made and shall contain at least the following information:

(i) Any information, observations, or calculation which may indicate employee exposure to 1,1-dimethylhydrazine;

(ii) Any measurements of 1,1-dimethylhydrazine taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to 1,1-dimethylhydrazine; and

(iv) Date of determination, work being performed at the time, location within work site, name, and social security number of each employee considered.

(3) If the employer determines that any employee may be exposed to 1,1-dimethylhydrazine at or above the action level, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b) (3) of this section reveals employee exposure to 1,1-dimethylhydrazine at or above the action level, the employer shall:

(i) Identify all employees who may be exposed at or above the action level; and

(ii) Measure the exposure of the employees so identified.

(5) If an employee exposure measurement reveals that an employee is exposed to 1,1-dimethylhydrazine at or above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every two months.

(6) If an employee exposure measurement reveals that an employee is exposed to 1,1-dimethylhydrazine above the permissible exposure, the employer shall:

(i) Measure the exposure monthly of the employee so exposed; and

(ii) Institute control measures as required by paragraph (d) of this section; and

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to 1,1-dimethylhydrazine above the permissible exposure. The employee shall also be notified of the corrective action being taken to reduce the exposure to at or below the permissible exposure.

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to 1,1-dimethylhydrazine

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below the action level, the employer may terminate measurement for the employee.

(8) For purposes of this paragraph, employee exposure is that which would occur if the employee were not using a respirator.

(c) Methods of measurement. (1) An employee's exposure shall be obtained by any combination of long term or short term samples which represents the employee's actual exposure averaged over an eight-hour work shift (See Appendix B (iv) of this section).

(2) The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than that given in Table 1.

Table 1

Concentration	Required Accuracy
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Above permissible exposure	$\pm 25\%$
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At or below permissible exposure	
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and above the action level	$\pm 35\%$
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At or below the action level	$\pm 50\%$
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(d) Compliance. (1) No employee shall be exposed to 1,1-dimethylhydrazine above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of 1,1-dimethylhydrazine shall be controlled to at or below the permissible exposure by engineering and work practice controls:

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not technically feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. When mechanical ventilation is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity, static pressure, or air volume, shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of 1,1-dimethylhydrazine.

(4) Compliance with the permissible exposure shall not be achieved by the use of respirators except:

(i) During the time period necessary to install or implement engineering or work practice controls; or

(ii) In work situations in which engineering and work practice controls are technically not feasible; or

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(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of 1,1-dimethylhydrazine to at or below the permissible exposure; or

(iv) For operations which require entry into tanks or closed vessels; or

(v) In emergencies.

(5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

TABLE 2 RESPIRATORY PROTECTION FOR 1,1-DIMETHYLHYDRAZINE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor Concentration	
25 ppm or less	Any supplied-air respirator with a full facepiece, helmet or hood. ----- Any self-contained breathing apparatus with a full facepiece. -----
50 ppm or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet or hood operated in continuous-flow mode. -----
Greater than 50 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. ----- A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. (Supplied-air suits may be necessary.) -----
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. -----
Escape	Any gas mask with full facepiece

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providing protection against
1,1-dimethylhydrazine.

Any escape self-contained breath-
ing apparatus with full facepiece.

(6) Respirators shall be approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with § 1910.134(b), (d), (e), and (f).

(e) Fire and safety. (1) The employer shall familiarize himself with the information contained in the Substance Technical Guidelines (Appendix B of this section) for 1,1-dimethylhydrazine.

(2) For the purpose of compliance with § 1910.309, locations classified as hazardous locations due to the presence of 1,1-dimethylhydrazine shall be Class I, Group C.

(3) For the purpose of compliance with § 1910.157, 1,1-dimethylhydrazine is classified as a Class B fire hazard, except that foam fire extinguishing media shall not be used.

(4) For the purpose of compliance with § 1910.178, locations classified as hazardous locations due to the presence of 1,1-dimethylhydrazine shall be Class I, Group C.

(5) For the purpose of compliance with § 1910.106, liquid 1,1-dimethylhydrazine is classified as a Class IB flammable liquid.

(6) Where a fan is located in ductwork and where 1,1-dimethylhydrazine is present in the ductwork in concentrations greater than 5000 ppm (approximately 25 percent of the lower flammable limit), the fan rotating element shall be of nonsparking material or the casing shall consist of, or be lined with, nonsparking material. There shall be sufficient clearance between the fan rotating element and the fan casing so as to prevent contact.

(7) Sources of ignition such as smoking or open flames are prohibited where 1,1-dimethylhydrazine is handled, used or stored.

(8) 1,1-Dimethylhydrazine shall be stored so as not to come in contact with oxidizers and metallic mercury. Anhydrous 1,1 dimethylhydrazine shall be stored under a nitrogen atmosphere.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use impervious clothing, gloves, face shields (eight-inch minimum) and other appropriate protective clothing necessary to prevent any possibility of skin contact with liquid 1,1-dimethylhydrazine. Face shields shall comply with § 1910.133 (a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that clothing wet with liquid 1,1-dimethylhydrazine is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of 1,1-dimethylhydrazine from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the 1,1-dimethylhydrazine, the employer shall inform the person performing the operation of the hazardous properties of 1,1-dimethylhydrazine.

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(3) Where there is any possibility of exposure of an employee's body to liquid 1,1-dimethylhydrazine, employers shall provide facilities for quick drenching of the body within the immediate work area for emergency use.

(4) Employers shall ensure that any clothing which becomes wet with or non-impervious clothing which becomes contaminated with 1,1-dimethylhydrazine be removed immediately and not reworn until the 1,1-dimethylhydrazine is removed from the clothing.

(5) Employers shall provide and ensure that employees use splash-proof safety goggles (cup-cover type dust and splash safety goggles) which comply with § 1910.133 (a)(2)-(a)(6) where there is any possibility of liquid 1,1-dimethylhydrazine contacting the eyes.

(6) Where there is any possibility that an employee's eyes may be exposed to liquid 1,1-dimethylhydrazine, employers shall provide an eye-wash fountain within the immediate work area for emergency use.

(g) Spills and disposal. (1) In the event that liquid 1,1-dimethylhydrazine is spilled the employer shall immediately eliminate potential sources of ignition, provide available ventilation and then clean up the spill.

(2) Liquid 1,1-dimethylhydrazine shall not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with 1,1-dimethylhydrazine immediately wash or shower to remove any 1,1-dimethylhydrazine from the skin.

(2) Employers shall ensure that employees do not eat or smoke in areas where liquid 1,1-dimethylhydrazine is handled, processed or stored.

(3) Employers shall ensure that employees who handle liquid 1,1-dimethylhydrazine wash their hands thoroughly before eating or smoking.

(i) Training and information. (1) Each employer who has a workplace in which 1,1-dimethylhydrazine is present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to 1,1-dimethylhydrazine above the action level or employees who may have skin or eye contact with liquid 1,1-dimethylhydrazine, or employees who work where 1,1-dimethylhydrazine presents a fire or explosion hazard, shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for 1,1-dimethylhydrazine (Appendix A of this section);

(ii) Advise affected employees as to the signs and symptoms of exposure to 1,1-dimethylhydrazine.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of exposure to 1,1-dimethylhydrazine which are listed in Appendix A of the section;

(iv) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to 1,1-dimethylhydrazine.

(j) Medical Surveillance. (1) The employer shall provide medical procedures as required by this paragraph. All medical procedures shall be performed by or under the supervision of a physician at no cost to the employee.

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(2) The employer shall make available to each employee who is to be exposed to liquid 1,1-dimethylhydrazine or airborne concentrations of 1,1-dimethylhydrazine at or above the action level, a medical examination which shall include the following:

(i) A medical history and physical examination with emphasis on central nervous system, liver, gastrointestinal tract, blood, respiratory system, skin and eyes.

(ii) A complete blood count to include a red and white cell count, a differential smear, hemoglobin and hematocrit.

(iii) A profile of liver function.

(iv) 14" x 17" chest roentgenogram.

(v) Pulmonary function testing, FVC and FEV (1 sec).

(3) The employer shall obtain from the physician, as a record of the examination, the following information:

(i) A written opinion which conforms with paragraph (j)(7) of this section.

(ii) A record of the results of the complete blood count.

(iii) A record of the results of liver function tests.

(iv) 14" x 17" chest roentgenogram or a medically acceptable copy.

(v) A record of the results of the pulmonary function testing.

(4) The employer shall make available to each employee, exposed to 1,1-dimethylhydrazine in excess of the action level at 12 months from the date of the employee's first exposure, and at every 12 months of exposure in excess of the action level thereafter, a medical examination which must include the following:

(i) A medical history and physical examination with emphasis on central nervous system, liver, gastrointestinal tract, blood, respiratory system, skin and eyes.

(ii) A complete blood count to include a red and white cell count, a differential smear, hemoglobin and hematocrit.

(iii) A profile of liver function.

(iv) 14" x 17" chest roentgenogram when indicated by results of pulmonary function testing.

(v) Pulmonary function testing, FVC and FEV (1 sec).

(5) The employer shall obtain from the physician, as a record of the periodic examination, the following information:

(i) A written opinion which conforms with paragraph (j)(7) of this section.

(ii) A record of the results of the complete blood count.

(iii) A record of the results of the liver function tests.

(iv) 14" x 17" chest roentgenogram or a medically acceptable copy.

(v) A record of the results of the pulmonary function testing.

(6) The employer shall provide to the examining physician the following information:

(i) A copy of this regulation with its Appendixes A, B, and C for 1,1-dimethylhydrazine;

(ii) A description of the employee's duties as they relate to his exposure to 1,1-dimethylhydrazine;

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurement which may indicate the affected employee's exposure;

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(v) The affected employee's anticipated exposure; and
(vi) Upon request of the physician, any available information from previous medical examination of the affected employee.

(7)(i) The physician's written opinion shall be a signed statement by the examining physician specifically stating: (A) Whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to 1,1-dimethylhydrazine or would directly or indirectly aggravate any detected medical condition;

(B) Any recommended limitations upon the employee's exposure to 1,1-dimethylhydrazine, including limitations upon the use of personal protective equipment and respirators;

(C) That the employee has been informed by the physician of any detected medical conditions which require further medical examination or treatment.

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to exposure to 1,1-dimethylhydrazine.

(iii) The employer shall provide the employee with a copy of the physician's written opinion.

(8) No employee shall be exposed to liquid 1,1-dimethylhydrazine or airborne concentrations of 1,1-dimethylhydrazine in such a way as would put the employee at increased risk of material impairment of his health from such exposure. This determination may be based on the physician's written opinion.

(9) The employer shall provide emergency and follow-up medical examinations and treatment for any employee injured through exposure to 1,1-dimethylhydrazine.

(10) If the examining physician chooses to use alternative medical examinations to those specified in paragraphs (j)(2) and (4) of this section, the employer may accept such alternative medical surveillance examinations as meeting the requirements of this part provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical examinations and the rationale for substitution and evidence that they will be equally effective.

(ii) Informs each exposed employee of the fact that alternative medical examinations to those required in paragraphs (j)(2) or (4) of this section are to be made available.

(11) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of such refusal and obtain a signed statement from the employee indicating that the employee understands the risks involved by refusing to be examined.

(12) No medical procedure which would be performed pursuant to this section need be performed if records of a previous such procedure performed within the past three months are acceptable to the examining physician.

(k) Recordkeeping. (1) Exposure determination. (i) The employer shall keep an accurate record of all determinations required to be made pursuant to paragraph (b)(1) of this section.

(ii) This record shall include the written determination required in paragraph (b)(2) of this section.

(iii) This record shall be maintained until replaced by a more recent record.

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(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to 1,1-dimethylhydrazine.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to 1,1-dimethylhydrazine which are being monitored;

(C) Sampling and analytical methods used and evidence of their accuracy, including the method, results and date of calibration of sampling equipment;

(D) Number, duration, and results of samples taken; and

(E) Name, social security number and exposure of the employee monitored.

(iii) This record shall be maintained until replaced by a more recent record but in no event for less than one year.

(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of the measurements demonstrating the effectiveness of such ventilation required by paragraph (d)(3) of this section.

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

(iii) These records shall be maintained for at least one year.

(4) Employee training and information. (i) The employer shall keep an accurate record of all employee training and information required by paragraph (i) of this section.

(ii) This record shall include:

(A) Date of training;

(B) Name and social security number of employee trained;

(C) Content or scope of training provided.

(iii) This record shall be maintained until replaced by a more recent record.

(5) Medical surveillance. (i) The employer shall keep an accurate record of employee medical surveillance required by paragraph (j) of this section.

(ii) This record shall include:

(A) Results of tests required by paragraph (j)(2) and (j)(5) of this section;

(B) Any employee medical complaints relative to exposure to 1,1-dimethylhydrazine;

(C) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(D) Physician's written opinion; and

(E) A signed statement of any refusal to be examined.

(iii) This record shall be maintained for the duration of the employment of the affected employee.

(6) Access to records. (i) All records required to be maintained by this section shall be made available upon request to authorized representatives of the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health.

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(ii) Employee exposure determination and exposure measurement records required to be maintained by this section shall be made available to employees and former employees and their designated representatives.

(iii) Employee medical records required to be maintained by this section shall be made available upon written request to a physician designated by the employee or former employee.

(1) Employee observation of measurement. (1) The employer shall give affected employees or their representatives an opportunity to observe any measurement of employee exposure to 1,1-dimethylhydrazine which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to 1,1-dimethylhydrazine requires entry into an area where the use of personal protective devices, including respirators, is required, the observer shall be provided with and required to use such equipment and comply with all other applicable safety procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

(i) Receive an explanation of the measurement procedure.

(ii) Visually observe all steps related to the measurement of the airborne concentration of 1,1-dimethylhydrazine that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendixes is advisory in nature and is not intended, by itself, to create any additional obligations not otherwise imposed or detract from any existing obligation.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR 1,1-DIMETHYLHYDRAZINE

I. SUBSTANCE IDENTIFICATION

- A. Substance: 1,1-Dimethylhydrazine
- B. Permissible Exposure: 0.5 parts of 1,1-dimethylhydrazine per million parts of air (ppm) (1 milligram of 1,1-dimethylhydrazine per cubic meter of air, (mg/M3)) averaged over an eight-hour work shift.
- C. Appearance and Odor: Fuming colorless liquid with an amine-like odor.

II. HEALTH HAZARD DATA

- A. Ways in Which the Chemical Affects Your Body: 1,1-Dimethylhydrazine can affect your body if you inhale it, if it comes in contact with your eyes or skin, or if you swallow it. It may enter your body through your skin.

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B. Effects of Overexposure:

1. Short-Term Exposure: Overexposure to 1,1-dimethylhydrazine may cause irritation of the eyes, skin and respiratory tract, nausea, choking, shortness of breath, chest pains, tiredness and indigestion. Inhalation of high concentrations may cause convulsions and death.
2. Long-Term Exposure: Prolonged or repeated exposure to this chemical may cause liver damage.
3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect they are caused by exposure to 1,1-dimethylhydrazine.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If 1,1-dimethylhydrazine gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.
- B. Skin Exposure: If 1,1-dimethylhydrazine gets on your skin, immediately flush the contaminated skin with water. If 1,1-dimethylhydrazine soaks through your clothing, remove the clothing immediately and flush the skin with water. If irritation persists after washing, get medical attention.
- C. Breathing: If you or any other person breathes in large amounts of 1,1-dimethylhydrazine move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- D. Swallowing: When 1,1-dimethylhydrazine has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
- E. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to 1,1-dimethylhydrazine. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective

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protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required. If you can smell 1,1-dimethylhydrazine while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

- B. Supplied-air suits: in some work situations the wearing of supplied-air suits may be necessary. Your employer should instruct you in their proper use and operation.
- C. Protective Clothing: You must wear impervious clothing, gloves, face shield or other appropriate protective clothing to prevent any possibility of skin contact with liquid 1,1-dimethylhydrazine. Replace or repair impervious clothing that has developed leaks.
- D. Eye Protection: You must wear splash-proof safety goggles where there is any possibility of liquid 1,1-dimethylhydrazine contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. 1,1-Dimethylhydrazine is a flammable liquid and its vapors can easily form explosive mixtures in air.
- B. 1,1-Dimethylhydrazine must be stored in tightly closed containers, in a cool, well ventilated area away from heat, sparks, flames, oxidizers, and metallic mercury. Anhydrous 1,1-dimethylhydrazine must be stored under a nitrogen atmosphere.
- C. Sources of ignition such as smoking and open flames are prohibited wherever 1,1-dimethylhydrazine is handled, used or stored in a manner that could create a potential fire or explosion hazard.
- D. You must use non-sparking tools when opening or closing metal containers of 1,1-dimethylhydrazine, and containers must be bonded and grounded when pouring or transferring liquid 1,1-dimethylhydrazine.
- E. You must immediately remove any non-impervious clothing that becomes contaminated with 1,1-dimethylhydrazine and this clothing must not be reworn until the 1,1-dimethylhydrazine is removed from the clothing.
- F. Clothing wet with liquid 1,1-dimethylhydrazine can be easily ignited. You must immediately remove this clothing and it must not be reworn until the 1,1-dimethylhydrazine has been removed from the clothing.
- G. If your skin becomes contaminated with 1,1-dimethylhydrazine, you must immediately wash or shower to remove the 1,1-dimethylhydrazine from your skin.
- H. You must not eat or smoke in areas where liquid 1,1-dimethylhydrazine is handled, processed or stored.
- I. If you handle liquid 1,1-dimethylhydrazine, you must wash your hands thoroughly with soap or mild detergent and water before eating or smoking.
- J. Fire extinguishers, eye flushing facilities and quick drenching facilities, where provided, must be readily

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available and you should know where they are and how to operate them.

- K. Ask your supervisor where 1,1-dimethylhydrazine is used in your work area and for any additional plant safety and health rules.

VI. ACCESS TO INFORMATION

- A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for 1,1-dimethylhydrazine. In addition, your employer must instruct you in the safe use of 1,1-dimethylhydrazine, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to 1,1-dimethylhydrazine. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and of the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of exposure determinations, exposure measurements, and medical surveillance. Your employer is required to make records of exposure determinations and your exposure measurements available to you or your representative upon your request. Your employer is required to release your medical records to your physician upon your written request.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR 1,1-DIMETHYLHYDRAZINE

I. PHYSICAL AND CHEMICAL DATA

- A. Substance Identification
1. Synonyms: Unsymmetrical dimethylhydrazine; UDMH
 2. Formula: $(CH_3)_2NNH_2$
 3. Molecular weight: 60.1
- B. Physical Data
1. Boiling point (760 mm Hg): 63 C (146 F)
 2. Specific gravity (water = 1): 0.78
 3. Vapor density (air = 1 at boiling point of 1,1-dimethylhydrazine): 2.0
 4. Melting point: -57.2 C (-71 F)
 5. Vapor pressure at 20 C (68 F): 103 mm Hg
 6. Solubility in water, % by weight at 20 C (68 F): Miscible in all proportions
 7. Evaporation rate (butyl acetate = 1): Greater than 1

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8. Appearance and odor: Fuming colorless liquid with an amine-like odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: -15 C (5 F) (closed cup)
2. Autoignition temperature: 250 C (480 F)
3. Flammable limits in air, % by volume: Lower: 2; Upper: 95
4. Extinguishing media: Flood with water; for small fires use carbon dioxide or dry chemical. Do not use foam.
5. Special fire-fighting procedures: Do not use a solid stream of water since the stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.
6. Unusual fire and explosion hazards: 1,1-Dimethylhydrazine is a flammable liquid. Its vapors can easily form explosive mixtures with air over a wide range. All ignition sources must be controlled where 1,1-dimethylhydrazine is handled, used or stored. 1,1-Dimethylhydrazine vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which 1,1-dimethylhydrazine is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, 1,1-dimethylhydrazine is classified as a Class IB flammable liquid. For example, above 5000 ppm, approximately one-fourth of the lower flammable limit, is one situation in which 1,1-dimethylhydrazine is considered to be a potential fire and explosion hazard.
8. For purposes of complying with 29 CFR 1910.309, the classification of hazardous locations as described in Article 500 of the National Electrical Code for 1,1-dimethylhydrazine shall be Class I Group C.

B. Reactivity

1. Conditions contributing to instability: Heat 1,1-dimethylhydrazine when spread on a large surface may ignite spontaneously.
2. Incompatibilities: Contact with oxidizers, including the halogens may cause fire and explosions. Contact with metallic mercury may form shock-sensitive materials. Spontaneous ignition can occur on contact with oxidants like fuming nitric acid and hydrogen peroxide.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released in a fire involving 1,1-dimethylhydrazine.
4. Special precautions: Liquid 1,1-dimethylhydrazine will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

- A. If 1,1-dimethylhydrazine is spilled or leaked, the following steps should be taken:

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1. Remove all ignition sources.
 2. Ventilate area of spill or leak.
 3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for vapors to completely clear hood ductwork, then burn the paper. Large quantities can be collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. 1,1-Dimethylhydrazine may not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.
- B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.
- C. Waste disposal methods: 1,1-Dimethylhydrazine may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

IV. MONITORING AND MEASUREMENT PROCEDURES

- A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average 8-hour exposure may be determined from a single eight-hour sample or two (2) 4-hour samples. Several short time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or gas and vapor adsorption tubes with subsequent chemical analyses. The method of measurement must determine the concentration of 1,1-dimethylhydrazine to plus or minus 35%.
- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. a. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of 1,1-dimethylhydrazine to plus or minus 25%.
- C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under the title "NIOSH Analytical Methods for Set K" (Order number XXXXXXXXXX).
- D. QUALIFIED PERSONS: Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

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V. MISCELLANEOUS PRECAUTIONS

- A. Store 1,1-dimethylhydrazine in closed containers in a cool, well-ventilated area. Anhydrous 1,1-dimethylhydrazine must be stored under a nitrogen atmosphere.
- B. High exposures to 1,1-dimethylhydrazine can occur when transferring the liquid from one container to another.
- C. Non-sparking tools must be used to open and close metal 1,1-dimethylhydrazine containers. These containers must be effectively grounded and bonded prior to pouring.
- D. Use of supplied-air suits or other impervious coverings may be necessary to prevent skin contact with 1,1-dimethylhydrazine where the concentration of 1,1-dimethylhydrazine is unknown or is greater than 50 ppm. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitations and potential life endangering characteristics of supplied-air suits.
- E. Employers should advise employees of all areas and operations where exposure to 1,1-dimethylhydrazine could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to 1,1-dimethylhydrazine is likely to occur are: during its production and its use as a component of jet and rocket propellant fuel; as a chemical reducing agent; as a fuel oil stabilizer; for preventing corrosion in oil well treating fluids and antifreeze fluids; in the preparation of catalyst systems; to control polymerization in the manufacture of SBR rubber; as an anti-skinning agent in paints; and as a dye intermediate; in the manufacture of photographic and agricultural chemicals; and its use in stripping and extraction processes as an acid gas absorbent.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; skin absorption.

II. TOXICOLOGY

1,1-Dimethylhydrazine vapor is a convulsant and a respiratory irritant. Exposure of dogs to 111 ppm for 3 hours caused vomiting, respiratory distress, convulsions, and death. Dogs repeatedly exposed to 25 ppm developed vomiting, diarrhea, ataxia, convulsions and hemolytic anemia. Accidental human exposures have resulted in eye irritation, a choking sensation, chest pain, dyspnea, lethargy, nausea, and skin irritation. Based upon the results of exposure of dogs, the effects expected in humans from exposure for 60 minutes are: 100 ppm, irritation of eyes and mucous membranes; 200 ppm, marked central nervous system stimulation and perhaps death; 900 ppm, convulsions and death. Impairment of liver function (elevated SGPT levels) has been reported in 47 of 1193 workers exposed to 1,1-dimethylhydrazine under variable conditions; in a few of these cases fatty infiltration of the liver was also demonstrated by

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liver biopsy. The liquid is highly corrosive and irritating to the eyes and skin. Symmetrical dimethylhydrazine induced intestinal and liver tumors in mice, hamsters, and rats; this unsymmetrical form is also suspected to be a carcinogen based on animal studies.

III. SIGNS AND SYMPTOMS

Eye irritation; choking sensation, chest pain, dyspnea; lethargy; nausea; skin irritation; may produce signs of anoxia; may cause convulsions. Liver injury may occur.

IV. SPECIAL TESTS

Urinary determinations of 1,1-dimethylhydrazine may be useful in verifying that exposure has occurred.

V. TREATMENT

Remove from exposure. Immediately flush eyes and skin with water. Give artificial resuscitation if indicated. The barbiturates are known to control convulsions of central origin. Recovery is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

In animals, 1,1-dimethylhydrazine causes convulsions. Most reported effects in humans are caused by its respiratory irritant properties. Skin absorption is known to occur. It is important that the physician become familiar with plant operating conditions in which exposure to 1,1-dimethylhydrazine occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

The following medical procedures must be made available to each employee who is exposed to 1,1-dimethylhydrazine:

1. A complete history and physical examination -- The purpose is to detect preexisting conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the central nervous system, liver, gastrointestinal tract, blood, respiratory system, skin and eyes should be stressed.
2. Liver function tests -- 1,1-Dimethylhydrazine causes liver damage. A profile of liver function shall be obtained using a medically acceptable array of biochemical tests.

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3. Complete blood count -- This compound has been shown to cause hemolysis and anemia. A complete blood count must be performed to include red and white cell count, a differential count of a stained blood smear, as well as hemoglobin and hematocrit.
4. 14" x 17" chest roentgenogram -- 1,1-Dimethylhydrazine has been reported to cause lung damage. Surveillance of the lungs is indicated.
5. FVC and FEV (1 sec) -- 1,1-Dimethylhydrazine has been reported to cause lung damage. Periodic surveillance is indicated.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis except that an X-ray is required only when indicated by pulmonary function testing.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "1,1-Dimethylhydrazine," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 91.
2. Hygienic Guide Series: "1,1-Dimethylhydrazine," American Industrial Hygiene Association Journal, 24:196-198, 1963.
3. "1,1-Dimethylhydrazine: Emergency Exposure Limits," American Industrial Hygiene Association Journal, 25:582-584, 1964.
4. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 2218-2222, 2225-2227.
5. Grant, W. Morton: Toxicology of the Eye (2d ed.), Charles Thomas, Illinois, 1974, pp. 401-402.
6. Petersen, Palle, et al: "Examination of the Liver in Personnel Working with Liquid Rocket Propellant," British Journal of Industrial Medicine, 27:141-146, 1970.
7. Druckrey, H., et al.: "Selektive Erzeugung von Darmkrebs bei Ratten -- durch 1,2-Dimethylhydrazine," Naturwissenschaften, 54:285-286, 1967.

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REFERENCES AND SOURCES
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1910.93

- (e) Fire and Safety
(1) Electrical - Classification based on "Fire Hazard Classification of Chemical Vapors Relative to Explosion-proof Electrical Equipment," H. Carhart et al, National Academy of Sciences, 1973, report to U. S. Coast Guard, report no. CG-D-92-74, p. 12.
- (f) Personal Protective Equipment, and, (h) Sanitation
Eye: Grant, "Toxicology of the Eye;" FMC, "Manufacturer's Bulletin - FMC Dimazine;" The Merck Index; Patty, "Industrial Hygiene and Toxicology;" Sax, "Dangerous Properties of Industrial Materials;" AIHA, "Hygienic Guide Series"
- Skin: Patty, "Industrial Hygiene and Toxicology;" ILO, "Encyclopedia of Occupational Health and Safety;" PHS-149, "Survey of Compounds Which Have Been Tested for Carcinogenic Activity;" AIHA, "Hygienic Guide Series;" FMC, "Manufacturer's Bulletin - FMC Dimazine"
- Ingestion: Patty, "Industrial Hygiene and Toxicology;" PHS-149, "Survey of Compounds Which Have Been Tested for Carcinogenic Activity;" Sax, "Dangerous Properties of Industrial Materials;" ILO, "Encyclopedia of Occupational Health and Safety;" NIOSH, "Toxic Substances List 1974;" Back and Thomas, "Pharmacology and Toxicology of 1,1-Dimethylhydrazine (UDMH)," AIHA journal, January - February 1963, p. 23.

COMMENTS

Eye - Classification: 1

Output statement numbers: 9, 13

Exceptions: None

Grant states that 1,1-dimethylhydrazine (UDMH) is strongly alkaline and highly corrosive and irritating to the eyes. FMC reports in a product bulletin that liquid placed in eyes of test animals "caused no permanent damage, with effects limited to mild conjunctivitis and slight reddening of the eye;" clearing was complete in several days. The Merck Index agrees with Grant. Patty states "it is less irritating for the . . . eyes . . . than hydrazine or monomethylhydrazine." Sax considers it to be a severe local irritant. The AIHA Hygienic Guide simply states "the liquid is irritant to eyes." Deichmann and Gerarde note that "contact with the skin and mucous membranes will cause irritation and chemical burns." The chemical nature of this substance and the serious hazard to the eyes presented by its related compounds supports the conclusion that UDMH can be severely damaging to the eyes.

Skin - Classification: 1

Output statement numbers: 1, 7b, 8a, 14g and 21 combined, 14i

Exceptions: See below

Patty states that skin application can cause death. According to the ILO, systemic effects from skin absorption include CNS stimulation perhaps followed by depression, respiratory arrest and death. The haematopoietic system, liver and kidney are also target organs, the former being

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most prominent in chronic intoxication; UDMH is a potent convulsant.

PHS-149 reports one study which produced one large intestine adenocarcinoma in a group of 110 test animals, with a latent period of 140 - 240 days; total dose was 420 - 540 mg by the subcutaneous route. Sax states that UDMH is severely irritating in acute local exposures. The Hygienic Guide states that UDMH is a skin irritant and absorbable through the skin, giving an overall severity of hazard rating as "high." Work reported by FMC determined a percutaneous LD50 (animal not specified) of 1040 mg/kg; it is noted that this is not totally reliable due to the relatively high volatility. In a more controlled experiment reported by FMC (with attempts to reduce evaporation), one of ten test animals died when subjected to 200 mg/kg. As the systemic effects of chronic ingestion are not cumulative (see below), it is assumed that there are no cumulative effects of skin absorption. The flash point of this substance is 5 F. It is miscible in all proportions with water and has a vapor pressure of 103 mm Hg at 20 C.

The low skin penetration LD50 of the substance leads to the conclusion that a classification of 1 is justified. Because of the volatility of the substance, however, statement 7b is used instead of statement 6 and statement 20a is not specified in this section.

Ingestion - Classification: 1

Output statement numbers: 19, 20b

Exceptions:

Patty reports a mean oral rat LD50 of 122 mg/kg, noting that the substance is rapidly absorbed from the gastrointestinal tract. PHS-149 summarizes one study which produced one pulmonary carcinoma in 30 animals during a 33 week experiment; total dose received was set at 7.2 mg. Another study reported in the same source produced multiple respiratory tumors in 4 of 9 mice surviving 50 - 60 weeks of dosing following 0.5 mg in water 5 d/wk for 40 weeks. Sax states that UDMH is a severe hazard locally and systemically through acute ingestion and a moderate hazard systemically through chronic systemic ingestions. ILO states that systemic effects from ingestion include CNS stimulation, perhaps followed by depression, respiratory arrest and death. The haematopoietic system, liver and kidney are also target organs, the former being most prominent in chronic intoxication; UDMH is a potent convulsant. The oral rat LD50 is set at 122 mg/kg in the Toxic Substances List. Work by Back and Thomas indicates that effects are not cumulative in that animals given 10 mg/kg for 20 days failed to exhibit any behavioral or morphological changes. The work also states "the experiment further demonstrates that neither increment nor decrement in tolerance is experienced in rats subjected to repeated subconclusive doses of the agent."

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The toxicity of the substance is concluded to be high enough to warrant a classification of 1 regardless of its volatility.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

- National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1973 (NFPA)
- FMC Corp., "Dimazine - Properties, Applications, Reactions," and Material Safety Data Sheet (FMC)
- Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, Vol. 11, p. 169 (K-O)

Sources of data items used:

- I. A. 1. Synonyms: NFPA-325M; FMC
- 2. Formula: NFPA-325M
- 3. Molecular weight: FMC
- B. 1. Boiling point: FMC
- 2. Specific gravity: FMC
- 3. Vapor density: NFPA-325M; FMC
- 4. Melting point: FMC
- 5. Vapor pressure: FMC
- 6. Solubility in water: FMC
- 7. Evaporation rate: FMC
- 8. Appearance and odor: FMC; K-O
- II. A. 1. Flash point: NFPA-325M
- 2. Autoignition temperature: NFPA-325M; FMC
- 3. Flammable limits: NFPA-325M; FMC
- 4. Extinguishing media: FMC, NFPA 49
- 5. Special fire fighting procedures: FMC
- 6. Unusual fire and explosion hazards: ADL
- B. 1. Conditions contributing to instability: ADL, NFPA 491M
- 2. Incompatibilities: FMC, NFPA 49
- 3. Hazardous decomposition products: ADL
- 4. Special precautions: FMC
- III. A. Steps if released or spilled: FMC
- C. Waste disposal method: FMC
- V. Miscellaneous precautions: FMC

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- "1,1 - Dimethylhydrazine," Hygienic Guide Series, American Industrial Hygiene Association, March - April, 1963 (AIHA)
- "Dimazine," Manufacturers Bulletin, FMC Corporation, Circa 1961 (Dimazine)
- "Dimazine," Material Safety Data Sheet, FMC Corporation (Safety)
- Faith, W. L., Keys, D. P. and Clark, R. L., "Industrial Chemicals," John Wiley and Sons, 3rd edition, 1965 (Faith)
- Gafafer, W. M. - edition, "Occupational Diseases - A Guide to their Recognition," U. S. Department of H.E.W.
- Hawley, G. G. - editor, "The Condensed Chemical Dictionary," Van Nostrand - Reinhold Company, 8th edition, 1971 (Hawley)
- International Labour Organization, "Encyclopedia of Occupational Health and Safety," Geneva, 1972 (ILO)
- "Merck Index of Chemicals and Drugs," Merck and Company, Rahway, New Jersey, 8th edition, 1968 (Merck)
- Plunkett, E. R., "Handbook of Industrial Toxicology," Chemical Publishing

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Company, Inc., 1966 (Plunkett)
Stanford Research Institute, "Chemical Origins and Markets," Menlo Park,
California, 4th edition, 1967 (Origins)

References for Specific Use/Exposures

1. Hawley, Gafafer, Plunkett, Faith
2. Merck, Origins
3. Hawley
4. Dimazine
5. Hawley, Dimazine
6. Hawley, Gafafer, Plunkett, Dimazine
7. Dimazine
8. Hawley, Plunkett
9. Hawley, Gafafer, Dimazine
10. Dimazine
11. Plunkett, Dimazine
12. Dimazine

References for Specific Control Methods

Dimazine, AIHA, Safety, ILO and Plunkett were the references used in
the Specific Control Methods numbers 1 - 12.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: 1,1-Dimethylhydrazine

D. O. L. STANDARD: 0.5 ppm

WARNING PROPERTIES:

Odor Threshold: According to Staub, the odor threshold of
1,1-dimethylhydrazine is 6 ppm.

Eye Irritation Level: Grant reports that 1,1-dimethylhydrazine is
"highly corrosive and irritating" to eyes. Grant gives no
quantitative information, but he reports that "only mild irrita-
tion of skin and eyes (occurs) from exposure to small amounts
of vapor escaping" during its use in rocket fuels.

Other Information: Grant reports that 1,1-dimethylhydrazine is also
"highly corrosive and irritating" to skin and mucous membranes.

Evaluation of Warning Properties: Since the odor threshold of
1,1-dimethylhydrazine is many times greater than the permissible
exposure limit, and since no quantitative information is
available concerning the irritation thresholds of this substance,
1,1-dimethylhydrazine, for the purposes of this standard,
has been treated as a material with poor warning properties. Gas
sorbent respiratory equipment is not permitted.

IDLH: 50 ppm

Basis for IDLH Value: This IDLH is based upon Patty's report that
1 out of 3 dogs died following a 4-hour exposure to 52 ppm
1,1-dimethylhydrazine. Levels above 50 ppm may cause permanent eye dama

Other Toxicological Information: Patty reports that "the outstanding
effects after single doses (of 1,1-dimethylhydrazine) are central
nervous system stimulation and convulsions, and the most signifi-
cant results of chronic inhalation are hemolytic anemia and
convulsive seizures."

Patty reports that a 3-hour exposure to 111 ppm
1,1-dimethylhydrazine killed all 3 dogs which had been exposed.
These dogs had exhibited such symptoms of exposure as
"salivation, vomiting, respiratory distress, and convulsions."

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Two out of 3 dogs exhibited similar symptoms following a 4-hour exposure to 52 ppm 1,1-dimethylhydrazine, and 1 of these dogs died. No deaths occurred among 3 dogs which had been exposed to 24 ppm for 4 hours.

The Documentation of TLV's reports that one investigator determined the following 4-hour LC50 values: 250 ppm for rats, 170 ppm for mice, and 390 ppm for hamsters.

The AIHA Hygienic Guides do not give an IDLH concentration but the Hygienic Guides report LC50 values for a 60-minute exposure to be 1410 ppm for rats and 980 ppm for dogs, and an LC50 for a 30-minute exposure to be 4010 ppm for rats.

Shook and Cowart report that one investigator found that "when applied to the skin of a rabbit, doses of 0.2 cc/kg or more produce death."

LFL: 20,000 ppm

VAPOR PRESSURE: 103 mm Hg at 20 deg. C.
157 mm Hg at 25 deg. C.

SATURATED CONCENTRATION: at 20 deg. C.: 135,500 ppm
at 25 deg. C.: 206,600 ppm

NOTE: Since all organic vapor cartridges may not be efficient in removing 1,1 dimethylhydrazine, only those cartridges and canisters which provide protection against 1,1 dimethylhydrazine are permitted.

Reference: Shook, B. S. and Cowart, O. H., "Health Hazards Associated with Unsymmetrical Dimethylhydrazine," Industrial Medicine and Surgery, July 1957, p. 333.

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Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1. Inhalation of vapor and skin contact with liquid during formulation of and use as jet and rocket propellants	A,B,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, goggles, and full protective clothing)
2. Inhalation of vapor and skin contact with liquid during the manufacture of 1,1-dimethylhydrazine and during maintenance of manufacturing and storage equipment. Manufacturing routes include the reaction of dimethylamine with ammonia, chloroamine with ammonia and the reduction of nitrosodimethylamine.	A,B,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, goggles, full protective clothing)
3. Inhalation of vapors and skin contact with liquid during use as an absorbent for acid gases in stripping and extraction processes	A,B,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, aprons and goggles)
4. Inhalation of vapor and skin contact with liquid during use as a corrosion control agent for oil well casings	A,B,D	Personal protective equipment (respiratory protective devices, gloves, aprons and goggles)
5. Inhalation of vapor and skin contact with liquid during formulation as a stabilizer for organic peroxide fuel additives	A,B,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, aprons and goggles)
6. Inhalation of vapor and skin contact with liquid during use in miscellaneous	A,B,D	General dilution ventilation; process enclosure; local exhaust ventilation;

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chemical synthesis. Products of this use include catalysts, pharmaceuticals, dyestuffs and stabilizing agents.

personal protective equipment (respiratory protective devices, gloves, aprons and goggles)

- | | | | |
|------|--|-------|--|
| 7. | Inhalation of vapor and skin contact with liquid during formulation of automotive antifreeze in which 1,1-dimethylhydrazine is used as a corrosion inhibitor | A,B,D | General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, aprons and goggles) |
| 8. | Inhalation of vapor and skin contact with liquid during formulation and use of certain agricultural plant growth control agents | A,B,D | General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, aprons and goggles) |
| 9. | Inhalation of vapors and skin contact with liquid during use in the formulation of photographic developers | A,B,D | General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, aprons and goggles) |
| 10. | Inhalation of vapor and skin contact with liquid during use as a supercontracting and permanent setting agent for animal fibers | A,B,D | General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, aprons and goggles) |
| 11. | Inhalation of vapor and skin contact with liquid during use as a short-stopping agent in the processing of styrene-butadiene rubber | A,B,D | General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, aprons and goggles) |
| -12. | Inhalation of vapor and skin contact with liquid during use as a paint antiskimming agent | A,B,D | General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves, aprons |

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and goggles)

- A -- Inhalation
- B -- Skin and eye contact resulting
in localized irritation
- C -- Ingestion
- D -- Skin contact resulting in
absorption and subsequent
systemic poisoning