

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** PENTANE ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for PENTANE

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 PENTANE.

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 - "Permissible Exposure" means inhalation of pentane in concentrations not in excess of 1,000 parts per million (ppm) (2,950 milligrams per cubic meter, mg/cu.m.) averaged over an eight hour work shift, as stated in section 1910.93, Table G-1.
- (2) ACTION LEVEL - "Action Level" means one half (1/2) of the permissible exposure for pentane.

(b) EMPLOYEE INFORMATION - Each employer who has a workplace in which pentane is present shall:

- (1) STANDARD AVAILABILITY - Keep a copy of this section with its appendices A, B and C, at the workplace. This material shall be made readily available to affected employees; and
- (2) PRESENCE OF PENTANE - Inform affected employees of the quantity, location, and manner of use or storage of pentane.

(c) EXPOSURE MEASUREMENT

- (1) INITIAL DETERMINATION - Each employer who has a place of employment in which pentane is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of pentane 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 pentane. A written determination shall be made and it shall contain at least the following information:

- (i) Any information, observations, or calculations which would indicate employee exposure to pentane;
- (ii) Any measurements of airborne concentrations of pentane taken;
- (iii) Any employee complaints of symptoms which may be attributable to exposure to pentane; and
- (iv) Date of determination, work being performed at the time, location within work site, name, and social security number of each employee considered.

- (2) INITIAL EXPOSURE MEASUREMENT - If the employer determines that any employee may be exposed to airborne concentrations of pentane at or above the action level, the exposure of the employee believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum exposure of the employee.

- (3) IDENTIFICATION OF EXPOSED EMPLOYEES - If the exposure measurement taken under paragraph (c)(2) of this section reveals employee exposure to airborne concentrations of pentane 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.

- (4) EXPOSURE ABOVE THE ACTION LEVEL - If an employee exposure measurement reveals that an employee is exposed to airborne concentrations of pentane 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.

- (5) EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE - If an employee exposure measurement reveals that an employee is exposed to airborne

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concentrations of pentane above the permissible exposure, the employer shall:

- (i) Inform the employee of the exposure as required by paragraph (N)(1) of this section; and
- (ii) Measure the exposure of the employee at least monthly; and
- (iii) Institute control measures as required by paragraph (E) of this section.

(6) TERMINATION OF EXPOSURE MEASUREMENT - If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to airborne concentrations of pentane below the action level, the employer may terminate measurement for the employee. For purposes of this subparagraph, use of respirators shall not constitute reduction of employee exposure below the action level.

(d) METHODS OF MEASUREMENT - 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 (Appendix B (iv)). The method of measurement shall have an accuracy, to a confidence level of 95%, of not less than that given in Table 1 below.

Table 1

Concentration	Required Accuracy
Above permissible exposure	Plus or Minus 25%
At or below permissible exposure and above the action level	Plus or Minus 35%
At or below the action level	Plus or Minus 50%

(e) Methods of Compliance

(1) Engineering controls - No employee shall be exposed to pentane above the permissible limit as defined in paragraph (a)(1) of this section. Engineering and work practice controls shall be used to reduce exposure to pentane to at or below the permissible exposure.

(i) When mechanical ventilation is used to control exposure, measurements which demonstrate system efficiency (for example: air velocity, static pressure, or air volume) shall be made at least every three months. Measurements of system efficiency shall also be made within five work days of any change in production, process or control which might result in a reduction in control.

(ii) Where a fan is located in duct work and where pentane is present in concentrations greater than 3750 ppm, one fourth of the lower flammable limit, the fan rotating element shall consist of, or be lined with, non-sparking material. There shall be sufficient clearance between the fan rotating element and the fan casing so as to prevent contact.

(iii) In the design of open surface tank ventilation for the purposes of section 1910.94 (d), operations involving pentane shall be classified as B-1 at 70 F.

(2) Respirators

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

- a. During the time period necessary to install engineering controls; or

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- b. In work situations in which engineering controls are technically not feasible; or
 - c. In work situations in which feasible engineering and work practice controls are insufficient to reduce employees exposure to at or below the permissible exposure. Where technically feasible engineering and work practice controls are not sufficient to reduce exposure to at or below permissible exposure, they shall be used to reduce exposure to the lowest level feasible; or
 - d. For operations not exceeding 40 hours per year; or
 - e. In emergencies.
- (ii) Respirators shall be jointly approved by the mining enforcement and safety administration (formerly Bureau of Mines) and by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.
 - (iii) Employers shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.
 - (iv) Employers shall institute a respiratory protection program in accordance with sections 1910.134(b), (d), (e), and (f).

TABLE 2 RESPIRATORY PROTECTION FOR PENTANE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor Concentration	
Equal to or less than 5000 ppm	A gas mask with a chin-style organic vapor canister
Equal to or less than 10,000 ppm	Any self-contained breathing apparatus. Any air-supplied respirator.
Equal to or less than 15,000 ppm	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece. A gas mask with a front- or back-mounted organic vapor canister.
Greater than 15,000 ppm or escape and entry 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.

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Fire Fighting Self-contained breathing apparatus
 with a full facepiece operated in
 pressure-demand or other positive pressure
 mode.

Escape Any gas mask providing protection
 against organic vapor(s).
 Any escape self-contained breathing
 apparatus.

(f) Fire and Safety

Employers shall familiarize themselves with the information contained in the Substance Technical Guidelines for pentane which is contained in Appendix B in order to ensure the safe handling and use of pentane.

- (1) Electrical - For the purposes of compliance with section 1910.309, locations classified as hazardous locations due to the presence of pentane shall be Class I Group D.
- (2) Portable fire extinguishers - For the purposes of compliance with section 1910.157, pentane is classified as a Class B fire hazard.
- (3) Powered industrial trucks - For the purposes of compliance with section 1910.178, locations classified as hazardous locations due to the presence of pentane shall be Class I Group D.
- (4) Flammable liquids - For the purposes of compliance with section 1910.106, liquid pentane is classified as a Class IA flammable liquid. Dip tank operations shall be performed in accordance with sections 1910.108 and 1910.94 (d).
- (5) Sources of ignition - Sources of ignition such as smoking or open flames are prohibited where pentane is handled, used or stored.
- (6) Storage - Pentane shall be stored so as not to come in contact with strong oxidizers.

(g) Personal Protective Equipment

(1) Skin Contact

- (i) Employers shall provide, and require employees to use, impervious clothing, gloves, face shields (8-inch minimum) and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact to liquid pentane. Face shields shall comply with section 1910.133(a)(6).
- (ii) Employers shall ensure that clothing which becomes wet with liquid pentane be removed immediately and not reworn until the pentane is removed from the clothing.
- (iii) Employers shall ensure that clothing wet with liquid pentane is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of pentane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the pentane, the employer shall inform the person performing the operation of the hazardous properties of pentane.

(2) Eye Contact

- (i) Employers shall provide, and require employees to use, splash-proof safety goggles (cup-cover type dust and splash

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safety goggles), which comply with section 1910.133 (a)(6), where eye contact to liquid pentane may occur.

- (h) Spills
 - (1) Spills of pentane shall be cleaned up immediately after eliminating potential sources of ignition and utilizing available ventilation.
 - (2) Liquid pentane may not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.
- (i) Sanitation
 - (1) Employers shall ensure that employees whose skin becomes wet with liquid pentane promptly wash or shower to remove any pentane from the skin.
- (j) Training and Information - Each employer who has employees exposed to pentane in excess of the action level, or employees who may have skin or eye contact with liquid pentane, or employees who work where accidental release, spill, fire, or explosion of pentane may occur, shall annually:
 - (1) Substance Safety Data Sheet - Inform each employee of the information contained in the Substance Safety Data Sheet for pentane, which is contained in Appendix A; and
 - (2) Medical -
 - (I) Advise employees as to the signs and symptoms of exposure to pentane.
 - (II) Instruct the employees to advise the employer of the development of signs and symptoms of exposure to pentane which are listed in Appendix A.
 - (III) Instruct the employees to inform the employer if they develop any of the medical conditions listed in (k)(2) of this section; and
 - (3) Procedures -
 - (I) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to pentane.
 - (II) The procedures required by (j)(1), (2), and (3)(I) shall be provided to employees at the expense of the employer during the employee's normal working hours.
- (k) Medical Surveillance
 - (1) The employer shall provide medical procedures as required by paragraph (k). These procedures shall be provided at no cost to the employee.
 - (2) Preplacement Questionnaire - The employer shall obtain from each employee who will be exposed to airborne concentrations of pentane at or above the action level, a written statement as to whether such employee has a history of any of the following:
 - (i) Skin disease
 - (ii) Liver disease
 - (iii) Kidney disease
 - (iv) Chronic lung disease
 - (3) Preplacement Medical Examination - The employer shall provide a medical examination for an employee if the employee provides a history of any of the conditions named in paragraph (k)(2).

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- (4) Results of Preplacement Examination - The employer shall obtain a physician's written opinion based on the medical examination pursuant to paragraph (k)(3).
 - (5) Periodic Medical Examinations - The employer shall provide a medical examination for an employee if the employee advises the employer of the development of:
 - (i) Any of the medical conditions listed in (k)(2).
 - (ii) Signs and symptoms listed in Appendix A which the employee suspects may be caused by exposure to pentane.
 - (6) Results of Periodic Examinations - The employer shall obtain a physician's written opinion based on the medical examination pursuant to paragraph (k)(5).
 - (7) Exclusion or Removal from Exposure - No employee shall continue to be exposed to pentane if such exposure could place the employee at increased risk of material impairment of his health.
 - (8) Emergency Procedures - The employer shall provide emergency and follow-up medical examinations and treatment for any employee injured through exposure to pentane.
 - (9) Informing the Physician - The employer shall provide to the examining physician the following information:
 - (i) A copy of this section with its Appendices A, B, and C;
 - (ii) A description of the employee's duties as they relate to his exposure to pentane;
 - (iii) A description of any personal protective equipment, including respirators, required to be used;
 - (iv) The results of any employee's exposure measurement, if available;
 - (v) The employee's anticipated exposure level; and
 - (vi) Upon request of the physician, information from previous medical examination of the employee.
 - (10) Physician's Written Opinion
 - (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 conditions which could be directly or indirectly aggravated by exposure to pentane or which could significantly interfere with the ability of the employee to follow recommended or required procedures for protecting himself from unusual or emergency exposure.
 - (B) Any recommended limitations upon the employee's exposure to pentane.
 - (C) The employee has been informed by the physician of any detected medical conditions which require further medical examination or treatment.
 - (ii) The written opinion shall not reveal medical information unrelated to exposure to pentane.
 - (11) Refusal to be Medically Examined - 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.
- (1) Recordkeeping.

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- (1) Initial determination.
 - (i) The employer shall keep an accurate record of all initial determinations required to be made pursuant to paragraph (c)(1) of this section.
 - (ii) The record shall include the written determination and any supporting documentation as required in paragraph (c)(1) of this section.
 - (iii) This record shall be maintained until replaced by a more recent record.
- (2) Exposure measurements.
 - (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to pentane.
 - (ii) This record shall include:
 - (a) The date of measurement;
 - (b) A reference to the subparagraph of this regulation which required the measurement, if any;
 - (c) Operations involving exposure to pentane which are being monitored;
 - (d) Sampling and analytical methods used and evidence of their accuracy;
 - (e) Number, duration, and results of samples taken;
 - (f) 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 a record of measurements demonstrating the effectiveness of such ventilation as required by paragraph (e)(1)(i) of this section.
 - (ii) This record shall include:
 - (a) Date of measurement;
 - (b) Type of measurement taken;
 - (c) Result of measurement.
 - (iii) This record shall be maintained for at least one year.
- (4) Training and information.
 - (i) The employer shall keep an accurate record of all employee training and advice required by paragraph (j) of this section.
 - (ii) The record shall include:
 - (a) Date of training;
 - (b) Name and Social Security number of employees trained;
 - (c) Substance of training provided.
 - (iii) This record shall be maintained until replaced by a more recent record.
- (5) Medical records.
 - (i) The employer shall keep an accurate medical record for each employee.
 - (ii) The record shall include:
 - (a) Physician's written opinion;
 - (b) Preplacement questionnaire;
 - (c) Any employee medical complaints relative to exposure to pent

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- (d) A signed statement of any refusal to be examined;
 - (e) A copy of information provided to the physician pursuant to paragraph (k)(9)(ii) through (vi) of this section.
 - (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 and the Director.
 - (ii) Employee 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.
- (m) Observation of monitoring.
- (1) Duty.
The employer shall give affected employees or their representatives an opportunity to observe any monitoring of employee exposure to pentane which is conducted pursuant to this section.
 - (2) Exercise of opportunity to observe monitoring.
 - (i) When observation of the monitoring of employee exposure to pentane requires entry into an area where the use of personal protective devices is required, the observer shall use such equipment and comply with all other applicable safety procedures.
 - (ii) Without interfering with the measurement, observers shall be entitled to:
 - (a) Receive an explanation of the measurement procedures;
 - (b) Visually observe all steps related to the measurement of exposure to pentane that are being performed at the place of exposure.
 - (c) Record the results obtained.
- (n) Employee notification.
- (1) The employer shall notify in writing, within five work days, every employee who is found to be exposed to pentane above the permissible exposure. The employee shall also be notified of the level of his exposure and the corrective action being taken to reduce the exposure to at or below the permissible exposure.
 - (2) Pursuant to paragraph (k) of this Section, when an employee is medically examined the employer shall provide the employee with a copy of the physician's written opinion.

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APPENDIX A

SUBSTANCE SAFETY DATA SHEET

I. SUBSTANCE: Pentane

PERMISSIBLE EXPOSURE: 1000 parts of pentane per million parts of air (ppm) or 2950 milligrams of pentane per cubic meter of air (mg/cu m).

APPEARANCE AND ODOR: Colorless liquid with a gasoline-like odor.

II. HEALTH HAZARD DATA

A. Ways in Which the Chemical Affects Your Body: Pentane may affect your body if you inhale it or if it comes in contact with your eyes or skin or if you swallow it.

B. Effects of Overexposure:

1. Short-Term Overexposure: Overexposure to pentane may cause drowsiness and irritation of the eyes and nose. Greater exposure may cause unconsciousness and death.
2. Long-Term Overexposure: Prolonged overexposure may cause irritation of the skin.
3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms associated with pentane exposure.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If pentane gets into your eyes, wash the eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

B. Skin Exposure: If pentane gets on your skin, promptly wash the contaminated skin with water. If pentane soaks through your clothing, remove the clothing immediately and wash the skin with water. If irritation persists after washing, get medical attention. Do not wear the clothing again until the pentane has evaporated. Replace or repair impervious clothing that has developed leaks.

C. Breathing: If you or any other person breathes in large amounts of pentane remove 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.

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- D. Swallowing: If pentane has been swallowed do not cause vomiting. 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 pentane. You can only be required to wear them for routine use if your employer is in the process of installing controls or if 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)/National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective 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 pentane 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. PROTECTIVE CLOTHING: You must wear impervious clothing, gloves, face shield or other appropriate protective clothing to prevent repeated or prolonged skin contact with liquid pentane.
- C. EYE PROTECTION: You must wear splash-proof safety goggles (cup-cover type dust and splash-proof goggles) where eye contact to liquid pentane may occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Pentane is a flammable liquid and its vapors easily form explosive mixtures with air even at low temperatures.
- B. Pentane must be stored in tightly closed containers in a cool, well ventilated area away from heat, sparks, flames and strong oxidizers.
- C. Sources of ignition such as smoking and open flames are prohibited wherever pentane is handled, used or stored.
- D. You must use non-sparking tools when opening or closing metal containers of pentane, and containers must be bonded and grounded when pouring or transferring liquid pentane.
- E. If your skin becomes wet with liquid pentane, you must promptly wash or shower to remove the pentane from your skin.
- F. Clothing wet with pentane can be easily ignited. You must immediately remove any clothing that becomes wet with liquid pentane and this clothing must not be reworn until the pentane is removed from the clothing.
- G. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them.
- H. Ask your supervisor where pentane is used in your work area and for any additional plant safety and health rules.

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APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
PENTANE

- I. PHYSICAL AND CHEMICAL DATA
- A. Substance Identification
1. Synonyms: Normal pentane
 2. Formula: C_5H_{12}
 3. Molecular weight: 72.2
- B. Physical Data
1. Boiling point (760 mm Hg): 36 C (97 F)
 2. Specific gravity (H₂O=1): 0.63
 3. Vapor density (air = 1 at boiling point of pentane): 2.5
 4. Melting point: -129 C (-200 F)
 5. Vapor pressure at 20 C (68 F): 426 mm Hg
 6. Solubility in water, % by weight at 20 C (68 F): 0.04
 7. Evaporation rate (butyl acetate = 1): 28.6
 8. Appearance and odor: Colorless liquid with a gasoline-like odor
- II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA
- A. Fire
1. Flash point: -49 C (-57 F) (closed cup)
 2. Autoignition temperature: 260 C (500 F)
 3. Flammable limits in air, % by volume: Lower: 1.5; Upper: 7.8
 4. Extinguishing media: Foam, dry chemical, carbon dioxide
 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: Pentane is a flammable liquid. Its vapors can easily form explosive mixtures with air even at low temperatures. All ignition sources must be controlled where pentane is handled, used or stored. Pentane 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 pentane is handled.
 7. For purposes of conforming with the requirements of 29 CFR 1910.106, pentane is classified as a Class IA flammable liquid. At 3750 ppm, one-fourth of the lower flammable limit, pentane 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 pentane shall be Class I Group D.
- B. Reactivity
1. Conditions contributing to instability: Heat

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2. Incompatibilities: Contact with strong oxidizing agents may cause fire and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving pentane.
4. Special precautions: Pentane will attack some forms of plastics, rubber and coatings

III. SPILL, LEAK AND DISPOSAL PROCEDURES

- A. If pentane is spilled or leaked, the following steps should be taken:
 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 duct work, then burn the paper. Large quantities may be collected, and atomized in a suitable combustion chamber. Pentane 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:
Pentane may be disposed of by atomizing in a suitable combustion chamber.

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 eight-hour exposure may be determined from a single eight-hour sample or two (2) 4-hour samples. Short term interval samples (up to 30 minutes) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the eight-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random equal duration samples taken on one (1) work shift is an estimate of an employee's average level of exposure for that work shift. 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, gas and vapor adsorption tubes with subsequent chemical analyses or dosimeters. The method of measurement must determine the concentration of pentane to plus or minus 35%.
- b. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring 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 (AIHA). The method of measurement must determine the concentration of pentane to plus or minus 25%. Methods meeting these accuracy requirements are available from NIOSH.

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V. MISCELLANEOUS PRECAUTIONS

- A. Store pentane in tightly closed containers in a cool, well-ventilated area.
- B. High exposures to pentane can occur when transferring the liquid from one container to another.
- C. Non-sparking tools must be used to open and close metal pentane containers. These containers must be effectively grounded and bonded prior to pouring.
- D. Employers must advise employees of all plant areas and operations where exposure to pentane could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to pentane is likely to occur are: during its production; in the use and handling of gasoline which contains pentane; during its use as an intermediate in the synthesis of amyl chlorides, olefins, polystyrene beads and polychlorocyclopentanes; its use as a blowing agent for polymeric foams; and its use as a heat exchange fluid.

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APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Pentane vapor is a mild narcotic and mucous membrane irritant. Exposure to 90,000 to 120,000 ppm resulted in narcosis in animals in 5 to 6 minutes; 130,000 ppm was fatal, with respiratory arrest occurring within 5 minutes of the start of exposure. Pentane injected subcutaneously in rats produced temporary impairment of liver function and moderate neutropenia. While other aliphatic hydrocarbons produce drowsiness and mild irritation of the eyes and nose in human subjects, no symptoms resulted from exposure to pentane vapor for 10 minutes at 5,000 ppm. Repeated or prolonged skin contact results in drying and cracking due to defatting action. No chronic systemic effects have been reported in humans. Aspiration may cause a chemical pneumonia.

III. SIGNS AND SYMPTOMS

Probable drowsiness and irritation of the eyes and nose; prolonged skin contact causes dermatitis. Aspiration may cause signs and symptoms of a chemical pneumonia.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Flush eyes with water and wash skin with soap and water. If swallowed, do not induce vomiting. Give artificial resuscitation if indicated. Recovery is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of pentane are caused by its narcotic and irritant properties. It is important that the physician becomes familiar with plant operating conditions in which exposure to pentane 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

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Routine medical histories and physical examination are not required. However, the employer must screen employees for history of certain medical conditions (listed below) which might place the employee at increased risk from pentane exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Skin disease -- Pentane is a skin defatting agent and can cause dermatitis on prolonged exposure. Persons with preexisting skin disorders may be more susceptible to the effects of this agent.
2. Liver disease -- Although pentane is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.
3. Kidney disease -- Although pentane is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.
4. Chronic respiratory disease -- In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of pentane might cause exacerbation of symptoms due to its irritant properties.

C. PERIODIC EXAMINATIONS

Routine periodic examinations are not required. However, if the employer becomes aware of an employee with the above listed conditions, he must refer such employee for further medical examination.

References

1. American Conference of Governmental Industrial Hygienists: "Pentane," (3d ed., 2d printing), Documentation of the Threshold Limit Values for Substances in Workroom Air, Cincinnati, 1974, p. 200.
2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1195, 1196, 1198.
3. Hygienic Guide Series: "Pentane," American Industrial Hygiene Association Journal, 27:207-209, 1966.
4. Swann, H.E., Jr., et al.: "Acute Inhalation Toxicology of Volatile Hydrocarbons," American Industrial Hygiene Association Journal, 35:511-518, 1974.

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5. Wirtschafter, Zolton T. and Marshall W. Cronyn: "Relative Hepatotoxicity: Pentane, Trichloroethylene, Benzene, Carbon Tetrachloride," American Industrial Hygiene Association Journal, 9:180-185, 1964.

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REFERENCES AND SOURCES

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1910.93

- (d) Methods of Compliance - Open surface tank classification based on a relative evaporation rate of 0.7 hours. A. K. Doolittle, "The Technology of Solvents and Plasticizers", John Wiley & Sons, Inc., New York, 1954, pp. 354-357.
- (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. 18.
- (f) Personal Protective Equipment, and, (h) Sanitation
- Eye: Grant, "Toxicology of the Eye"
- Skin: Patty, "Ind. Hyg. and Tox.;" AIHA Hyg. Guide
- Ingestion: Sax, "Dangerous Properties of Ind. Materials;" AIHA Hyg. Guide

COMMENTS:

Eye - Classification: 2
Output statement numbers: 10
Exceptions: None

Grant reports in general for mixtures of hydrocarbons that various liquid hydrocarbons of petroleum cause little or no injury on direct external contact with the eye. In particular, Kerosene Deo-base, Stoddard solvent, and petroleum oil on rabbit and human corneas are essentially innocuous. Liquid petrolatum and purified deodorized kerosene such as used for insecticide solvent can be applied to human eyes without causing discomfort or signs of irritation.

"More volatile derivatives, high-test gasoline in particular, cause smarting and pain on splash contact with the eye, but only slight transient corneal epithelial disturbance." He adds that butane injected into the anterior chamber of rabbits as a gas caused no disturbance.

For solvents, Grant states "A splash of a chemically inert solvent usually causes immediate stinging and smarting pain, and may cause loss of some or all of the corneal epithelium, particularly if it is a good fat solvent, but as a general rule it does not damage the corneal stroma underlying the epithelium. Even if all the epithelium is lost from the cornea as a result of splash of ordinary organic solvents, it generally regenerates in a few days without residual permanent damage. While the epithelium is missing, the stroma may be slightly swollen and the posterior surface of the cornea may appear wrinkled."

A classification of 2 is concluded appropriate to prevent the possible effects cited.

Skin - Classification: 2
Output statement numbers: 2, 7b, 16i, 21
Exceptions: None

Patty notes in general that "the liquid paraffin hydrocarbon fat solvents and primary skin irritants. Repeated or prolonged contact will dry and defat the skin, resulting in irritation and chapping. The AIHA Hygienic Guide agrees with the above.

Pentane has a vapor pressure of 426 mm Hg at 20 degrees C.

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a flash point of -57 degrees F and is 0.04% soluble in water.

A classification of 2 is concluded appropriate to prevent the possible effects cited.

Ingestion - Classification: 0

Output statement numbers: None

Exceptions: None

Sax lists the acute systemic effects of ingestion of the vapor to be of slight toxic hazard. The AIHA Hygienic Guides for hexane and heptane report "the paraffin hydrocarbons are anesthetic agents to the mucous membranes, but do not cause systemic toxicity."

It is concluded that ingestion of this substance, in the context of this standard, would not be a hazard in the industrial environment.

SUBSTANCE TECHNICAL GUIDELINES

PENTANE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Normal pentane
2. Formula: C₅H₁₂
3. Molecular weight: 72.2

B. Physical Data

1. Boiling point (760 mm Hg): 36 C (97 F)
2. Specific gravity (water=1): 0.63
3. Vapor density (air = 1 at boiling point of pentane): 2.5
4. Melting point: -129 C (-200 F)
5. Vapor pressure at 20 C (68 F): 426 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.04
7. Evaporation rate (butyl acetate = 1): 28.6
8. Appearance and odor: Colorless liquid with a gasoline-like odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: -49 C (-57 F) (closed cup)
2. Autoignition temperature: 260 C (500 F)
3. Flammable limits in air, % by volume: Lower: 1.5; Upper: 7.8
4. Extinguishing media: Foam, dry chemical, carbon dioxide
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: Pentane is a flammable liquid. Its vapors can easily form explosive mixtures with air even at low temperatures. All ignition sources must be controlled where pentane is handled, used or stored in a manner that could create a potential fire or explosion hazard. Pentane 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 pentane is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, pentane is classified as a Class IA flammable liquid. For example, 3800 ppm, approximately one-fourth of the lower flammable limit, is one situation in which pentane is considered to be a potential fire and explosion hazard.

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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 pentane shall be Class I Group D.

B. Reactivity

1. Conditions contributing to instability: Heat.
2. Incompatibilities: Contact with strong oxidizing agents may cause fire and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving pentane.
4. Special precautions: Pentane will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK AND DISPOSAL PROCEDURES

A. If pentane is spilled or leaked, the following steps should be taken:

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 duct work, then burn the paper. Large quantities may be collected, and atomized in a suitable combustion chamber. Pentane 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: Pentane may be disposed of by atomizing in a suitable combustion chamber.

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 eight-hour exposure may be determined from a single eight-hour sample or two (2) 4-hour samples. Short term interval samples (up to 30 minutes) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the eight-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random equal duration samples taken on one (1) work shift is an estimate of an employee's average level of exposure for that work shift. 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, gas and vapor adsorption tubes with subsequent chemical analyses or dosimeters. The method of measurement must determine the concentration of pentane to plus or minus 35%.

b. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring under this section should be essentially the same as described under paragraph IV.

a. Laboratories performing chemical analyses should be

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accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association (AIHA). The method of measurement must determine the concentration of pentane to plus or minus 25%. Methods meeting these accuracy requirements are available from NIOSH.

V. MISCELLANEOUS PRECAUTIONS

- A. Store pentane in tightly closed containers in a cool, well-ventilated area.
- B. High exposures to pentane can occur when transferring the liquid from one container to another.
- C. Non-sparking tools must be used to open and close metal pentane containers. These containers must be effectively grounded and bonded prior to pouring.
- D. Employers should advise employees of all plant areas and operations where exposure to pentane could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to pentane is likely to occur are: During its production; in the use and handling of gasoline which contains pentane; during its use as an intermediate in the synthesis of amyl chlorides, olefins, polystyrene beads and polychlorocyclopentanes; its use as a blowing agent for polymeric foams; and its use as a heat exchange fluid.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Pentane

D. O. L. STANDARD: 1000 ppm

WARNING PROPERTIES:

Odor Threshold: Staub reports an odor threshold of 2.2 ppm. The AIHA Hygienic Guides state that "the odor threshold of pentane vapor is approximately the same as the recommended maximal concentration of 1000 ppm."

Eye Irritation Level: Pentane is not a known eye irritant.

Evaluation of Warning Properties: Since the odor threshold of pentane is at below the permissible exposure limit, pentane is treated as a material with adequate warning properties. Gas sorbent respiratory equipment is permitted.

IDLH: 15,000 ppm

Basis for IDLH Value: Since the toxicological information given below indicates that the IDLH concentration for pentane is above the lower flammable limit (15,000 ppm), the LFL has been chosen as the concentration above which only the most highly reliable, positive pressure respiratory devices are permitted.

Other Toxicological Information: Patty states that pentane "causes narcosis 5 to 60 minutes at a concentration range of 90,000 to 120,000 ppm (9 - 12 per cent by volume) in air. Only a narrow margin exists between the concentrations which cause narcosis and death in mice. In human studies, a 10-minute exposure to 5000 ppm (0.5 per cent) did not cause mucous membrane irritation or other symptoms. The odor of pentane at this concentration is readily detectable."

The AIHA Hygienic Guides state that the atmospheric concentration immediately hazardous to life is unknown for man, but that the "lethal concentration for mice has been reported as 377 mg/liter (128,200 ppm) at a 37-minute exposure."

The TLV (500 ppm) is recommended "as a level where odor and irrita-

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do not constitute a nuisance during prolonged exposure."

LEL: 15,000 ppm

VAPOR PRESSURE AT 20 C: 426 mm Hg

SATURATED CONCENTRATION AT 20 C: Approximately 561,000 ppm

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USE/EXPOSURE AND CONTROL DOCUMENT
PENTANE

Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1. Inhalation of vapor and skin contact with liquid when using gasolines for automative, aviation and farm equipment	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles)
2. Inhalation of vapor and skin contact with liquid when used as a raw material in the synthesis of amyl chlorides. Amyl chlorides are intermediates in the manufacture of paint and lacquer solvents, lube oil additives, hydraulic fluids, pesticides organic sulfur compounds, paint removers, solvent extendus, and other miscellaneous petrochemicals.	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles)
3. Inhalation of vapor and skin contact with liquid during cleaning and maintenance of pentane processing equipment such as distillation, fractimation, and reflex columns, storage vessels, and pumping equipment. This includes most petrochemical processing equipment from that refining crude oil and natural gas to the equipment processing pentane to its end products.	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protection, gloves, aprons, eye goggles)
4. Inhalation of vapor and skin contact with liquid when used as a raw material in the synthesis of polychlorocyclopentanes. Polychlorocyclopentanes are intermediates in the manufacture of plasticizers, fire resistant polyester	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles)

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resins and paints, dye intermediates, and insecticides.

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| 5. | Inhalation of vapor when used as a blowing agent for polymeric foams such as styrofoam | A | Local exhaust ventilation; general dilution ventilation |
| 6. | Inhalation of vapor and skin contact with liquid when used as a raw material in the synthesis of olefins such as ethylene and isoprene (ultimately as a synthetic rubber) and in the synthesis of many other petrochemicals | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles) |
| 7. | Inhalation of vapor and skin contact with liquid when used in solvent extraction processes | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles) |
| 8. | Inhalation of vapor and skin contact with liquid when used as a general laboratory solvent (for example, pentane is a component of petroleum ether) | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, eye goggles) |
| 9. | Inhalation of vapor and skin contact with liquid when used as medium (solvent for polymerization reactions) | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles) |
| 10. | Inhalation of vapor when used as a component of torch fuel | A | Local exhaust ventilation; general dilution ventilation |
| 11. | Inhalation of vapor and skin contact with liquid in the manufacture of polystyrene beads with a pentane component for later styrofoam production | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles) |

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| 12. Inhalation of vapor and skin contact with liquid when used as a heat exchange medium in the manufacture of artificial ice | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles) |
| 13. Inhalation of vapor and skin contact with liquid during manufacture of low temperature thermometers | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, aprons, goggles) |

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

----- JES2 JOB STATISTICS -----

1,283 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

