

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** HEXANE ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

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 HEXANE.

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.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

(a) DEFINITIONS

- (1) PERMISSIBLE EXPOSURE - "Permissible Exposure" means inhalation of hexane in concentrations not in excess of 500 parts per million (ppm) (1,800 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 hexane.

(b) EMPLOYEE INFORMATION - Each employer who has a workplace in which hexane 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 HEXANE - Inform affected employees of the quantity, location, and manner of use or storage of hexane.

(c) EXPOSURE MEASUREMENT

- (1) INITIAL DETERMINATION - Each employer who has a place of employment in which hexane is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of hexane 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 hexane. 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 hexane;
 - (ii) Any measurements of airborne concentrations of hexane taken;
 - (iii) Any employee complaints of symptoms which may be attributable to exposure to hexane; and
 - (iv) Date of determination, work being performed at the time, location within work site, names, 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 hexane 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 hexane 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.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

- (4) EXPOSURE ABOVE THE ACTION LEVEL - If an employee exposure measurement reveals that an employee is exposed to airborne concentrations of hexane 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 concentrations of hexane above the permissible exposure, the employer shall:
- (i) Inform the employee of the exposure as required by paragraph (a)(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 hexane 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.
- (a) 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 hexane 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 hexane 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.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

- (ii) Where a fan is located in duct work and where hexane is present in concentrations greater than 2750 ppm, one fourth of the lower flammable limit, the fan rotating element 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.
- (iii) In the design of open surface tank ventilation for the purposes of compliance with section 1910.94(d), operations involving hexane 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
 - (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 HEXANE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor Concentration	
Equal to or less than 1,000 ppm	Any chemical cartridge respirator with an organic vapor cartridge(s). Any supplied-air respirator.

NIDOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

Any self-contained breathing apparatus

Equal to or less
than 5,000 ppm

A gas mask with chin style or front-
or back-mounted organic vapor canister
Any supplied-air respirator with a
full facepiece, helmet or hood.
Any self-contained breathing apparatus
with a full facepiece.

Greater than
5,000 ppm or
escape and or other 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
contained breathing apparatus operate
pressure-demand or other positive pressure

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 vapors.
Any escape self-contained breathing
apparatus.

(f) Fire and safety

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

- (1) Electrical - For the purposes of compliance with section
1901.309, locations classified as hazardous locations
due to the presence of hexane shall be Class I Group D.
- (2) Portable fire extinguishers - For the purposes of
compliance with section 1910.157, hexane 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 hexane
shall be Class I Group D.
- (4) Flammable liquids - For the purposes of compliance with
section 1910.106, liquid hexane is classified as a Class
IB flammable liquid. Spray finishing operations shall
be performed in accordance with sections 1910.107 and
1910.94(c). 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 hexane is

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

used, handled or stored in a manner so as to create a potential fire or explosion hazard.

- (6) Storage - Hexane 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, and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact to liquid hexane. Face shields shall comply with section 1910.133(a)(6).
 - (ii) Employers shall ensure that clothing which becomes wet with liquid hexane be removed immediately and not re-worn until the hexane is removed from the clothing.
 - (iii) Employers shall ensure that clothing wet with liquid hexane is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of hexane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the hexane, the employer shall inform the person performing the operation of the hazardous properties of hexane.

- (2) Eye Contact

- (i) Employers shall provide, and require employees to use, splash-proof safety goggles (cup-cover type dust and splash safety goggles), which comply with section 1910.133(a)(6), where eye contact to liquid hexane may occur.

- (h) Spills

- (1) Spills of hexane shall be cleaned up immediately after eliminating potential sources of ignition and utilizing available ventilation.
 - (2) Liquid hexane 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 hexane promptly wash or shower using soap or mild detergent to remove any hexane from the skin.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

(j) Training and Information - Each employer who has employees exposed to hexane in excess of the action level, or employees who may have skin or eye contact with liquid hexane, or employees who work where accidental release, spills, fire, or explosion of hexane may occur, shall annually:

(1) Substance Safety Data Sheet - Inform each employee of the information contained in the Substance Safety Data Sheet for Hexane, which is contained in Appendix A; and

(2) Medical -

(I) Advise employees as to the signs and symptoms of exposure to hexane.

(II) Instruct the employees to advise the employer of the development of signs and symptoms of exposure to hexane 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 hexane.

(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 hexane at or above the action level, a written statement as to whether such employee has a history of any of the following:

(i) Chronic lung disease

(ii) Skin disease

(iii) Liver disease

(iv) Kidney 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).

(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).

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

- (ii) Signs and symptoms listed in Appendix A which the employee suspects may be caused by exposure to hexane.
- (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 hexane 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 hexane.
- (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 hexane;
 - (iii) A description of any personal protective equipment, including respirators, required to be used;
 - (iv) The results of any employee's exposure measurements, if available;
 - (v) The employee's anticipated exposure levels; 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 hexane 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 hexane.
 - (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 hexane.
- (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

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

statement from the employee indicating that the employee understands the risks involved by refusing to be examined.

(1) Recordkeeping.

(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 hexane.
- (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 hexane 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.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

(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 hexane;
- (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 hexane which is conducted pursuant to this section.

(2) Exercise of opportunity to observe monitoring.

(i) When observation of the monitoring of employee exposure to hexane 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 hexane 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 hexane above the permissible exposure. The employee

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

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.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

APPENDIX A

SUBSTANCE SAFETY DATA SHEET

I. SUBSTANCE IDENTIFICATION

SUBSTANCE: Hexane (n-Hexane)

PERMISSIBLE EXPOSURE: 500 parts of hexane per million parts
of air (ppm) or 1800 milligrams of hexane per cubic
meter of air (mg/cu m).

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

II. HEALTH HAZARD DATA

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

B. Effects of Overexposure:

1. Short-Term Overexposure: Overexposure to hexane
may cause lightheadedness, giddiness, nausea and
headache. It may also cause irritation of the
eyes and nose. Greater exposure may cause
unconsciousness and death.

2. Long-Term Overexposure: Prolonged overexposure
to the liquid 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 hexane exposure.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If hexane 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 hexane gets on your skin promptly
wash the contaminated skin using soap or a mild
detergent. If hexane soaks through your clothing,
remove the clothing immediately and wash the skin using
soap or a mild detergent. If irritation persists after
washing get medical attention. Do not wear the clothing
again until the hexane is removed. Replace or repair
impervious clothing that has developed leaks.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

- C. Breathing: If you or any other person breathes in large amounts of hexane 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.
- D. Swallowing: If hexane 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 hexane. 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 hexane 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 hexane.
 - C. EYE PROTECTION: You must wear splash-proof safety goggles (cup-cover type dust and splash-proof goggles) where eye contact to liquid hexane may occur.
- V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE
- A. Hexane is a flammable liquid and its vapors easily form explosive mixtures with air.
 - B. Hexane 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 hexane is handled, used or stored in a manner that could create a potential fire or explosion hazard.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

- D. You must use non-sparking tools when opening or closing metal containers of hexane, and containers must be bonded and grounded when pouring or transferring liquid hexane.
- E. If your skin becomes wet with liquid hexane, you must promptly wash or shower using soap or mild detergent to remove the hexane from your skin.
- F. Clothing wet with hexane can be easily ignited. You must immediately remove any clothing that becomes wet with liquid hexane and this clothing must not be reworn until the hexane 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 hexane is used in your work area and for any additional plant safety and health rules.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES

HEXANE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Hexyl hydride; normal hexane
2. Formula: $\text{CH}_3(\text{CH}_2)_4\text{CH}_3$
3. Molecular weight: 86

B. Physical Data

1. Boiling point (760 mm Hg): 68.9 C (156 F)
2. Specific gravity (water=1): 0.7
3. Vapor density (air=1 at boiling point of Hexane): 3.0
4. Melting point: -95 C (-139 F)
5. Vapor pressure at 20 C (68 F): 124 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.014
7. Evaporation rate (butyl acetate=1): Data not available
8. Appearance and odor: Colorless liquid with a mild gasoline-like odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARDS DATA

A. Fire

1. Flash point: -21.7 C (-7 F) (closed cup)
2. Autoignition temperature: 225 C (437 F)
3. Flammable limits in air, % by volume: Lower: 1.1;
Upper: 7.5
4. Extinguishing media: Dry chemical, foam, 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: Hexane is a flammable liquid. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where hexane is handled, used or stored. Hexane 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 hexane is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, hexane is classified as a Class IB flammable liquid. At 2750 ppm, one-fourth of the lower flammable limit, hexane 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

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

Electrical Code for hexane 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 hexane.
4. Special precautions: Hexane will attack some forms of plastics, rubber and coatings

III. SPILL, LEAK AND DISPOSAL PROCEDURES

- A. If hexane 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 hood duct work, then burn the paper. Large quantities may be collected, and atomized in a suitable combustion chamber. Hexane 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:

Hexane 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

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

vapor adsorption tubes with subsequent chemical analyses or dosimeters. The method of measurement must determine the concentration of hexane 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 hexane to plus or minus 25%. Methods meeting these accuracy requirements are available from NIOSH.

V. MISCELLANEOUS PRECAUTIONS

- A. Store hexane in tightly closed containers in a cool, well-ventilated area.
- B. High exposures to hexane can occur when transferring the liquid from one container to another.
- C. Non-sparking tools must be used to open and close metal hexane 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 hexane could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to hexane is likely to occur are: during its production; in the use and handling of gasoline which contains hexane; its use as a solvent for inks, rubbers, adhesives, lacquers, and stains; its use as an extraction solvent in the processing of vegetable oils and meat scraps; and its use as an intermediate in the synthesis of polyolefins and elastomers; its use as a laboratory reagent and thermometer fluid; and its use in the pharmaceutical industry.

NIOOH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Hexane vapor is a narcotic; it also is a mild upper respiratory irritant. Polyneuropathy has been reported to occur in Japanese workers exposed to hexane vapors. Effects appeared to be reversible. Concentrations of 30,000 ppm produced narcosis in mice within 30 to 60 minutes; convulsions and death occurred at 35,000 to 40,000 ppm; at 64,000 ppm respiratory arrest was produced in 2.5 to 4.5 minutes from the start of exposure. Concentrations up to 8,000 ppm produced no anesthesia. In human subjects, 2,000 ppm for 10 minutes produced no effects, but 5,000 ppm resulted in dizziness and a sensation of giddiness. Other investigators reported slight nausea, headache, and irritation of the eyes and throat at 1,400 to 1,500 ppm. In industrial practice, mild narcotic symptoms such as dizziness have been observed when concentrations exceeded 1,000 ppm, but not below 500 ppm. Chronic effects have rarely been reported. The liquid is a defatting agent, and prolonged exposure may cause irritation of the skin. Aspiration may cause a chemical pneumonia.

III. SIGNS AND SYMPTOMS

Lightheadedness, nausea, headache, numbness of extremities, muscular weakness; irritation of the eyes and nose; dermatitis may occur from prolonged skin exposure. 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. Do not induce vomiting if swallowed. Give artificial resuscitation if indicated. Recovery is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

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

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 hexane exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Skin disease -- Hexane 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. Chronic respiratory disease -- In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of hexane might cause exacerbation of symptoms due to its irritant properties.
3. Liver disease -- Although hexane 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.
4. Kidney disease -- Although hexane 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.

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

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

1. American Conference of Governmental Industrial Hygienists: "Hexane," (3d ed., 2d printing), Documentation of the Threshold Limit Values for Substances in Workroom Air, Cincinnati, 1974, p. 126.
2. Hygienic Guide series: "Hexane," American Industrial Hygiene Association Journal, 20:70-71, 1959.
3. Swann, H. E., Jr., et al.: "Acute Inhalation Toxicology of Volatile Hydrocarbons," American Industrial Hygiene Association Journal, 35:511-518, 1974.
4. Inoue, T., et al.: "Polyneuritis Caused by n-Hexane and the Maximum Allowable Concentration," Presentation at XVI Congress on Occupational Health, Tokyo, Japan, Sept. 22-27, 1969.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

REFERENCES AND SOURCES

HEXANE
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- (d) Methods of Compliance - Open surface tank classification based on relative evaporation rate of 0.75 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-2-92-74, p. 16.
- (f) Personal Protective Equipment, and, (h) Sanitation
- Eye: AIHA Hyg. Guide; Charter Chemical Co. Product Bulletin; Grant, "Toxicology of the Eye"
- Skin: Patty, "Ind. Hyg. and Tox."; AIHA Hyg. Guide; and Sax, "Dangerous Properties of Ind. Materials"
- Ingestion: Sax, "Dangerous Properties of Ind. Materials" and 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 n-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."

AIHA simply says to flush eyes immediately. Charter Chemical Product Bulletin simply states that eye contamination can cause "undesirable effects."

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

Skin - Classification: 2
Output statement numbers: 2, 7b, 16i, 21

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

Exceptions: None

Patty notes in general that "the liquid paraffin hydrocarbons are fat solvents and primary skin irritants. Repeated or prolonged skin contact will dry and defat the skin, resulting in irritation dermatitis."

The AIHA Hygienic Guide agrees with the above, as does Sax who lists it as being an acute and chronic local irritant of slight to moderate hazard.

Hexane has a vapor pressure of 124 mm Hg at 20 degrees C. It has a flash point of -7 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 vapors 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.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Hexane (n-hexane)

O. O. L. STANDARD: 500 ppm

WARNING PROPERTIES:

Odor Threshold: No quantitative information is available concerning the odor threshold of hexane.

Irritation Levels: The Documentation of TLV's notes that "Drinker, Yaglou and Warren found slight nausea, headache, eye and throat irritation at 1400 to 1500 ppm. Nelson found no irritation at 500 ppm in unacclimated subjects."

Evaluation of Warning Properties: Since hexane can be detected at a concentration approximately 3 times the permissible exposure limit, hexane is treated as a material with good warning properties.

Gas sorbent respiratory equipment is permitted.

IDLH: 5000 ppm

Basis for IDLH Value: This IDLH is based upon the report in Patty that a 10-minute exposure to 5000 ppm "caused dizziness and a sensation of giddiness." Since these symptoms could impede escape, 5000 ppm is judged to be the IDLH concentration.

Other Toxicological Information: Patty states that "hexane is three times as toxic to mice as pentane. Narcosis is produced in mice at concentrations of approximately 30,000 ppm (3 per cent); convulsions and death resulted from exposures of equal duration to 35,000 to 40,000 ppm (93.5 to 4 per cent). The AIHA Hygienic Guides note that these exposures are for 1 hour. In man, 2000 ppm (0.2 per cent) hexane produced no symptoms during a 10-minute exposure, whereas 5000 ppm (0.5 per cent) caused dizziness and a sensation of giddiness."

The Hygienic Guides note that "narcosis is the most important effect of exposure" to hexane.

IDLH: 12,000 ppm

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

VAPOR PRESSURE AT 20 C: 37 mm Hg

SATURATED CONCENTRATION AT 20 C: Approximately 48,700 ppm

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

USE/EXPOSURE AND CONTROL DOCUMENT
HEXANE

Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1. Inhalation of vapor during use as an extractant of agricultural products (soybeans, cottonseed, flaxseed, safflower, corn, peanuts)	A	Process enclosure; general dilution ventilation
2. Inhalation of vapor and skin contact with liquid during manufacture of polyolifins and certain elastomers (high-density polyethylene, polypropylene, polyisoprene, ethylene-propylene rubber). Hexane is a catalyst carrier and assists in controlling molecular weight by dropping the polymer out of solution when a certain molecular weight is reached	A,B	Process enclosure; general dilution ventilation
3. Inhalation of vapor and skin contact with liquid during use as an extractant of animal fat (rendering and degreasing of meat scraps, extraction of edible meats)	A,B	Process enclosure; general dilution ventilation
4. Inhalation of vapor and skin contact with liquid during use as a solvent in adhesives to control viscosity and reduce drying time (rubber cements - extensively, shoe cement, china cement, waterproof adhesives)	A,B	General dilution ventilation to keep TLV below 500 ppm.
5. Inhalation of vapor and skin contact with liquid during use in the pharmaceutical industry (reaction medium, immiscible solvent for the isolation of products of synthesis and constituents of drugs, extractant-ergot for production of alkaloids and	A,B	Local exhaust ventilation; general dilution ventilation; enclosed process (depending on procedure)

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HEXANE

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| 6. | Inhalation of vapor during the manufacture of hexane (fractional distillation of petroleum cracking products or natural gas) | A | Process enclosure |
| 7. | Inhalation of vapor during the compounding of adhesives using hexane as a diluent or vehicle solvent | A | Local exhaust ventilation; general dilution ventilation |
| 8. | Inhalation of vapor and skin contact with liquid during cleaning and maintenance of storage drums and tanks and during accidental spills | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices, gloves goggles) |
| 9. | Inhalation of vapor and skin contact with liquid during compounding and use of printing inks, lacquers and stains | A,B | Local exhaust ventilation; general dilution ventilation |
| 10. | Inhalation of vapor and skin contact with liquid during use as a laboratory reagent (general solvent, quantitative analysis - for determining pesticides in blood and plasma, determination of refractive index of minerals) | A,B | Local exhaust ventilation; general dilution ventilation |
| 11. | Inhalation of vapor and skin contact with liquid during manufacture of low temperature thermometers (hexane replaces mercury and is colored blue or red) | A,B | Local exhaust ventilation; general dilution ventilation |

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