

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** ETHYL ETHER ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for ETHYL ETHER

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 ETHYL ETHER.

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 ethyl ether in concentrations not in excess of 400 parts per million (ppm) (1,200 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 ethyl ether.

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

(c) EXPOSURE MEASUREMENT

- (1) INITIAL DETERMINATION - Each employer who has a place of employment in which ethyl ether is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of ethyl ether 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 ethyl ether. 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 ethyl ether;
 - (ii) Any measurements of airborne concentrations of ethyl ether taken;
 - (iii) Any employee complaints of symptoms which may be attributable to exposure to ethyl ether; 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 ethyl ether 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 ethyl ether 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 ethyl ether 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 ethyl ether 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 ethyl ether 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 ethyl ether 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 ethyl ether 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 ethyl ether is present in concentrations greater than 4750 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 ethyl ether 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 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 ETHYL ETHER

Condition

Vapor Concentration

Equal to or less
than 1000 ppm cartridge(s).

Equal to or less
than 4000 ppm Any supplied-air respirator
Any self-contained breathing apparatus.

Equal to or less
than 8,000 ppm Any supplied-air respirator with a full facepiece.

Equal to or less
15,000 ppm piece.

Greater than
15,000 ppm, or
Entry & Escape
from Unknown
Concentrations Self-contained breathing apparatus with a full facepiece
air respirator with a full facepiece operated in pressure-
auxiliary self-contained air supply 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 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 ethyl ether which is contained in Appendix B in order to ensure the safe handling and use of ethyl ether.

- (1) Electrical - For the purposes of compliance with section 1910.309, locations classified as hazardous locations due to the presence of ethyl ether shall be Class I Group C.
- (2) Portable fire extinguishers - For the purposes of compliance with section 1910.157, ethyl ether 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 ethyl ether shall be Class I Group C.
- (4) Flammable liquids - For the purposes of compliance with section 1910.106, liquid ethyl ether is classified as a Class IA 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 ethyl ether is handled, used or stored.
- (6) Storage - Ethyl ether shall be stored so as not to come in contact with strong oxidizers and shall be stored away from heat and sunlight. Stored lots of ethyl ether shall be checked for the presence of explosive peroxides. Ethyl ether containing peroxides may not be distilled to dryness.
- (7) Static electricity - Precautions shall be taken to prevent the ignition of ethyl ether by static electricity. These shall include, but are not limited to:
 - (i) Grounding and bonding of all piping or tubing in which ethyl ether flows.
 - (ii) Grounding and bonding of all metal containers of ethyl ether prior to transfer.

(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 ethyl ether. Face shields shall comply with section 1910.133(a)(6).

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- (ii) Employers shall ensure that clothing wet with liquid ethyl ether is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of ethyl ether from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the ethyl ether, the employer shall inform the person performing the operation of the hazardous properties of ethyl ether.
- (iii) Employers shall ensure that clothing which becomes wet with liquid ethyl ether be removed immediately and not reworn until the ethyl ether is removed from the clothing.
- (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 ethyl ether may occur.
- (h) Spills
 - (1) Spills of ethyl ether shall be cleaned up immediately after eliminating potential sources of ignition and utilizing available ventilation.
 - (2) Liquid ethyl ether may not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.
- (i) Reserved
- (j) Training and Information - Each employer who has employees exposed to ethyl ether in excess of the action level, or employees who may have skin or eye contact with liquid ethyl ether, or employees who work where accidental release, spill, fire, or explosion of ethyl ether may occur, shall annually:
 - (1) Substance Safety Data Sheet - Inform each employee of the information contained in the Substance Safety Data Sheet for ethyl ether, which is contained in Appendix A; and
 - (2) Medical -
 - (I) Advise employees as to the signs and symptoms of exposure to ethyl ether.
 - (II) Instruct the employees to advise the employer of the development of signs and symptoms of exposure to ethyl ether 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 ethyl ether.
 - (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 liquid ethyl ether, or airborne

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concentrations of ethyl ether 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) Kidney disease
 - (III) Chronic lung disease
 - (IV) Liver 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).
 - (II) Signs and symptoms listed in Appendix A which the employee suspects may be caused by exposure to ethyl ether.
- (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 ethyl ether 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 ethyl ether.
- (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 ethyl ether;
 - (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 ethyl ether or which could significantly interfere with the ability of the employee to follow recommended or required procedures for protecting himself from unusual or emergency

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exposure.

- (B) Any recommended limitations upon the employee's exposure to ethyl ether.
- (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 ethyl ether.

- (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.

(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 ethyl ether.
- (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 ethyl ether 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.

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- (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 ethyl ether;
 - (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 ethyl ether which is conducted pursuant to this section.
 - (2) Exercise of opportunity to observe monitoring.
 - (i) When observation of the monitoring of employee exposure to ethyl ether 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 ethyl ether that are being performed at the place of exposure.
 - (c) Record the results obtained.
- (n) Employee notification.

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- (1) The employer shall notify in writing, within five work days, every employee who is found to be exposed to ethyl ether 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 IDENTIFICATION

SUBSTANCE: Ethyl ether

PERMISSIBLE EXPOSURE: 400 parts of ethyl ether per million parts of air (ppm) or 1200 milligrams of ethyl ether per cubic meter of air (mg/cu m).

APPEARANCE AND ODOR: Colorless liquid with a characteristic sweet ether odor

II. HEALTH HAZARD DATA

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

B. Effects of Overexposure:

1. Short-Term Overexposure: Overexposure to ethyl ether may cause irritation of the eyes, nose and throat. It may also cause dizziness, drowsiness, unconsciousness and death.

2. Long-Term Overexposure: Prolonged overexposure may cause loss of appetite, dizziness, drowsiness, headache, exhaustion, excitation and mental disturbances. It may also increase the severity of the effects of drinking alcoholic beverages. Repeated exposure may be habit forming.

3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms associated with ethyl ether exposure.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If ethyl ether gets into your eyes, wash the eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

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

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- C. Breathing: If you or any other person breathes in large amounts of ethyl ether 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: When ethyl ether has been swallowed get medical attention immediately. If medical attention is not immediately available get the affected person to vomit by having him touch the back of the throat with his finger or by giving him large amounts (one pint or more) of warm salt water (two tablespoons of salt per pint of water). Do not make an unconscious person vomit.
- 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 ethyl ether. You can only be required to wear them for routine use if your employer is in the process of installing controls or other 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.) If you can smell ethyl ether 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 ethyl ether.
- C. EYE PROTECTION: You must wear splash-proof safety goggles (cup-cover type dust and splash safety goggles) where eye contact to liquid ethyl ether may occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

Ethyl ether is a flammable liquid and its vapors easily form explosive mixtures with air even at low temperatures over a wide range of concentrations. It must be stored in tightly closed containers in a cool, well-ventilated area away from heat, sparks, flames and strong oxidizers. Sources of ignition such as smoking and open flames are prohibited wherever ethyl ether is handled, used, or stored. You must use non-sparking tools when opening or closing metal containers of ethyl ether, and containers must be bonded and grounded when pouring or transferring liquid ethyl ether. You must immediately remove any clothing that becomes wet with liquid ethyl ether and this clothing must not be reworn until the ethyl ether is removed from the clothing. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them. Ask your supervisor where

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ethyl ether is used in your work area and for any additional plant safety and health rules.

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APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
ETHYL ETHER

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: diethyl ether; ethyl oxide; ether; diethyl oxide; ~~ethyl ether~~ ^{solvent}
2. Formula: $C_2H_5OC_2H_5$
3. Molecular weight: 74.1

B. Physical Data

1. Boiling point (760 mm Hg): 35 C (95 F)
2. Specific gravity (water=1): 0.7
3. Vapor density (air=1 at boiling point of ethyl ether): 2.6
4. Melting point: -123 C (-190 F)
5. Vapor pressure at 20 C (68 F): 442 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 7.5
7. Evaporation rate (butyl acetate=1): 37.5
8. Appearance and odor: Colorless liquid with a characteristic sweet ether odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: -45 C (-49 F) (closed cup)
2. Autoignition temperature: 160 C (320 F)
3. Flammable limits in air, % by volume: Lower: 1.9;
Upper: 36.0
4. Extinguishing media: Dry chemical, alcohol 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: Ethyl ether is a flammable liquid. Its vapors can easily form explosive mixtures with air even at low temperatures over a wide range of air concentrations. All ignition sources must be controlled where ethyl ether is handled, used or stored. Ethyl ether 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 ethyl ether is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, ethyl ether is classified as a Class IA flammable liquid. At 4750 ppm, one-fourth of the lower flammable limit, ethyl ether 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

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500 of the National Electrical Code for ethyl ether shall be Class I Group C.

B. Reactivity

1. Conditions contributing to instability: Heat, sunlight
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 ethyl ether.
4. Special precautions: Ethyl ether will attack some forms of plastics, rubber and coatings. Ethers which have been in contact with air or exposed to light for a long time may contain peroxides. Ethers which contain peroxides may explode when the caps or stoppers of their containers are removed. Ethyl ether, being a nonconductor, may accumulate static electric charges that may result in ignition of its vapors.

III. SPILL, LEAK AND DISPOSAL PROCEDURES

- A. If ethyl ether 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 the hood ductwork, then burn the paper. Large quantities may be collected, dissolved in alcohol of greater molecular weight than butyl alcohol, and atomized in a suitable combustion chamber. Ethyl ether 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:

Ethyl ether may be disposed of by dissolving in an alcohol of greater molecular weight than butyl alcohol, and 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 8-hour exposure may be determined from a single 8-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 8-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

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

V. MISCELLANEOUS PRECAUTIONS

- A. Store ethyl ether in tightly closed containers in a cool, well-ventilated area.
- B. High exposures to ethyl ether can occur when transferring the liquid from one container to another.
- C. Non-sparking tools must be used to open and close metal ethyl ether containers. These containers must be effectively grounded and bonded prior to pouring.
- D. Stored lots of ethyl ether must be checked for the presence of explosive peroxides. Ethyl ether containing peroxides must not be distilled to dryness.
- E. Employers must advise employees of all plant areas and operations where exposure to ethyl ether could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to ethyl ether is likely to occur are: during its production; its use as an anesthetic; its use during the manufacture of pharmaceuticals, smokeless powder, alkali or sodium ethylxanthates, textiles, cellulose acetate plastics, dyes, denatured alcohol, motor fuels and perfumes; and its use as a solvent cleaning agent and a laboratory solvent and extract medium.

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APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Ethyl ether has predominantly narcotic properties leading to anesthesia; it is also an eye and respiratory irritant. Continued inhalation of 2,000 ppm in human subjects may produce dizziness. Higher concentrations produce vomiting, pallor, and irregular respiration. Temporary after effects are salivation, vomiting, respiratory tract irritation, headache, and either depression or excitation. Chronic exposure results in some persons in anorexia, exhaustion, headache, drowsiness, dizziness, excitation and psychic disturbances. Albuminuria has been reported. Tolerance may be acquired through repeated exposures. Ethyl ether is a mild skin irritant; repeated exposure causes drying and cracking. The vapor is irritating to the eye, and the undiluted liquid causes painful inflammation of a transitory nature. Human subjects found 200 ppm irritating to the nose, but not to the eyes or throat. Permanent after effects are rare.

III. SIGNS AND SYMPTOMS

Dizziness, drowsiness, headache and excitation leading to narcosis; nausea and vomiting; irritation of the eyes, upper respiratory tract and skin.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Flush eyes and skin with water. If swallowed and the person is conscious, induce vomiting. Recovery is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of ethyl ether are caused by its irritant properties. It is important that the physician becomes familiar with plant operating conditions in which exposure to ethyl ether 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 ethyl ether exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Skin disease -- Ethyl ether 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 ethyl ether 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 ethyl ether 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 ethyl ether 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: "Ethyl Ether," (3d ed., 2d printing), Documentation of the Threshold Limit Values for Substances in Workroom Air, Cincinnati, 1974, p. 106.
2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1656-1661.
3. Hygienic Guide Series: "Ethyl Ether," American Industrial Hygiene Association Journal, 27:85-87, 1966.

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APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; minor skin absorption.

II. TOXICOLOGY

Cyclopentadiene vapor is irritating to the eyes and nose and has an objectionable odor. Repeated daily exposure of rats at 500 ppm produced mild toxic effects in the liver and kidneys, whereas repeated daily exposures in several species of animals at 250 ppm for 135 times produced no manifest effects. Dogs exposed to repeated daily exposures of up to 800 ppm had no ill effects; liver function and hematologic findings remained negative. Chronic systemic effects have not been reported in humans.

III. SIGNS AND SYMPTOMS

Irritation of the eyes and nose.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Flush eyes and skin with water. Recovery is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of cyclopentadiene are caused by its irritant properties and objectionable odor. It is important that the physician becomes familiar with plant operating conditions in which exposure to cyclopentadiene 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 cyclopentadiene exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Liver disease -- Although cyclopentadiene is not known as a liver toxin in humans, the importance of this organ in the

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biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

2. Kidney disease -- Although cyclopentadiene 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.
3. Chronic respiratory disease -- In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of cyclopentadiene 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: "Cyclopentadiene," (3d ed., 2d printing), Documentation of the Threshold Limit Values for Substances in Workroom Air, Cincinnati, 1974, p. 66-67.

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REFERENCES AND SOURCES

ETHYL ETHER

1910.93

- (d) Methods of Compliance - Open surface tank classification based on relative evaporation rate of 0.25 hour.
- (e) Fire and Safety
 - (1) Electrical - Classification based on "National Electrical Code," National Fire Protection Association
- (f) Personal Protective Equipment, and (h) Sanitation
 - Eye: MCA MSDS and Union Carbide Toxicology Study
 - Skin: MCA MSDS; Union Carbide Toxicology Study; and Deichmann and Gerards "Toxicology of Drugs and Chemicals"
 - Ingestion: Union Carbide Toxicology Study; MCA MSDS

COMMENTS

Eye - Classification: 2

Output statement numbers: 10

Exceptions: None

MCA states that the liquid causes painful inflammation if it comes in direct contact with the eyes. Union Carbide states that "flooding the rabbit eye with an excess of the chemical causes a reaction no more severe than moderate inflammation." Grant report ethyl ether "tested in a standard manner on rabbit eyes has caused reversible injury, graded 2 on a scale of 1 to 10" after 24 hours. He adds that it causes "a transitory smarting sensation if splash in the eye . . . but momentary exposure generally does not cause injury." Of significance is the statement "corneal opacification from injury by ether in the course of general anesthesia has occurred rarely."

The data generally support the conclusion that ethyl ether does not cause permanent injury. It is therefore assigned a classification of 2.

Skin - Classification: 2

Output statement numbers: 2, 7b, 21

Exceptions: Statement 16i deleted because of high vapor pressure

MCA says it is a mild irritant which will cause moderate reddening of the skin for acute exposure. Prolonged contact will produce irritation. A dry, scaly dermatitis may be caused, probably because of its defatting action on the skin. Union Carbide notes that 20 ml/kg applied to four rabbits in a skin penetration test killed none. It is further noted that application to rabbit skin caused only a faint redness of short duration. Deichmann and Gerards agree with Union Carbide in regard to skin absorption.

Ethyl ether has a vapor pressure of 442 mm Hg at 20 degrees. It is 7.5% soluble in water and has a flash point of -49 degrees.

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

Ingestion - Classification: 0

Output statement numbers: None

Exceptions: None

Union Carbide gives a rat LD50 of 3.56 g/kg. MCA notes that it is of low toxicity. Given this information and the considerable vapor pressure of the substance, it is concluded that ingestion

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not be a hazard in the industrial environment.

SUBSTANCE TECHNICAL GUIDELINES
ETHYL ETHER

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: diethyl ether; ethyl oxide; ether; diethyl oxide; sulfuric ether
2. Formula: $C_2H_5OC_2H_5$
3. Molecular weight: 74.1

B. Physical Data

1. Boiling point (760 mm Hg): 35 C (95 F)
2. Specific gravity (water=1): 0.7
3. Vapor density (air=1 at boiling point of ethyl ether): 2.6
4. Melting point: -123 C (-190 F)
5. Vapor pressure at 20 C (68 F): 442 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 7.5
7. Evaporation rate (butyl acetate=1): 37.5
8. Appearance and odor: Colorless liquid with a characteristic sweet ether odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: -45 C (-49 F) (closed cup)
2. Autoignition temperature: 160 C (320 F)
3. Flammable limits in air, % by volume: Lower: 1.9; Upper: 36.0
4. Extinguishing media: Dry chemical, alcohol 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: Ethyl ether is a flammable liquid. Its vapors can easily form explosive mixtures with air even at low temperatures over a wide range of air concentrations. All ignition sources must be controlled where ethyl ether is handled, used or stored. Ethyl ether 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 ethyl ether is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, ethyl ether is classified as a Class IA flammable liquid. For example, 4800 ppm, approximately one-fourth of the lower flammable limit, is one situation in which ethyl ether 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 ethyl ether shall be Class I Group C.

B. Reactivity

1. Conditions contributing to instability: Heat, sunlight.

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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 ethyl ether.
4. Special precautions: Ethyl ether will attack some forms of plastics, rubber and coatings. Ethers which have been in contact with air or exposed to light for a long time may contain peroxides. Ethers which contain peroxides may explode when the caps or stoppers of their containers are removed. Ethyl ether, being a nonconductor, may accumulate static electric charges that may result in ignition of its vapors.

III. SPILL, LEAK AND DISPOSAL PROCEDURES

- A. If ethyl ether 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 the hood ductwork, then burn the paper. Large quantities can be collected and atomized in a suitable combustion chamber. Ethyl ether 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: Ethyl ether 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 8-hour exposure may be determined from a single 8-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 8-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 ethyl ether 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

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Industrial Hygiene Association (AIHA). The method of measurement must determine the concentration of ethyl ether to plus or minus 25%. Methods meeting these accuracy requirements are available from NIOSH.

V. MISCELLANEOUS PRECAUTIONS

- A. Store ethyl ether in tightly closed containers in a cool, well-ventilated area.
- B. High exposures to ethyl ether can occur when transferring the liquid from one container to another.
- C. Non-sparking tools must be used to open and close metal ethyl ether containers. These containers must be effectively grounded and bonded prior to pouring.
- D. Stored lots of ethyl ether must be checked for the presence of explosive peroxides. Ethyl ether containing peroxides must not be distilled to dryness.
- E. Employers should advise employees of all plant areas and operations where exposure to ethyl ether could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to ethyl ether is likely to occur are: during its production; its use as an anesthetic; its use during the manufacture of pharmaceuticals, smokeless powder, alkali or sodium ethylxanthates, textiles, cellulose acetate plastics, dyes, denatured alcohol, motor fuels and perfumes; and its use as a solvent cleaning agent and a laboratory solvent and extract medium.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Ethyl ether

D. O. E. STANDARD: 400 ppm

WARNING PROPERTIES:

Odor Threshold: Staub reports an odor threshold for ethyl ether of 0.33 ppm. Patty notes that the odor is pungent.

Eye Irritation Level: Grant states that ethyl ether "causes a transitory smarting sensation if splashed in the eye or if a high vapor concentration contacts the eye, but momentary exposure generally does not cause injury. Prolonged exposure of the cornea to high concentration of ether vapor, such as employed in general anesthesia, does cause superficial epithelial injury, from which recovery is usually prompt." Patty also reports that in high concentrations ethyl ether causes eye irritation. For the purposes of this standard, therefore, full facepiece respirators are required above 4000 ppm, a concentration which is 10 times the permissible exposure limit.

Other Information: Patty reports that "Nelson et al. reported that human subjects found ethyl ether irritating to the nose, but not to the eyes or throat, at a vapor concentration of 200 ppm."

Evaluation of Warning Properties: Through its odor and nasal irritation, ethyl ether can be detected below the permissible exposure limit. For the purposes of this standard, therefore, ethyl ether is treated as a material with good warning properties. Gas sorbent respiratory equipment is permitted.

IDLH: 19,000 ppm

Basis for IDLH Value: The chosen IDLH (19,000 ppm) is based upon the

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LFL. The available toxicological information does not indicate that exposure to this concentration for 1/2 hour would impede escape or cause irreversible health effects. According to the state of Pennsylvania's Hygienic Information Guide, "the inhalation of 3.5 percent by volume of ethyl ether in air causes loss of consciousness within 30 - 40 minutes, and concentrations above 7.5 percent are dangerous to life."

Other Toxicological Information: Patty states the "without question, the primary physiological response to ethyl ether is that of general anesthesia. Absorption through the lungs occurs quickly upon the onset of exposure and elimination by this route postexposure is also rapid Concentrations of ethyl ether anesthetic to humans range from 3.6 to 6.5 volume per cent in air. Respiratory arrest may occur from 7 to 10 volume per cent, while air concentrations over 10 per cent are usually fatal to humans. Karber reported that the lethal concentration for mice was 133.4 mg/liter, or 4.4 volume per cent, during a continuous exposure for 97 minutes. Similar results for the mouse were obtained by Molitor, who calculated the LC50 for a continuous 3-hour exposure to be 127.4 mg/liter or 4.2 volume per cent. The lethal concentrations for the rat, dog, and monkey are reported to be 6.4, 10.6, and 7.16 to 19.25 volume per cent, respectively. It would appear that the smaller animal species succumbed to a lower concentration of ethyl ether in air than do the large animal species. However, Robbins found a lethal concentration for dogs of 6.7 to 8 volume per cent. He states that differences in induction mixtures and in the duration of anesthesia lead to the differences in results for lethal concentrations. This is further illustrated by more recent work in which the concentration necessary to produce respiratory arrest in mice was found to be 18 volume per cent. Rapid induction and short duration of anesthesia were used in this experiment.

"Cases of human death in industry due to acute inhalation of ethyl ether are rare. Browning cites one such case where ethyl ether was used in perfumery manufacture. The subject developed acute mania and died in uremic convulsions. Doubtless, there are a few other such cases. Cases of narcosis are more frequent, largely due to the fact that permanent aftereffects are rare. Early symptoms of acute overexposure range from excitement to drowsiness vomiting, paleness in the face, lowering of the pulse and body temperature, and irregular respiration. Temporary aftereffects of acute exposure are vomiting, salivation, irritation of the respiratory passages, headaches, and depression or excitation. Kidney injury has been listed as a result of acute intoxication but this has been open to question."

The Documentation of TLV's states that regular exposure at the recommended limit (400 ppm) "should cause no demonstrable injury to health nor produce irritation or signs of narcosis among workers."

The Hygienic Information Guide for ethyl ether of the Pennsylvania Department of Environmental Resources, Occupational Health, states that "the inhalation of 3.5 percent by volume of ethyl ether in air causes loss of consciousness within 30 to 40

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minutes, and concentrations above 7.5 percent are dangerous to life."

LFL: 19,000 ppm

VAPOR PRESSURE AT 20 C: 442 mm Hg

SATURATED CONCENTRATION AT 20 C: Approximately 581,600 ppm

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USE/EXPOSURE AND CONTROL DOCUMENT
ETHYL ETHER

Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1. Inhalation of vapors during use as a solvent in the manufacture of smokeless powder	A	Local exhaust ventilation; general dilution ventilation
2. Inhalation of vapors and skin contact with liquid during handling and subdivision of quantities of ethyl ether	A,B	General dilution ventilation; local exhaust ventilation; personal protective equipment (gloves and goggles)
3. Inhalation of vapors and skin contact with liquid during use as a laboratory	A,B	General dilution ventilation; personal protective equipment (gloves and