

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** ETHYL BROMIDE ***

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

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 BROMIDE.

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

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

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(a) Definitions.

(1) "Permissible exposure" means inhalation of ethyl bromide in concentrations not in excess of 200 parts per million (ppm) (890 milligrams per cubic meter, mg/cu.m.) averaged over an eight-hour work shift, as stated in §§ 1910.93, Table G-1.

(2) "Action level" means one half of the permissible exposure for ethyl bromide.

(b) Exposure determination and measurement.

(1) Each employer who has a place of employment in which ethyl bromide is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of ethyl bromide 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 bromide.

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

(i) Any information, observations, or calculations which may indicate employee exposure to ethyl bromide;

(ii) Any measurements of ethyl bromide taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to ethyl bromide; and

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

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

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

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

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

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

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

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

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

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

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to ethyl bromide below the action level, the employer may terminate measurement for the employee.

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

(c) Methods of measurement.

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

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

Table 1

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

(2) Employee exposures to airborne concentration of ethyl bromide shall be controlled to at or below the permissible exposure by engineering and work practice controls:

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

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

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

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

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

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

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

(iv) In emergencies.

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

TABLE 2 RESPIRATORY PROTECTION FOR ETHYL BROMIDE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor Concentration	
2000 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
3500 ppm or less	Any self-contained breathing apparatus with a full facepiece. Any supplied-air respirator with full facepiece, helmet, or hood. A Type C supplied air respirator with half-facepiece operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 3500 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
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.

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Any escape self-contained breathing
apparatus.

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

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

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

(2) For the purpose of compliance with § 1910.309, locations classified as hazardous locations due to the presence of ethyl bromide shall be Class I, Group D.

(3) For the purpose of compliance with § 1910.157, ethyl bromide is classified as a Class B fire hazard.

(4) For the purpose of compliance with § 1910.178, locations classified as hazardous locations due to the presence of ethyl bromide shall be Class I, Group D.

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

(6) Where a fan is located in ductwork and where ethyl bromide is present in the ductwork in concentrations greater than 17000 ppm (25 % of the lower flammable limit), the fan rotating element shall be of nonsparking material or the casing shall consist of, or be lined with, nonsparking material. There shall be sufficient clearance between the fan rotating element and the fan casing so as to prevent contact.

(7) Sources of ignition such as smoking or open flames are prohibited where ethyl bromide presents a fire or explosion hazard.

(8) Ethyl bromide shall be stored so as not to come in contact with chemically active metals.

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

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

(3) Employers shall ensure that clothing which becomes wet with liquid ethyl bromide be removed immediately and not reworn until the ethyl bromide is removed from the clothing.

(4) Employers shall provide and ensure that employees use splash-proof safety goggles (cup-cover type dust and splash safety goggles) which comply with § 1910.133(a)(2)-(a)(6) where liquid ethyl bromide may contact the eyes.

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

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

(h) Sanitation. Employers shall ensure that employees whose skin becomes wet with liquid ethyl bromide promptly wash or shower using soap or mild detergent and water to remove any ethyl bromide from the skin.

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

(2) Each employer who has employees exposed to ethyl bromide above the action level or employees who may have skin or eye contact with liquid ethyl bromide, or employees who work where accidental release, spill, fire, or explosion of ethyl bromide may occur, shall annually:

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

(ii) Advise affected employees as to the signs and symptoms of exposure to ethyl bromide;

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of exposure to ethyl bromide which are listed in Appendix A of this section;

(iv) Instruct affected employees to inform the employer if they develop any of the medical conditions listed in paragraph (j)(2) of this section; and

(v) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to ethyl bromide.

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

(2) The employer shall obtain from each employee who is exposed, or will be exposed, to liquid ethyl bromide or airborne concentrations of ethyl bromide at or above the action level, without regard to the use of respirators, information as to whether such employee has a history of any of the following medical conditions:

(i) Kidney disease

(ii) Liver disease

(iii) Chronic lung disease

(iv) Skin disease

(v) Heart disease

(3) The employer shall provide a medical examination for the employee if:

(i) The employee provides a history of any of the medical conditions listed in paragraph (j)(2) of this section; or

(ii) The employee informs the employer of the development of any of the medical conditions listed in paragraph (j)(2) of this section or any of the signs or symptoms of exposure to ethyl bromide which are listed in Appendix A which the employee suspects are caused by exposure to ethyl bromide.

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

(i) A copy of this regulation with Appendices A, B and C for ethyl bromide;

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(ii) A description of the affected employee's duties as they relate to his exposure to ethyl bromide;

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

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

(v) The affected employee's anticipated exposure level; and

(vi) Upon request of the physician, any available information from previous medical examinations of the affected employee.

(5) Where a medical examination is required by paragraph (j)(3) of this section, following such examination the employer shall obtain a written opinion from the examining physician which conforms with paragraph (j)(6) of this section.

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

(B) Any recommended limitations upon the employee's exposure to ethyl bromide including limitations upon the use of protective equipment and respirators;

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

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to exposure to ethyl bromide.

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

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

(8) The employer shall provide emergency medical treatment for any employee injured through exposure to ethyl bromide.

(9) 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 risk involved by refusal to be examined.

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

(k) Recordkeeping. (1) Exposure determination.

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

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

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

(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to ethyl bromide.

(ii) This record shall include:

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(A) The date of measurement;

(B) Operations involving exposure to ethyl bromide which are being monitored;

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

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

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

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

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

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

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

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

(ii) This record shall include:

(A) Date of training;

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

(C) Content or scope of training provided.

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

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

(ii) This record shall include:

(A) Information concerning medical conditions obtained from the employee pursuant to paragraph (j)(2) of this section;

(B) Any employee medical complaints relative to exposure to ethyl bromide;

(C) A copy of information provided to the physician pursuant to paragraph (j)(4)(ii), (iii), (iv), (v), and (vi) of this section.

(D) Physician's written opinion; and

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

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

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

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

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

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

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

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

(i) Receive an explanation of the measurement procedure.

(ii) Visually observe all steps related to the measurement of the airborne concentration of ethyl bromide that are being performed at the place of exposure; and

(iii) Record the results obtained.

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

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APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR ETHYL BROMIDE

I. SUBSTANCE IDENTIFICATION

- A. Substance: Ethyl bromide
- B. Permissible Exposure: 200 parts of ethyl bromide per million parts of air (ppm) or 890 milligrams of ethyl bromide per cubic meter of air (mg/cu m) averaged over an eight-hour work shift.
- C. Appearance and Odor: Colorless to yellow liquid with an ether-like odor.

II. HEALTH HAZARD DATA

- A. Ways in Which the Chemical Affects Your Body:
Ethyl bromide can affect your body if you inhale it or if it comes in contact with your eyes or skin. It may also affect your body if you swallow it.
- B. Effects of Overexposure:
 - 1. Exposure to ethyl bromide may cause irritation of the lungs, eyes, and skin. It may cause dizziness, loss of balance and slurred speech, unconsciousness and death. Overexposure to this agent may also cause damage to the liver, kidneys and heart. After effects from severe exposure may occur up to 30 hours after the exposure has ceased.
 - 2. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect they are caused by exposure to ethyl bromide.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If ethyl bromide gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.
- B. Skin Exposure: If ethyl bromide gets on your skin, promptly flush the contaminated skin with soap or mild detergent and water. If ethyl bromide soaks through your clothing, remove the clothing immediately and flush the skin with soap or mild detergent and water. If irritation persists after washing, get medical attention.
- C. Breathing: If you or any other person breathes in large amounts of ethyl bromide, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the

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affected person warm and at rest. Get medical attention immediately.

- D. Swallowing: When ethyl bromide 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 bromide. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where there use is required. If you can smell ethyl bromide 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 ethyl bromide. Replace or repair impervious clothing that has developed leaks.
- C. Eye Protection: You must wear splash-proof safety goggles (cup-cover type dust and splash safety goggles) where eye contact to liquid ethyl bromide may occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Ethyl bromide is a flammable liquid and its vapors easily form explosive mixtures with air.
- B. Ethyl bromide must be stored in tightly closed containers in a cool, well-ventilated area away from heat, sparks, flames, and chemically active metals.
- C. Sources of ignition such as smoking and open flames are prohibited wherever ethyl bromide is handled, used or stored in a manner that could create a potential fire or explosion hazard.
- D. You must use non-sparking tools when opening or closing metal containers of ethyl bromide, and containers must be bonded and grounded when pouring or transferring liquid ethyl bromide.

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- E. If your skin becomes wet with liquid ethyl bromide, you must promptly wash or shower using soap or mild detergent and water to remove the ethyl bromide from your skin.
- F. Clothing wet with liquid ethyl bromide can be easily ignited. You must immediately remove this clothing and it must not be reworn until the ethyl bromide has evaporated 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 ethyl bromide is used in your work area and for any additional plant safety and health rules.

VI. ACCESS TO INFORMATION

- A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for ethyl bromide and to instruct you in the safe and correct use of protective equipment.
- B. Your employer is required to determine whether you are being overexposed to ethyl bromide. You or your representative has the right to observe employee exposure measurements and to be informed of the results.
- C. Your employer is required to release your exposure determination and medical records to your physician upon written request from your physician.

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APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR ETHYL BROMIDE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Bromoethane
2. Formula: C_2H_5Br
3. Molecular weight: 109

B. Physical Data

1. Boiling point (760 mm Hg): 38.4 C (100 F)
2. Specific gravity (Water=1): 1.45
3. Vapor density (air=1 at boiling point of ethyl bromide): 3.8
4. Melting point: -119 C (-182 F)
5. Vapor pressure at 20 C (68 F): 375 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.9
7. Evaporation rate (butyl acetate=1): data not available
8. Appearance and odor: Colorless to yellow liquid with an ether-like odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: less than -20 C (less than -4 F) (closed cup)
2. Autoignition temperature: 511 C (952 F)
3. Flammable limits in air, % by volume: Lower: 6.7;
Upper: 11.3
4. Extinguishing media: Foam, carbon dioxide, dry chemical
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 bromide is a flammable liquid. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where ethyl bromide is handled, used or stored. Ethyl bromide 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 bromide is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, ethyl bromide is classified as a Class IB flammable liquid. At 17,000 ppm, one-fourth of the lower flammable limit, ethyl bromide 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 bromide shall be Class I Group D.

B. Reactivity

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1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with chemically active metals such as sodium, potassium, calcium, powdered aluminum, zinc and magnesium may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving ethyl bromide. Ethyl bromide readily decomposes into hydrogen bromide and bromine particularly in the presence of hot surfaces.
4. Special precautions: Liquid ethyl bromide will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK AND DISPOSAL PROCEDURES

- A. If ethyl bromide 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 can be collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Ethyl bromide 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 bromide may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

IV. MONITORING AND MEASUREMENT PROCEDURES

- A. Exposure Above the Action Level: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Several short term interval samples (up to 30 minutes) may also be used to determine average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR Part 84, portable direct-reading instruments, dosimeters, or gas and vapor adsorption tubes with subsequent chemical analyses. The method of measurement must determine the concentration of ethyl bromide 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 bromide to plus or minus 25%.
- C. Methods meeting these accuracy requirements are available from NIOSH.

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D. Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. MISCELLANEOUS PRECAUTIONS

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

VI. COMMON OPERATIONS

Common operations in which exposure to ethyl bromide is likely to occur are: during its use as a solvent for fats, waxes and resins; as a refrigerant; as a local surface anesthetic; as a grain and fruit fumigant; as an intermediate in the synthesis of pharmaceuticals; and during its production.

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APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Ethyl bromide vapor is a respiratory irritant, a narcotic and a hepato- and renal toxin. Exposure of guinea pigs for 30 minutes to 2.4 volume percent (24,000 ppm) was fatal within 3 days due to pulmonary congestion, centrilobular necrosis of the liver, and diffuse nephritis; exposure to 3,200 ppm for 9 hours produced lung irritation and nephritis; death occurred after 1 to 5 days. The former use of ethyl bromide as a human anesthetic produced respiratory irritation and caused some fatalities, either immediately, due to respiratory or cardiac arrest, or delayed, due to effects on the liver, kidney, or heart. Relatively little experience with this substance in industry has been reported, but exposure of volunteers to 6,500 ppm for 5 minutes produced vertigo, slight headache, and mild eye irritation. Irritation of the skin occurs from repeated contact with ethyl bromide liquid.

III. SIGNS AND SYMPTOMS

Irritation of the eyes and respiratory tract; central nervous system depression; skin irritation. Pulmonary edema may occur several hours after exposure. Signs and symptoms of liver and kidney disease. May cause cardiac arrhythmias and cardiac arrest.

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. Give artificial resuscitation if indicated. If overexposed, consideration should be given to hospitalization and observation for possible delayed onset of pulmonary edema. Recovery is usually complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of ethyl bromide are caused by its narcotic and irritant properties. It is possible that extremely high concentrations may cause cardiac arrhythmias and death. It is important that the physician becomes familiar with plant operating conditions in which exposure to ethyl bromide occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with

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

1. Skin disease -- Ethyl bromide can cause dermatitis on prolonged exposure. Persons with preexisting skin disorders may be more susceptible to the effects of this agent.
2. Liver disease -- Ethyl bromide has produced liver damage in animals and man, which should be considered before exposing persons with impaired liver function.
3. Kidney disease -- Since ethyl bromide has produced kidney damage in animals and man, special consideration in those with impaired renal function is justified.
4. Chronic respiratory disease -- In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of ethyl bromide might cause exacerbation of symptoms due to its irritant properties.
5. Cardiovascular disease -- In persons with impaired cardiovascular function, especially those with a history of cardiac arrhythmias, the inhalation of ethyl bromide might cause exacerbation of disorders of the conduction mechanism due to its sensitizing effects on the myocardium.

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 Bromide," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 105.
2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1276-1277.

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3. Hygienic Guide Series: "Ethyl Bromide," American Industrial Hygiene Association Journal, 26:192-195, 1965.

4. von Oettingen, W. F.: The Halogenated Aliphatic, Olefinic, Cyclic, Aromatic, and Aliphatic-Aromatic Hydrocarbons Including the Halogenated Insecticides, Their Toxicity and Potential Dangers, U.S. Public Health Service Publication No. 414, U.S. Government Printing Office, Washington, D.C., 1955, pp. 134-138.

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REFERENCES AND SOURCES
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1910.93

- (e) Fire and Safety
(1) Electrical - Classification based on "Fire Hazard Classification of Chemical Vapors Relative to Explosion-proof Electrical Equipment," H. Carhart et al, National Academy of Sciences, 1973, report to U. S. Coast Guard, report no. CG-D-92-74, P. 31
(f) Personal Protective Equipment, and, (h) Sanitation
Eye: American Industrial Hygiene Association, Hygienic Guide Series, "Ethyl Bromide"; Dow Chemical Material Safety Data Sheet, "Ethyl Bromide"
Skin: International Labour Organization, "Encyclopedia of Occupational Health and Safety";
Dow Chemical Material Safety Data Sheet, "Ethyl Bromide"
Ingestion: American Industrial Hygiene Association, Hygienic Guide Series, "Ethyl Bromide"

COMMENTS

Eye - Classification: 2

Output statement numbers: 10

Exceptions: None

The AIHA Guide Series states that eye contact with the liquid "may be painful, but is likely to cause only minor irritation." The Dow MSDS rates the irritation as mild to moderate; exposure is painful, but no significant injury results.

Skin - Classification: 2

Output statement numbers: 2, 7b, 16d, 21

Exceptions: 20 deleted because of high volatility

ILO lists skin absorption as a route of entry; however, the Dow MSDS states that the rate of skin absorption is slow and its toxicity by this route is low.

According to Dow, short periods of skin contact cause "minimal irritation at most" while prolonged or repeated contact causes "up to marked irritation, a mild burn may result if confined to the skin." ILO states that:

"Lengthy skin contact with clothing contaminated by splashes can cause second degree burns." Its vapor pressure is about 475 mm Hg at 25 C. Its flash point is below -4 F.

Ingestion - Classification: 0

Output statement numbers: None

Exceptions: None

According to the AIHA guide, "rats fed 1200 mg/kg of ethyl bromide in oil did not show any serious ill effects although it is almost completely absorbed." The AIHA guide states that "ingestion is not a problem in industry."

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1973 (NFPA)

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Dow Chemical USA, Material Safety Data Sheet; "Dow Products and Services" (Dow)

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, Vol. 3, p. 774 (K-O)

Sources of data items used:

- I. A. 1. Synonyms: NFPA-325M
- 2. Formula: NFPA-325M
- 3. Molecular weight: ADL
- B. 1. Boiling point: Dow, NFPA-325M
- 2. Specific gravity: Dow, NFPA-325M
- 3. Vapor density: Dow, NFPA-325M
- 4. Melting point: Dow
- 5. Vapor pressure: Dow
- 6. Solubility in water: Dow
- 7. Evaporation rate: data not available
- 8. Appearance and odor: Dow
- II. A. 1. Flash point: NFPA-325M
- 2. Autoignition temperature: Dow, NFPA-325M
- 3. Flammable limits: NFPA-325M
- 4. Extinguishing media: Dow
- 5. Special fire fighting procedures: Dow
- 6. Unusual fire and explosion hazards: Dow
- B. 1. Conditions contributing to instability: ADL
- 2. Incompatibilities: Dow
- 3. Hazardous decomposition products: ADL
- 4. Special precautions: ADL
- III. A. Steps if released or spilled: ADL
- C. Waste disposal method: Dow
- V. Miscellaneous precautions: ADL
- VI. Common operations: K-O

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

- "Chemical Abstracts," American Chemical Society, 72, 109987 (1970), 71, 11837 (1969) (CA)
- "Ethyl Bromide," American Conference of Government Industrial Hygienists, Hygienic Guide Series, 1965 (Hygienic Guide)
- International Labour Organization, "Encyclopedia of Occupational Health and Safety," Geneva, 1972 (ILO)
- Jolles, Z. E., "Bromine and Its Compounds," Academic Press, Inc., 1966 (Jolles)
- Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, Division of John Wiley, 1st edition, 1954 (Chem Tech)
- Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, Division of John Wiley, 2nd edition, 1972 (K-O)
- Mellan, I., "Source Book of Industrial Solvents," Volume II, Reinhold Publishing Corporation, 1957 (Mellan)
- "Merck Index of Chemicals and Drugs," Merck and Co., Inc., Rahway, N. J., 9th edition (Merck)

References for Specific Use/Exposure

- 1. K-O, Mellan

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2. ILO, Merck
3. Chem Tech, Mellan
4. ADL estimate, ILO
5. Jolles, K-O
6. Mellan
7. CA, Jolles

Reference for Specific Control Methods

Hygienic Guide and ILO were the references used for the Specific Control Methods in numbers 1 - 7.

RESPIRATOR TABLE JUSTIFICATION

Patty reports that in an acute study on the response of guinea pigs to ethyl bromide, some deaths occurred among the animals after exposures to 140,000 ppm for 10 minutes; 50,000 ppm for 98 minutes; 24,000 ppm for 90 minutes and for 30 minutes; 12,000 ppm for 270 minutes; 6500 ppm for 270 minutes; 700 ppm for 810 minutes. Some pathological changes were observed in the animals which survived after exposures to 60,000 ppm for 10 minutes; 24,000 ppm for 30 minutes; 12,000 ppm for 270 minutes, 90 minutes and 55 minutes; 6500 ppm for 180 minutes.

The Documentation of TLV's cites an investigation in which the minimal lethal concentration for mice was determined to be 3500 ppm. Also the Documentation notes that a concentration of 3200 ppm ethyl bromide for nine hours has been shown to be fatal to guinea pigs.

The AIHA Hygienic Guides report that 6500 ppm caused vertigo, mild eye irritation, and headache in a human subject after a five-minute exposure. A 30-minute exposure to 6700 ppm caused delayed deaths in three guinea pigs. Humans, anesthetized with ethyl bromide, have been exposed to concentrations near 100,000 ppm. Deaths in humans have resulted from the use of ethyl bromide as an anesthetic.

WARNING PROPERTIES: Since the AIHA Hygienic Guides state that the odor of ethyl bromide is detectable only at concentrations well above the permissible exposure, ethyl bromide has been treated as a substance with poor warning properties. In addition, the Hygienic Guides report a situation in which only mild eye irritation was produced in a human subject after a five-minute exposure to 6500 ppm, a concentration many times greater than the permissible exposure. Information on the eye irritation threshold is not available.

EYE IRRITATION: Ethyl bromide is an eye irritant at concentrations above 6500 ppm, according to the Hygienic Guides. The Hygienic Guides report that mild eye irritation was produced in a human subject after a 5-minute exposure to 6500 ppm ethyl bromide.

IDLH: Based upon the minimal lethal concentration for mice of 3500 ppm reported in the Documentation of TLV's, an IDLH of 3500 ppm is assumed for the purposes of this standard.

LFL: The lower flammable limit of ethyl bromide is 67,000 ppm.

PERMISSIBLE EXPOSURE: 200 ppm.

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Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1. Inhalation of vapor and skin contact with liquid during use in organic synthesis as an alkylating or ethylating agent (manufacture of pharmaceuticals and also to a lesser extent for chemicals, dyes and perfumes)	A, B	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves, coveralls)
2. Inhalation of vapor and skin contact with liquid during the manufacture of ethyl bromide (reaction of potassium bromide or hydrogen bromide with ethyl alcohol in presence of sulfuric acid)	A, B	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves, coveralls)
3. Inhalation of vapor and skin contact with liquid during use as a solvent (fats, waxes, resins)	A, B	Process enclosure - if possible; local exhaust ventilation; personal protective equipment (goggles, gloves, coveralls)
4. Inhalation of vapor and skin contact with liquid during cleaning and maintenance of storage vessels and during cleanup of accidental spills	A, B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (respirator, goggles, coveralls, gloves)
5. Inhalation of vapor or mist and skin contact with liquid or mist during use as a local surface anesthetic (spray for minor surgery and neuralgic pain)	A, B	General dilution ventilation
6. Inhalation of vapor during use as a refrigerant	A	Process enclosure; general dilution ventilation
7. Inhalation of vapor and skin contact with liquid during use as a liquid fumigant (grain and fruit)	A, B	General dilution ventilation; personal protective equipment (respiratory protective devices, pro-

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protective clothing)

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

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

1,184 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME