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NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** TRIBUTYL PHOSPHATE ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for TRIBUTYL PHOSPHATE

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 TRIBUTYL PHOSPHATE.

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

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

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(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of tributyl phosphate not in excess of 5 milligrams per cubic meter (mg/M3) averaged over an eight-hour work shift (time weighted average), as stated in § 1910.1000, Table Z-1.

(2) "Action level" means one half of the permissible exposure for tributyl phosphate.

(b) Exposure determination and measurement. (1) Each employer who has a place of employment in which tributyl phosphate is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of tributyl phosphate 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 tributyl phosphate.

(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 tributyl phosphate;

(ii) Any measurements of tributyl phosphate taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to tributyl phosphate; 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 tributyl phosphate 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 tributyl phosphate 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 tributyl phosphate 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 tributyl phosphate 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 tributyl phosphate 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 tributyl phosphate 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 percent, of not less than that given in Table 1.

Table 1

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

(d) Compliance. (1) No employee shall be exposed to tributyl phosphate above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of tributyl phosphate 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. (i) 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 tributyl phosphate.

(ii) In the design of open surface tank ventilation for the purposes of § 1910.94(d), operations involving tributyl phosphate shall be classified as C-4 at 70 degrees F (21 degrees C).

(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

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- (ii) In work situations in which engineering and work practice controls are technically not feasible; or
 - (iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of tributyl phosphate to at or below the permissible exposure; or
 - (iv) For operations which require entry into tanks or closed vessels; or
 - (v) In emergencies.
- (5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

TABLE 2 RESPIRATORY PROTECTION FOR TRIBUTYL PHOSPHATE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Particulate or Vapor Concentration	
50 mg/M3 or less	Any supplied-air respirator. ----- Any self-contained breathing apparatus.
250 mg/M3 or less	A gas mask with a chin style or front- or back-mounted organic vapor cartridge and dust and mist filter. ----- Any supplied-air respirator with a full facepiece, helmet, or hood. ----- Any self-contained breathing apparatus with a full facepiece.
1300 mg/M3 or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 1300 mg/M3 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 and particulates.

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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 tributyl phosphate.

(2) For the purpose of compliance with § 1910.157, tributyl phosphate is classified as a Class B fire hazard.

(3) Spray finishing operations shall be performed in accordance with §§ 1910.107 and 1910.94(c).

(4) Dip tank operations shall be performed in accordance with §§ 1910.108 and 1910.94(d).

(5) Sources of ignition such as smoking or open flames are prohibited where tributyl phosphate presents a fire or explosion hazard.

(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 tributyl phosphate. 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 tributyl phosphate is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of tributyl phosphate from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the tributyl phosphate, the employer shall inform the person performing the operation of the hazardous properties of tributyl phosphate.

(3) Employers shall ensure that non-impervious clothing which becomes wet with liquid tributyl phosphate be removed promptly and not re worn until the tributyl phosphate 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 tributyl phosphate may contact the eyes.

(g) Spills and disposal. In the event that liquid tributyl phosphate is spilled the employer shall immediately provide available ventilation and then clean up the spill.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes wet with liquid tributyl phosphate promptly wash or shower with soap or mild detergent and water to remove any tributyl phosphate from the skin.

(2) Employers shall ensure that employees who handle liquid tributyl phosphate wash their hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.

(i) Training and information. (1) Each employer who has a workplace in which tributyl phosphate is present shall keep a copy of this regulation

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with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to tributyl phosphate above the action level or employees who may have skin or eye contact with liquid tributyl phosphate, or employees who work where a spill of tributyl phosphate may occur, shall annually:

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

(ii) Advise affected employees as to the signs and symptoms of exposure to tributyl phosphate.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of exposure to tributyl phosphate which are listed in Appendix A of the 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 tributyl phosphate.

(j) Medical surveillance. (i) 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 tributyl phosphate or airborne concentrations of tributyl phosphate at or above the action level information as to whether such employee has a history of any of the following medical conditions:

(i) Chronic lung disease

(ii) Skin 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 tributyl phosphate which are listed in Appendix A which the employee suspects are caused by exposure to tributyl phosphate.

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

(i) A copy of this regulation with Appendixes A, B and C for tributyl phosphate;

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

(iii) A description of any personal protective equipment and 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; and

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

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(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 tributyl phosphate or would directly or indirectly aggravate any detected medical condition;

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

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

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

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

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

(8) The employer shall provide emergency and follow-up medical examinations and treatment for any employee injured through exposure to tributyl phosphate.

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

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

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

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to tributyl phosphate which are being monitored;

(C) Sampling and analytical method used and evidence of their accuracy;

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

(E) Name and exposure of the employee monitored.

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(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 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) The name of the employee;
- (B) Information concerning medical conditions obtained from the employee pursuant to paragraph (j)(2) of this section;
- (C) Any employee medical complaints relative to exposure to tributyl phosphate;

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

(E) Physician's written opinion; and

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

(iii) This record shall be maintained for the duration of and for one year after termination 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) Each employee or former employee shall have access to the exposure determination and exposure measurement records required to be maintained by this section which indicate his own exposure to tributyl phosphate.

(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 each employee or his representative an opportunity to observe any measurement of his exposure to tributyl phosphate which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to tributyl phosphate requires entry into an area where the use of personal protective

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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 tributyl phosphate that are being performed at the place of exposure; and
- (iii) Record the results obtained.

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

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR TRIBUTYL PHOSPHATE

- I. SUBSTANCE IDENTIFICATION
- A. Substance: Tributyl phosphate
 - B. Permissible Exposure: 5 milligrams of tributyl phosphate per cubic meter of air (mg/M3) averaged over an eight-hour work shift.
 - C. Appearance and Odor: Colorless to pale yellow, odorless liquid
- II. HEALTH HAZARD DATA
- A. Ways in which the chemical affects your body: Tributyl phosphate 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. Short-term Exposure: Tributyl phosphate may cause irritation of the eyes, nose, and throat. It may also cause nausea and headache.
 2. Long-term Exposure: None known.
 3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to tributyl phosphate.
- III. EMERGENCY FIRST AID PROCEDURES
- A. Eye Exposure: If liquid tributyl phosphate gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation

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- persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.
- B. Skin Exposure: If liquid tributyl phosphate gets on your skin, promptly wash the skin using soap or mild detergent and water. If liquid tributyl phosphate soaks through your clothing, remove the clothing promptly and wash the skin using 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 tributyl phosphate move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.
 - D. Swallowing: When liquid tributyl phosphate has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
 - E. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to tributyl phosphate. 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 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 tributyl phosphate. Replace or repair impervious clothing that has developed leaks.
- C. Eye Protection: You must wear splash-proof safety goggles where liquid tributyl phosphate may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Tributyl phosphate is a combustible liquid and its vapors can form explosive mixtures with air at elevated temperatures.
- B. Tributyl phosphate must be stored in tightly closed containers in a cool, well ventilated area.

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- C. Sources of ignition such as smoking and open flames are prohibited wherever tributyl phosphate is handled, used or stored in a manner that could create a potential fire or explosion hazard.
- D. You must promptly remove any non-impervious clothing that becomes wet with liquid tributyl phosphate and this clothing must not be reworn until the tributyl phosphate is removed from the clothing.
- E. If your skin becomes wet with liquid tributyl phosphate, you must promptly wash or shower with soap or mild detergent and water to remove the tributyl phosphate from your skin.
- F. If you handle liquid tributyl phosphate, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.
- 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 tributyl phosphate is used in your work area and for any additional 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 tributyl phosphate. In addition, your employer must instruct you in the safe use of tributyl phosphate, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to tributyl phosphate. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of one year following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.
- D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES

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FOR TRIBUTYL PHOSPHATE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Tri-n-butyl phosphate; TBP
2. Formula: $(C_4H_9O)_3PO$
3. Molecular weight: 266

B. Physical Data

1. Boiling point (760 mm Hg): 293 C (560 F)
2. Specific gravity (water = 1): 0.97
3. Vapor density (air = 1 at boiling point of tributyl phosphate): Not applicable
4. Melting point: Less than -80 C (-112 F)
5. Vapor pressure at 20 C (68 F): Very low
6. Solubility in water, % by weight at 20 C (68 F): 0.1
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless to pale yellow, odorless liquid

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: 166 C (330 F) (closed cup)
2. Autoignition temperature: Higher than 482 C (900 F)
3. Flammable limits in air, % by volume: Data not available
4. Extinguishing media: Carbon dioxide, dry chemical, foam
5. Special fire-fighting procedures: Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.
6. Unusual fire and explosion hazards: Tributyl phosphate is a combustible liquid. At elevated temperatures its vapors can form explosive mixtures with air. All ignition sources must be controlled where tributyl phosphate is used, handled or stored in a manner that could create a potential fire or explosion hazard.
7. For purposes of complying with the requirements of 29 CFR 1910.106, tributyl phosphate is classified as a Class IIIB combustible liquid.

B. Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: None.
3. Hazardous decomposition products: Toxic gases and vapors (such as phosphoric acid fume and carbon monoxide) may be released in a fire involving tributyl phosphate.
4. Special precautions: Liquid tributyl phosphate will attack some forms of plastic, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If liquid tributyl phosphate is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. For small quantities, absorb on paper towels. Remove to a safe place (such as a fume hood) and burn the paper. Large quantities can be collected and atomized in a

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suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

- B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.
- C. Waste disposal methods: Liquid tributyl phosphate may be disposed of:
 - 1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.
 - 2. 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 eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Several short time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or by collection of the particulates using a high efficiency membrane filter with subsequent chemical analyses. The method of measurement must determine the concentration of tributyl phosphate to plus or minus 35%.
- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. A. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of tributyl phosphate to plus or minus 25%.
- C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under the title "NIOSH Analytical Methods for Set P" (Order number XXXXXXXXXXXX).
- D. QUALIFIED PERSONS: Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. MISCELLANEOUS PRECAUTIONS

- A. Store tributyl phosphate in tightly closed containers in a cool, well ventilated area.
- B. Employers should advise employees of all areas and operations where exposure to tributyl phosphate could occur.

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VI. COMMON OPERATIONS

Common operations in which exposure to tributyl phosphate is likely to occur are: During its production; during its use as a plasticizer and solvent for resins and rubbers; as an anti-foaming agent in paints; as a solvent for inks; as an extraction solvent for certain metals such as uranium; and during its handling related to use as a heat-exchange medium.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Tributyl phosphate vapor is a pulmonary irritant and in animals causes a moderate excitation of the nervous system. In rats, the oral LD50 is 3 g/kg; the effects are muscle twitching, weakness, dyspnea, and pulmonary edema. In vitro, tributyl phosphate causes weak inhibition of cholinesterases in human erythrocytes and plasma. Workers exposed to unspecified concentrations of vapor complained of headache and nausea; hot vapor was severely irritating to the eyes and throat. The liquid dropped on the eye of a rabbit caused temporary epithelial injury and discomfort. The liquid may be irritating to the skin.

III. SIGNS AND SYMPTOMS

Eye, respiratory, and skin irritation; headache, nausea; by analogy to effects caused in animals it may cause muscle twitching, weakness, dyspnea, and pulmonary edema.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Promptly flush eyes with water and wash skin with soap or mild detergent and water. If swallowed and the person is conscious, induce vomiting. Give artificial resuscitation and administer oxygen if indicated. Consideration should be given to hospitalization and observation for the possible delayed onset of pulmonary edema.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Tributyl phosphate is a pulmonary irritant and has caused excitation of the nervous system in animals. Hot vapor is an irritant of the eyes and throat. It is important that the physician become familiar

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with plant operating conditions in which exposure to tributyl phosphate 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 examinations 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 tributyl phosphate exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Chronic respiratory disease -- Tributyl phosphate causes respiratory irritation. In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of tributyl phosphate might cause exacerbation of symptoms due to its irritant properties.
2. Skin disease -- Tributyl phosphate is a primary skin irritant. Persons with preexisting skin disorders may be more susceptible to the effects of this agent.

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.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Tributyl Phosphate," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 262.

2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1851, 1853, 1914-1917, 1920, 1924-1925.

3. Sabine, J.C. and F.N. Hayes: "Anticholinesterase Activity of Tributyl Phosphate," A.M.A. Archives Of Industrial Hygiene and Occupational Medicine, 6:174-177, 1952.

4. Grant, W. Morton: Toxicology of the Eye (2d ed.), Charles C. Thomas, Springfield, Illinois, 1974, p. 1032.

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REFERENCES AND SOURCES
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1910.1000

- (d) Compliance - Open surface tank classification based on boiling point and guidelines in ANSI Z9.1.
- (f) Personal Protective Equipment, and, (h) Sanitation
- Eye: Grant, "Toxicology of the Eye;" Patty, "Industrial Hygiene and Toxicology"
- Skin: Patty, "Industrial Hygiene and Toxicology;" Sax, "Dangerous Properties of Industrial Materials"
- Ingestion: Patty, "Industrial Hygiene and Toxicology;" Sax, "Dangerous Properties of Industrial Materials;" Stecher, "The Merck Index," eighth edition

COMMENTS

Eye - Classification: 2

Output statement numbers: 10

Exceptions: None

Grant reports that the application of a drop of tributyl phosphate on the eye of a rabbit has "an effect similar to ethyl alcohol, causing temporary epithelial injury and pain, a reaction graded 3 on a scale of 1 to 10 after twenty-four hours, but no permanent injury."

Patty mentions that if the compound were used in boiling water, the vapors produced may be irritating to the eyes.

A classification of 2 is concluded to be appropriate.

Skin - Classification: 2

Output statement numbers: 2, 7b, 16g, 16i, 20a

Exceptions: None

Patty considers tributyl phosphate to be a strong skin irritant and implies that it is readily absorbed through the skin in the statement "some phosphate esters are readily absorbed through the skin (triorthocresyl phosphate) without any evident local irritant effects, while others are quite irritating (tributyl phosphate)." Effects of the compound are noted in general as being "a definite central nervous system excitatory action which does not usually progress to a state of convulsions. Muscle twitching, weakness, and terminal pulmonary edema are present."

Sax rates this compound as being of moderate toxic hazard as an acute local irritant.

Tributyl phosphate has a very low vapor pressure. It is 0.1% soluble in water and has a flash point of 330 degrees F.

The information found for this substance does not precisely define the rapidity of skin absorption, if any, or the duration or extent of skin contact necessary to produce significant local or systemic effects. Based on the statement that it is "quite irritating" a classification of 2 is assigned.

Ingestion - Classification: 2

Output statement numbers: 20a

Exceptions: None

Patty reports an oral LD50 of 3 g/kg for rats and states that large oral doses, "cause weakness, dyspnea, pulmonary

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edema, and twitching" in rats. Tributyl phosphate is reported by Patty and also the Merck Index as causing "convulsive or central nervous system stimulation."

Sax rates the acute systemic effects of ingestion to be of moderate toxic hazard.

Its systemic and local effects, together with its low vapor pressure, indicate that a classification of 2 is appropriate.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

- National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1975 (NFPA)
- Stauffer Chemical Co., Product Safety Information, Phosphlex - 4 (Stauffer)
- FMC Corporation, Technical Data, Kronitex TBP, and Material Safety Data Sheet (FMC)

Sources of data items used:

- I. A. 1. Synonyms: ADL
- 2. Formula: FMC
- 3. Molecular weight: FMC
- B. 1. Boiling point: NFPA-325M
- 2. Specific gravity: CRC Handbook of Chemistry and Physics
- 3. Vapor density: Not applicable
- 4. Melting point: FMC
- 5. Vapor pressure: FMC
- 6. Solubility in water: FMC
- 7. Evaporation rate: Not applicable
- 8. Appearance and odor: FMC
- II. A. 1. Flash point: FMC (Factory Mutual reports 295 F open cup)
- 2. Autoignition temperature: Stauffer
- 3. Flammable limits: Not applicable
- 4. Extinguishing media: FMC, Stauffer
- 5. Special fire fighting procedures: FMC, ADL
- 6. Unusual fire and explosion hazards: NFPA-325M, Stauffer
- B. 1. Conditions contributing to instability: ADL
- 2. Incompatibilities: None
- 3. Hazardous decomposition products: FMC
- 4. Special precautions: ADL
- III. A Steps if released or spilled: FMC, Stauffer
- C. Waste disposal method: FMC, ADL
- V. Miscellaneous precautions: ADL

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

- Ellis, C., "Printing Inks," Reinhold, New York, 1940 (Ellis)
- Hawley, G., "The Condensed Chemical Dictionary," 8th edition, Van Nostrand Reinhold, 1971 (Hawley)
- Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, Division of John Wiley, 2nd edition, 1972 (K-O)
- Lefaux, R., "Practical Toxicology of Plastics," The Chemical Rubber Company, Cleveland, 1968 (Lefaux)
- McGuire, E. P., "Adhesive Raw Materials Handbook," Padric Publishing,

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1964 (McGuire)

"Phosflex 4," Product Safety Information, Stauffer Chemical Company,
Westport, Connecticut (Stauffer)

Sabine, J. C. and Hayes, F. M., "Anticholinesterase Acitivity of Tributyl
Phosphate," Archives of Industrial Hygiene and Occupational Medicine,
6:174 - 177, 1952 (Sabine)

Stanford Research Institute, "Chemical Economics Handbook," Menlo Park,
California (SRI)

"Tributyl Phosphate," Manufacturer's Safety Data Sheet, FMC Corporation,
Nitro, West Virginia (FMC)

References for Specific Use/Exposure

1. McGuire, K-O, Ellis, Lefaux
2. ADL estimate
3. K-O, Hawley
4. SRI, Hawley

References for Specific Control Methods

Sabine, FMC and Stauffer were the references used in all of the
Specific Control Methods.

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RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Tributyl phosphate

D. O. L. STANDARD: 5 mg/M3

WARNING PROPERTIES:

Odor Threshold: There is no quantitative information available concerning the odor threshold of tributyl phosphate.

Eye Irritation Level: Grant states that tributyl phosphate, "tested on rabbit eyes by application of a drop, . . . had an effect similar to ethyl alcohol, causing temporary epithelial injury and pain, a reaction graded 3 on a scale of 1 to 10 after twenty-four hours, but no permanent injury." According to the Hygienic Guides, some eye irritation occurs at vapor concentrations of ethyl alcohol which are greater than 5500 ppm. For the purposes of this standard, therefore, since tributyl phosphate and ethyl alcohol in liquid form produce similar effects on the eye, allowing half-facepiece respirators up to the IDLH concentration for tributyl phosphate seems reasonable.

Evaluation of Warning Properties: Since there is no quantitative information available relating the warning properties of tributyl phosphate with air concentrations, this substance is treated as a substance with poor warning properties. Gas sorbent respiratory equipment is not allowed.

IDLH: 1300 mg/M3

Basis for IDLH: This IDLH is based upon the only available acute inhalation toxicity data concerning the physiological effects of exposure to tributyl phosphate. Patty states that no rats out of 3 succumbed to a 6-hour exposure at a concentration of 123 ppm (1337 mg/M3). No other quantitative information is available upon which to base the IDLH.

Other Toxicological Information: Concerning tributyl (and triisobutyl) phosphates, Patty states that "these materials possess a definite central nervous system excitatory action, which does not usually progress to a state of convulsions. Muscle twitching, weakness, and terminal pulmonary edema are present. They are respiratory irritants. Although their vapor pressures are low, if they are used in boiling water, the steam produced may be quite irritating to the eyes and throat. Heated vapor from the hot concentrated material also may be irritating. . . Tributyl phosphate shows weak in vitro inhibition of human red-blood-cell and plasma cholinesterase."

The Documentation of TLV's notes that "workers exposed to it (tributyl phosphate) have complained of nausea and headache. There is little information on tributyl phosphate. The majority of the phosphate esters which are used industrially are liquids with very high boiling points. Few of them have received intensive toxicologic investigation . . . It is difficult to assign a TLV for tributyl phosphate in the absence of more data. A limit of 5 mg/M3 should be sufficient to prevent complaints of nausea and headache associated with its use."

Patty, in a table summarizing the physiological responses to phosphate esters, states that tributyl phosphate is a "strong skin and respiratory irritant." Inhalation of 123 ppm (1337 mg/M3), however, for 6 hours caused no deaths in 3 exposed rats.

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VAPOR PRESSURE AT 20 C: Very low

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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 as an antifoaming agent or plasticizer in manufacture of surface coatings and adhesives (including latex exterior paints, pigment coatings for paper, inks, lacquers and synthetic enamel finishes, and during milling of pigments)	A, B	General dilution ventilation; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves)
2. Inhalation of vapor and skin contact with liquid during synthesis and handling of substance	A, B	General dilution ventilation; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves)
3. Inhalation of vapor and skin contact with liquid during use as a solvent in extraction of metals (including uranium, thorium, and the rare earths in atomic energy processing)	A, B	General dilution ventilation; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves)
4. Inhalation of vapor and skin contact with liquid during handling related to use as a heat-exchange medium (including in aircraft engines)	A, B	General dilution ventilation; local exhaust ventilation; personal protective equipment (respiratory protective devices, gloves)

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

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

1,131 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

