

Occupational Health Guideline for Tributyl Phosphate

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $(C_4H_9O)_3PO$
- Synonyms: Tri-n-butyl phosphate; TBP
- Appearance and odor: Colorless to pale yellow, odorless liquid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for tributyl phosphate is 5 milligrams of tributyl phosphate per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. The American Conference of Governmental Industrial Hygienists has issued a Notice of Intended Changes of its recommended Threshold Limit Value for tributyl phosphate from $5 mg/m^3$ to $2.5 mg/m^3$.

HEALTH HAZARD INFORMATION

• Routes of exposure

Tributyl phosphate can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

• 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:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to tributyl phosphate.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to tributyl phosphate at potentially hazardous levels:

1. *Initial Medical Screening:* Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from tributyl phosphate exposure.

—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.

—Skin disease: Tributyl phosphate is a primary skin irritant. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

2. *Periodic Medical Examination:* Any employee developing the above-listed conditions should be referred for further medical examination.

• Summary of 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.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 266
2. Boiling point (760 mm Hg): 293 C (560 F)
3. Specific gravity (water = 1): 0.97
4. Vapor density (air = 1 at boiling point of tributyl phosphate): Not applicable

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

5. Melting point: Less than -80 C (-112 F)
6. Vapor pressure at 20 C (68 F): Very low
7. Solubility in water, g/100 g water at 20 C (68 F):

0.1

8. Evaporation rate (butyl acetate = 1): Not applicable

- **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 plastics, rubber, and coatings.

- **Flammability**

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. Extinguishant: Carbon dioxide, dry chemical, foam

- **Warning properties**

1. Odor Threshold: No quantitative information is available concerning the odor threshold of tributyl phosphate.

2. 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 24 hours, but no permanent injury." According to the *Hygienic Guide*, some eye irritation occurs at vapor concentrations of ethyl alcohol which are greater than 5500 ppm. Tributyl phosphate and ethyl alcohol in liquid form produce similar effects on the eye.

3. Evaluation of Warning Properties: Since no quantitative information is available relating the warning properties of tributyl phosphate to air concentrations, this substance is treated as having poor warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on 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).

- **Method**

Sampling and analyses may be performed by collection of tributyl phosphate on a filter, followed by extraction with ether, and gas chromatographic analysis. An analytical method for tributyl phosphate is in the *NIOSH*

Manual of Analytical Methods, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to 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.
- Clothing wet with liquid tributyl phosphate should be placed in closed containers for storage until it can be discarded or until provision is made 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 person performing the operation should be informed of tributyl phosphate's hazardous properties.
- Non-impervious clothing which becomes wet with liquid tributyl phosphate should be removed promptly and not reworn until the tributyl phosphate is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid tributyl phosphate may contact the eyes.

SANITATION

- Skin that becomes wet with liquid tributyl phosphate should be promptly washed or showered with soap or mild detergent and water to remove any tributyl phosphate.
- Employees who handle liquid tributyl phosphate should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to tributyl phosphate may occur and control methods which may be effective in each case:

Operation	Controls
Use as an antifoaming agent or plasticizer in manufacture of surface coatings and adhesives for latex exterior paints, pigment coatings for paper, inks, lacquers, and synthetic enamel finishes, and during milling pigments	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use as a solvent in extraction of metals, including uranium, thorium, and rare earths in atomic energy processing	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use as a heat-exchange medium in aircraft engines	General dilution ventilation; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

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

• Skin Exposure

If liquid tributyl phosphate gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If liquid tributyl phosphate soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing

If a 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.

• Swallowing

When liquid tributyl phosphate has been swallowed and the person is conscious, 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.

• Rescue

Move the 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. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• 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. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

• 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.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Tributyl Phosphate," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
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RESPIRATORY PROTECTION FOR TRIBUTYL PHOSPHATE

Condition	Minimum Respiratory Protection* Required Above 5 mg/m ³
Particulate or Vapor Concentration	
50 mg/m ³ or less	Any supplied-air respirator. Any self-contained breathing apparatus.
250 mg/m ³ or less	A gas mask with a chin-style or a 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/m ³ or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 1300 mg/m ³ 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. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.