

# Occupational Health Guideline for Phosphorus Pentachloride

## 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:  $\text{PCl}_5$
- Synonyms: None
- Appearance and odor: Pale yellow solid with an odor like hydrochloric acid.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for phosphorus pentachloride is 1 milligram of phosphorus pentachloride per cubic meter of air ( $\text{mg}/\text{m}^3$ ) averaged over an eight-hour work shift.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Phosphorus pentachloride 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

Exposure to phosphorus pentachloride may cause irritation of the eyes and respiratory tract. Cases of bronchitis have resulted from exposure to this chemical. Severe breathing difficulties may occur. These breathing difficulties may be delayed in onset several hours after exposure has ceased. Phosphorus pentachloride on the skin may cause burning and irritation of the skin.

### • 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 phosphorus pentachloride.

### • Recommended medical surveillance

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

#### 1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory system, skin, and eyes should be stressed.

—14" x 17" chest roentgenogram: Phosphorus pentachloride causes lung damage in animals. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Phosphorus pentachloride is a respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is necessary only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

#### • Summary of toxicology

Phosphorus pentachloride fume is a severe irritant of the eyes and mucous membranes. Exposure of mice to 120 ppm for 10 minutes was fatal. In humans, the fume causes irritation of the eyes and respiratory tract, and cases of bronchitis have resulted from exposure; although not reported, delayed onset of pulmonary edema may occur. The material on the skin could be expected to cause dermatitis.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 208.3
2. Boiling point (760 mm Hg): 167 C (333 F) (sublimes)
3. Specific gravity (water = 1): 1.6
4. Vapor density (air = 1 at boiling point of phosphorus pentachloride): 4.7

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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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phorus pentachloride): Not applicable (reacts rapidly with water in air)

5. Melting point: 167 C (333F) (sublimes)

6. Vapor pressure at 20 C (68 F): Less than 1

7. Solubility in water, g/100 g water at 20 C (68 F): Reacts to form hydrogen chloride and phosphoric acid

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

#### • Reactivity

1. Conditions contributing to instability: High temperatures may cause containers to burst. Exposure to moisture will cause the development of pressure in closed containers.

2. Incompatibilities: Contact with water will cause violent spattering and formation of toxic hydrogen chloride gas and phosphoric acid mist. Phosphorus pentachloride reacts with magnesium oxide, chemically active metals such as sodium and potassium, and with alkalis.

3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosphoric acid mist, and carbon monoxide) may be released in a fire involving phosphorus pentachloride.

4. Special precautions: Phosphorus pentachloride will attack some forms of plastics, rubber, and coatings.

#### • Flammability

1. Not combustible

#### • Warning properties

1. Odor Threshold: Patty states that phosphorus pentachloride "has a pungent, unpleasant odor." No quantitative information is available concerning the odor threshold, however.

2. Irritation Levels: Patty states that the "vapor or fume is very irritant to all mucous membranes, including the lungs." No quantitative information is available concerning the threshold of eye irritation, however.

3. Evaluation of Warning Properties: Since no quantitative information is available relating its warning properties to air concentrations, this substance is treated as a material with 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

An analytical method for phosphorus pentachloride is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 5, 1979, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00349-1).

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## 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 any possibility of skin contact with phosphorus pentachloride or liquids containing phosphorus pentachloride.

• If employees' clothing may have become contaminated with solid phosphorus pentachloride, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with phosphorus pentachloride should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of phosphorus pentachloride from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the phosphorus pentachloride, the person performing the operation should be informed of phosphorus pentachloride's hazardous properties.

• Where there is any possibility of exposure of an employee's body to phosphorus pentachloride or liquids containing phosphorus pentachloride, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Non-impervious clothing which becomes contaminated with phosphorus pentachloride should be removed immediately and not reworn until the phosphorus pentachloride is removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of phosphorus pentachloride or liquids containing phosphorus pentachloride contacting the eyes.

• Where there is any possibility that employees' eyes may be exposed to phosphorus pentachloride or liquids

containing phosphorus pentachloride, an eye-wash fountain should be provided within the immediate work area for emergency use.

## SANITATION

- Skin that becomes contaminated with phosphorus pentachloride should be immediately washed or showered to remove any phosphorus pentachloride.
- Eating and smoking should not be permitted in areas where solid phosphorus pentachloride is handled, processed, or stored.
- Employees who handle phosphorus pentachloride or liquids containing phosphorus pentachloride should wash their hands thoroughly before eating, smoking, or using toilet facilities.

## COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use as a chlorinating agent in organic synthesis or chemical reactant for aryl or alkyl acids and salts, ketones, aldehydes, and synthesis of phosphorus compounds	Local exhaust ventilation; personal protective equipment
Use as a catalyst in organic synthesis in production of polyethylene from ethylene	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 phosphorus pentachloride or liquids containing phosphorus pentachloride get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

### • Skin Exposure

If phosphorus pentachloride or liquids containing phosphorus pentachloride get on the skin, immediately flush the contaminated skin with water. If phosphorus pentachloride or liquids containing phosphorus pentachloride penetrate through the clothing, remove the clothing immediately and flush the skin with water. Get medical attention.

### • Breathing

If a person breathes in large amounts of phosphorus pentachloride, 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

If phosphorus pentachloride or liquids containing phosphorus pentachloride have been swallowed and the person is conscious, give him large quantities of water immediately to dilute the phosphorus pentachloride. Do not attempt to make the exposed 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 AND DISPOSAL PROCEDURES

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

- If phosphorus pentachloride is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill, or
3. Cover with sodium bicarbonate or an equal mixture of soda ash and slaked lime, dilute carefully with small spray of water, then excess water, and dispose in a secured sanitary landfill.

- Waste disposal method:

See 2 and 3 above.

## REFERENCES

- American Conference of Governmental Industrial Hygienists: "Phosphorus Pentachloride," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- Henderson, Y., and Haggard, H. W.: *Noxious Gases*, Reinhold, New York, 1927.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.
- Sax, N. I.: *Dangerous Properties of Industrial Materials* (3rd ed.), Van Nostrand Reinhold, New York, 1968.
- Stecher, P. G. (ed.): *The Merck Index* (8th ed.), Merck Co., Inc., Rahway, New Jersey, 1968.

## RESPIRATORY PROTECTION FOR PHOSPHORUS PENTACHLORIDE

Condition	Minimum Respiratory Protection* Required Above 1 mg/m <sup>3</sup>
Particulate or Vapor Concentration	
10 mg/m <sup>3</sup> or less	Any supplied-air respirator. Any self-contained breathing apparatus.
50 mg/m <sup>3</sup> or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
200 mg/m <sup>3</sup> or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 200 mg/m <sup>3</sup> 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/or gases and particulates. Any escape self-contained breathing apparatus.

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