

Occupational Health Guideline for Phosphorus Pentasulfide

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: P_2S_5 or P_4S_{10}
- Synonyms: Phosphorus persulfide; regular phosphorus pentasulfide; reactive phosphorus pentasulfide; distilled phosphorus pentasulfide; undistilled phosphorus pentasulfide
- Appearance and odor: Greenish-yellow solid with the odor of rotten eggs.

PERMISSIBLE EXPOSURE LIMIT (PEL)

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

HEALTH HAZARD INFORMATION

• Routes of exposure

Phosphorus pentasulfide 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: Phosphorus pentasulfide on contact with water (including the water normally found in air) may produce hydrogen sulfide. This is a primary health hazard associated with phosphorus pentasulfide. Hydrogen sulfide is a very dangerous chemical. It smells like rotten eggs, but at high concentrations paralyzes the sense of smell so that the odor will not be noticed. Hydrogen sulfide acts as an irritant to the eyes and respiratory tract and can produce severe breathing

difficulties which may not occur until a number of hours after exposure has ceased. High concentrations of hydrogen sulfide can stop breathing immediately and cause death. Phosphorus pentasulfide, if allowed to remain on the skin, may cause irritation. On contact with the eyes, it may cause serious irritation which may be delayed for a matter of hours.

2. Long-term Exposure: Repeated exposure to hydrogen sulfide released from contact of water with phosphorus pentasulfide will increase a person's sensitivity to hydrogen sulfide so that irritation of the eyes, coughing, dizziness, headache, and tiredness and other systemic effects may occur more readily.

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 phosphorus pentasulfide.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to phosphorus pentasulfide 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, central nervous system, eyes, and skin should be stressed.

—14" x 17" chest roentgenogram: Phosphorus pentasulfide in contact with water will release hydrogen sulfide, which causes respiratory impairment. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Phosphorus pentasulfide in contact with water will release hydrogen sulfide, which causes respiratory impairment. 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

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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indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

• Summary of toxicology

Phosphorus pentasulfide dust irritates the eyes and skin. Since it is readily converted in the presence of moisture to hydrogen sulfide gas and phosphoric acid, its inhalation toxicology is based on hydrogen sulfide. The latter is a rapidly acting systemic poison which causes respiratory paralysis with consequent asphyxia at high concentrations; it is an irritant of the eyes and respiratory tract at low concentrations. Inhalation of high concentrations of hydrogen sulfide, 1000 to 2000 ppm, may cause coma after a single breath and may be rapidly fatal; convulsions may also occur. Exposure to concentrations of hydrogen sulfide above 50 ppm for 1 hour may produce acute conjunctivitis with pain, lacrimation, and photophobia; in severe form this may progress to keratoconjunctivitis and vesiculation of the corneal epithelium. In low concentrations, hydrogen sulfide may cause headache, fatigue, irritability, insomnia, and gastrointestinal disturbances; in somewhat higher concentrations, it affects the central nervous system, causing excitement and dizziness. Prolonged exposure to 250 ppm may cause pulmonary edema. Prolonged exposure to concentrations as low as 50 ppm may cause rhinitis, pharyngitis, bronchitis, and pneumonitis. Repeated exposure to hydrogen sulfide results in increased susceptibility, so that eye irritation, cough, and systemic effects may result from concentrations previously tolerated without any effect. Rapid olfactory fatigue can occur at high concentrations.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 222.3 (or 444.6)
2. Boiling point (760 mm Hg): 513 C (955 F)
3. Specific gravity (water = 1): Bulk density powder = 1.3; solid = 2.1; liquid = 1.7
4. Vapor density (air = 1 at boiling point of phosphorus pentasulfide): Not applicable
5. Melting point: 275 C (527 F)
6. Vapor pressure at 300 C (572 F): 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Reacts to form hydrogen sulfide and liberate heat
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: Heat, particularly in presence of moisture or moist air
2. Incompatibilities: Contact with water, alcohols, and strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as sulfur dioxide, hydrogen sulfide, phosphorus pentoxide, phosphoric acid fume, and carbon monoxide) may be released in a fire involving phosphorus pentasulfide.
4. Special precautions: None listed

• Flammability

1. Flash point: Data not available
2. Autoignition temperature: 260– 290 C (500– 544 F) (dust); 275 C (527 F) (liquid) (approximately)
3. Minimum explosive concentration: Data not available
4. Extinguishant: Dry chemical, carbon dioxide, dry sand for small fires

• Warning properties

1. Odor Threshold: The MCA states that phosphorus pentasulfide reacts with moisture to liberate hydrogen sulfide. Phosphorus pentasulfide, according to the MCA, has a "characteristic hydrogen sulfide odor."
2. Eye Irritation Level: Phosphorus pentasulfide itself is not a known eye irritant. Hydrogen sulfide, however, which is liberated when the compound comes into contact with atmospheric moisture, is known to produce eye (and respiratory) irritation after 1 hour at 50 to 100 ppm (MCA).
3. Evaluation of Warning Properties: Since hydrogen sulfide "paralyzes" olfactory nerves at high concentrations "and, therefore, cannot be detected by odor," phosphorus pentasulfide 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

At the time of publication of this guideline, no measurement method for phosphorus pentasulfide had been published by NIOSH.

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 Enforce-

ment 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 phosphorus pentasulfide or liquids containing phosphorus pentasulfide.

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

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

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

- Employees should be provided with and required to use dust- and splash-proof safety goggles where phosphorus pentasulfide or liquids containing phosphorus pentasulfide may contact the eyes.

SANITATION

- Skin that becomes contaminated with phosphorus pentasulfide should be promptly washed or showered with soap or mild detergent and water to remove any phosphorus pentasulfide.

- Eating and smoking should not be permitted in areas where solid phosphorus pentasulfide is handled, processed, or stored.

- Employees who handle phosphorus pentasulfide or liquids containing phosphorus pentasulfide 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 phosphorus pentasulfide may occur and control methods which may be effective in each case:

Operation

Use in preparation of lubrication oil additives for low-lead gas and reduction of air pollution

Controls

Local exhaust ventilation; general dilution 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 pentasulfide or liquids containing phosphorus pentasulfide 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 solid phosphorus pentasulfide gets on the skin, dust it off immediately and then flush the contaminated skin with water. If phosphorus pentasulfide or liquids containing phosphorus pentasulfide penetrate through the clothing, remove the clothing promptly and flush the skin with water. Get medical attention immediately.

• Breathing

If a person breathes in large amounts of phosphorus pentasulfide, 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 phosphorus pentasulfide or liquids containing phosphorus pentasulfide have 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 AND DISPOSAL PROCEDURES

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

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

1. Ventilate area of spill.
2. For small quantities, sweep onto paper or other suitable material, place in an appropriate container and

burn in a safe place (such as a fume hood). Large quantities may be reclaimed; however, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device, 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 methods:

Phosphorus pentasulfide may be disposed of:

1. By making packages of phosphorus pentasulfide in paper or other flammable material and burning in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

2. By dissolving phosphorus pentasulfide in a flammable solvent (such as alcohol) and atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

3. See 2 and 3 above.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Phosphorus Pentasulfide," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- Baskin, A. D. (ed.): *Handling Guide for Potentially Hazardous Commodities*, Railway Systems and Management Association, Chicago, 1972.
- Christensen, H. E., and Luginbyhl, T. L. (eds.): *NIOSH Toxic Substances List*, 1974 Edition, HEW Publication No. 74-134, 1974.
- Gleason, M. N., Gosselin, R. E., Hodge, H. C., and Smith, R. P.: *Clinical Toxicology of Commercial Products* (3rd ed.), Williams and Wilkins, Baltimore, 1969.
- Manufacturing Chemists Association, Inc.: *Chemical Safety Data Sheet SD-71, Phosphorus Pentasulfide*, Washington, D.C., 1958.
- Milby, T. H.: "Hydrogen Sulfide Intoxication - Review of the Literature and Report of Unusual Accident Resulting in Two Cases of Nonfatal Poisoning," *Journal of Occupational Medicine*, 4:431-437, 1962.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.

RESPIRATORY PROTECTION FOR PHOSPHORUS PENTASULFIDE

Condition	Minimum Respiratory Protection* Required Above 1 mg/m³
Particulate Concentration	
10 mg/m ³ or less	Any supplied-air respirator. Any self-contained breathing apparatus.
50 mg/m ³ or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
750 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 750 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 hydrogen sulfide and particulates. Any escape self-contained breathing apparatus.

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