

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** PHOSPHORIC ACID ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for PHOSPHORIC ACID

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 PHOSPHORIC ACID.

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 phosphoric acid not in excess of 1 milligram 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 phosphoric acid.

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

(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 phosphoric acid;

(ii) Any measurements of phosphoric acid taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to phosphoric acid; 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 phosphoric acid 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 phosphoric acid 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 phosphoric acid 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 phosphoric acid 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 phosphoric acid 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 phosphoric acid 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

$\pm$ 25%

At or below permissible exposure

and above the action level

$\pm$ 35%

At or below the action level

$\pm$ 50%

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

(2) Employee exposures to airborne concentrations of phosphoric acid 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 phosphoric acid.

(ii) Open surface tank operations shall be performed in accordance with § 1910.94(d).

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

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

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

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(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of phosphoric acid 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 PHOSPHORIC ACID

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Particulate or Vapor Concentration	
50 mg/M3 or less	A high efficiency particulate filter respirator with a full facepiece. ----- Any supplied-air respirator with a full facepiece, helmet, or hood. ----- Any self-contained breathing apparatus with a full facepiece.
2000 mg/M3 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 2000 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.

(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).

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(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 phosphoric acid.

(2) Phosphoric acid shall be stored so as not to come in contact with strong caustics and metals.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use impervious clothing, gloves, face shields (eight-inch minimum) and other appropriate protective clothing necessary to prevent any possibility of skin contact with solid or liquid phosphoric acid or solutions containing greater than 1.6% orthophosphoric acid by weight or any concentration of meta-phosphoric acid. Face shields shall comply with § 1910.133 (a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employees 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 solutions containing 1.6% or less orthophosphoric acid by weight. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (a)(6).

(3) Employers shall ensure that employees whose clothing may have become contaminated with solid phosphoric acid change into uncontaminated clothing before leaving the work premises.

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

(5) Where there is any possibility of exposure of an employee's body to solid or liquid phosphoric acid or solutions containing phosphoric acid, employers shall provide facilities for quick drenching of the body within the immediate work area for emergency use.

(6) Employers shall ensure that non-impervious clothing which becomes contaminated with phosphoric acid be removed immediately and not reworn until the phosphoric acid is removed from the clothing.

(7) Employers shall provide and ensure that employees use safety goggles (cup-cover type dust and splash safety goggles) which comply with § 1910.133 (a)(2)-(a)(6) where there is any possibility of solid or liquid phosphoric acid or solutions containing phosphoric acid contacting the eyes.

(8) Where there is any possibility that an employee's eyes may be exposed to solid or liquid phosphoric acid or solutions containing more than 1.6% ortho-phosphoric acid by weight or any concentration of meta-phosphoric acid, employers shall provide an eye-wash fountain within the immediate work area for emergency use.

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

(h) Sanitation. Employers shall ensure that employees whose skin becomes contaminated with phosphoric acid immediately wash or shower to remove any phosphoric acid from the skin.

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

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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 phosphoric acid above the action level or employees who may have skin or eye contact with solid or liquid phosphoric acid or solutions containing phosphoric acid, or employees who work where a spill of phosphoric acid may occur, shall annually:

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

(ii) Advise affected employees as to the signs and symptoms of exposure to phosphoric acid.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of exposure to phosphoric acid 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 phosphoric acid.

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

(2) The employer shall obtain from each employee who is exposed, or will be exposed, to liquid phosphoric acid or airborne concentrations of phosphoric acid 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 phosphoric acid which are listed in Appendix A which the employee suspects are caused by exposure to phosphoric acid.

(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 phosphoric acid;

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

(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 phosphoric acid or would directly or indirectly aggravate any detected medical condition;

(B) Any recommended limitations upon the employee's exposure to phosphoric acid 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 phosphoric acid.

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

(7) No employee shall be exposed to liquid phosphoric acid or airborne concentrations of phosphoric acid 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 phosphoric acid.

(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 phosphoric acid.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to phosphoric acid which are being monitored;

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

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

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

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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 and social security number of employee trained;
- (C) Content or scope of training provided.

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

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

(ii) This record shall include:

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

(B) Any employee medical complaints relative to exposure to phosphoric acid;

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

(D) Physician's written opinion; and

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

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

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

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

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

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

(2) When observation of measurement of employee exposure to phosphoric acid requires entry into an area where the use of personal protective devices, including respirators, is required, the observer shall be provided

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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 phosphoric acid 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 PHOSPHORIC ACID

- I. SUBSTANCE IDENTIFICATION
 - A. Substance: Phosphoric acid
 - B. Permissible Exposure: 1 milligrams of phosphoric acid per cubic meter of air (mg/M3) averaged over an eight-hour shift.
 - C. Appearance and Odor: Viscous, colorless, odorless liquid which can solidify at temperatures below 21 C (70 F).
- II. HEALTH HAZARD DATA
 - A. Ways in which the chemical affects your body: Phosphoric acid 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: Solid phosphoric acid or its solutions may cause skin burns. Contact with the eyes may produce irritation and eye burns. Exposure to phosphoric acid vapor or mist may cause irritation of the eyes, nose and throat.
 - 2. Long-term Exposure: Repeated or prolonged exposure may cause irritation of the skin.
 - 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 phosphoric acid.
- III. EMERGENCY FIRST AID PROCEDURES
 - A. Eye Exposure: If phosphoric acid gets into your eyes, wash your eyes immediately with large amounts of water, lifting

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the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

- B. Skin Exposure: If phosphoric acid gets on your skin, immediately flush the contaminated skin with water. If phosphoric acid soaks through your clothing, remove the clothing immediately and flush the skin with water.
- C. Breathing: If you or any other person breathes in large amounts of phosphoric acid 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 phosphoric acid 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 phosphoric acid. 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 any possibility of skin contact with solid or liquid phosphoric acid or solutions containing more than 1.6% orthophosphoric acid by weight or any concentration of metaphosphoric acid. You must wear impervious clothing, gloves, face shields or other appropriate protective clothing to prevent repeated or prolonged skin contact with solutions containing 1.6% or less orthophosphoric acid by weight. Replace or repair impervious clothing that has developed leaks.
- C. Eye Protection: You must wear dust-resistant safety goggles where there is any possibility of solid phosphoric acid

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contacting your eyes. You must wear splash-proof safety goggles where there is any possibility of liquid phosphoric acid or solutions containing phosphoric acid contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Phosphoric acid must be stored in tightly closed containers in a well-ventilated area away from strong caustics and metals.
- B. If your work clothing may have become contaminated with solid phosphoric acid, you must change into uncontaminated clothing before leaving the work premises.
- C. You must immediately remove any non-impervious clothing that becomes contaminated with phosphoric acid and this clothing must not be reworn until the phosphoric acid is removed from the clothing.
- D. If your skin becomes contaminated with phosphoric acid, you must immediately wash or shower to remove the phosphoric acid from your skin.
- E. Eye flushing facilities and quick drenching facilities, where provided, must be readily available and you should know where they are and how to operate them.
- F. Ask your supervisor where phosphoric acid is used in your work area and for any additional plant safety and health rules.

VI. ACCESS TO INFORMATION

- A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for phosphoric acid. In addition, your employer must instruct you in the safe use of phosphoric acid, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to phosphoric acid. 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 of the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of exposure determinations, exposure measurements, and medical surveillance. Your employer is required to make records of exposure determinations and your exposure measurements available to you or your representative upon your request. Your employer is required to release your medical records to your physician upon your written request.

APPENDIX B

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SUBSTANCE TECHNICAL GUIDELINES
FOR PHOSPHORIC ACID

- I. PHYSICAL AND CHEMICAL DATA
 - A. Substance Identification
 - 1. Synonyms: White phosphoric acid; orthophosphoric acid; 85% phosphoric acid; metaphosphoric acid
 - 2. Formula: H_3PO_4
 - 3. Molecular weight: 98
 - B. Physical Data
 - 1. Boiling point (760 mm Hg): 260 C (500 F)
 - 2. Specific gravity (water = 1): 1.7
 - 3. Vapor density (air = 1 at boiling point of phosphoric acid): 3.4
 - 4. Melting point: 21 C (70 F)
 - 5. Vapor pressure at 20 C (68 F): 0.0285 mm Hg
 - 6. Solubility in water, % by weight at 20 C (68 F): Miscible in all proportions
 - 7. Evaporation rate (butyl acetate = 1): Not applicable
 - 8. Appearance and odor: Viscous, colorless, odorless liquid which can solidify at temperatures below 21 C (70 F)
- II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA
 - A. Fire
 - 1. Not combustible
 - B. Reactivity
 - 1. Conditions contributing to instability: None.
 - 2. Incompatibilities: Contact with strong caustics can cause liberation of much heat and violent spattering. Contact with most metals causes formation of flammable and explosive hydrogen gas.
 - 3. Hazardous decomposition products: Toxic gases and vapors (such as phosphoric acid fume) may be released when phosphoric acid decomposes.
 - 4. Special precautions: Liquid phosphoric acid will attack some forms of plastics, rubber and coatings.
- III. SPILL, LEAK, AND DISPOSAL PROCEDURES
 - A. If phosphoric acid is spilled or leaked, the following steps should be taken:
 - 1. Ventilate area of spill or leak.
 - 2. If in the solid form, collect spilled material in the most convenient and safe manner for reclamation or for disposal in a secured sanitary landfill.
 - 3. If in the liquid form, collect for reclamation or absorb in vermiculite, dry sand, earth or similar material.
 - 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 phosphoric acid may be disposed of by absorbing in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.
- IV. MONITORING AND MEASUREMENT PROCEDURES

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- A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average 8-hour exposure may be determined from a single eight-hour sample or two (2) 4-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 phosphoric acid 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 phosphoric acid 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 M" (Order number XXXXXXXXXX).
- 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 phosphoric acid in tightly closed containers in a well ventilated area.
- B. Employers should advise employees of all areas and operations where exposure to phosphoric acid could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to phosphoric acid is likely to occur are: during its production and its use in the manufacture of soil fertilizers, livestock and poultry feed, detergents, soap builders, water treatment chemicals, opal glass, dental cements; as an acid flavoring agent in foods, for treating boiler water; in the production of aluminum, steel, brass, bronze, and copper products; in flame-retardant processing and production; in the manufacture of cleaning preparations, textile and leather processing chemicals, pharmaceuticals and other chemicals; as a bonding agent in the manufacture of refractory bricks; and during lithography and photoengraving operations.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

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I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Phosphoric acid mist is an irritant to the eyes, upper respiratory tract, and skin. The solid is especially irritating to skin in the presence of moisture. Unacclimated workers could not endure exposure to fumes of phosphorus pentoxide (the anhydride of phosphoric acid) at a concentration of 100 mg/m³; exposure to concentrations between 3.6 and 11.3 mg/m³ produced coughing. Concentrations of 0.8 to 5.4 mg/m³ were noticeable but not uncomfortable. There is no evidence that phosphorus poisoning can result from contact with phosphoric acid. The risk of pulmonary edema resulting from the inhalation of mist or spray is remote. A dilute solution buffered to pH 2.5 caused a moderate brief stinging sensation but no injury when dropped in the human eye. A 75 per cent solution will cause severe skin burns.

III. SIGNS AND SYMPTOMS

Irritation of upper respiratory tract, eyes, and skin; skin and eye burns from splashes of concentrated solutions; may cause dermatitis from prolonged or repeated exposure.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Immediately flush eyes and skin with water. If swallowed and the person is conscious, immediately administer water orally and induce vomiting. Give artificial resuscitation if indicated.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of phosphoric acid are caused by its irritant properties. It is important that the physician become familiar with plant operating conditions in which exposure to phosphoric acid 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

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of certain medical conditions (listed below) which might place the employee at increased risk from phosphoric acid exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Chronic respiratory disease -- In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of phosphoric acid dust or mist might cause exacerbation of symptoms due to its irritant properties.
2. Skin disease -- Phosphoric acid dust, mist, or solutions may cause dermatitis. 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: "Phosphoric Acid," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 210.
2. Hygienic Guide Series: "Phosphoric Acid," American Industrial Hygiene Quarterly, 18:175-176, 1957.
3. Manufacturing Chemists' Association, Inc.: Chemical Safety Data Sheet SD-70, Phosphoric Acid, Washington, D.C., 1958, pp. 5-6, 12-13.
4. Grant, W. Morton: Toxicology of the Eye (2d ed.), Charles C. Thomas, Illinois, 1974, pp. 826-827.

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REFERENCES AND SOURCES
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- (d) Compliance - Open surface tank classification provided for hazard rating only since contaminant evolution rate is dependent on characteristics of each specific installation.
- (f) Personal Protective Equipment, and (h) Sanitation
- Eye: "Phosphoric Acid," Manufacturing Chemists' Association; Grant, "Toxicology of the Eye;" "Phosphoric Acid," Industrial Bio-Test Labs; "Phosphoric Acid," AIHA Hygienic Guide Series
- Skin: "Phosphoric Acid," Manufacturing Chemists' Association; Sax, "Dangerous Properties of Industrial Materials," "Phosphoric Acid," Industrial Bio-Test Labs; "Phosphoric Acid," AIHA Hygienic Guide Series; Patty, "Industrial Hygiene and Toxicology"
- Ingestion: "Phosphoric Acid," Hazard Process Index; "Phosphoric Acid," Manufacturing Chemists' Association; "Phosphoric Acid," Industrial Bio-Test Labs

COMMENTS

Eye - Classification: 1, 2, and 5

Output statement numbers: 9, 11, 13

Exceptions: See below; Statements 9 and 11 are combined and used to require eye protection for all situations involving potential eye exposure to phosphoric acid.

According to Grant, phosphoric acid "topically may irritate and injure the eyes, owing to its acidity." He continues, "tested on human eyes, 0.16 M orthophosphoric acid buffered to pH 2.5 caused moderate brief stinging sensation but no injury when applied as a single drop. A drop of the same solution adjusted to pH 3.4 caused no discomfort. Irrigation of a rabbit's eye for five minutes with orthophosphoric acid diluted to pH 3.8 caused slight transient epithelial edema and conjunctival hyperemia, but the eye was completely normal by the next day. On the other hand, when injected into the rabbit corneal stroma or applied to the cornea after removal of the epithelium, metaphosphoric acid caused detectable injury below pH 5.5. Phosphoric acid has been held responsible for burns of the eye from superphosphate fertilizers."

The MCA states simply that "contact with the eyes will produce irritation and eye burns but no permanent damage is to be expected." The Hygienic Guide generally reports "75% phosphoric acid will cause destruction of body tissues and severe burns." Both of the above sources recommend that eye wash fountains should be close to work sites.

The Industrial Bio-Test Labs assigned undiluted liquid o-phosphoric acid an acute eye irritation to rabbits score of 107/110 and indicated that the degree of injury remained constant at all "times of reading" up to 72 hours. The score of 107/110 indicates almost "maximum irritation and damage to all three ocular tissues - the cornea, iris, and conjunctivae."

As would be expected with such an acid, strong solutions can cause severe, irreversible injury while dilute solutions

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produce proportionately minor injury. Grant's data indicate that a 0.16 M (1.56% by weight) solution of o-phosphoric acid does not produce irreversible injury. Since he also notes that the meta-isomer is more corrosive, however, a classification of 2 cannot be assigned to such dilute solutions of phosphoric acid in general but only to the ortho-isomer. Thus, the substance is assigned classifications of 1, 2, and 5 with the appropriate distinctions being made between the two isomers. The 1.56% concentration is rounded to 1.6%.

Skin - Classification: 1, 2 and 5

Output statement numbers: 1, 2, 5b, 7a, 8a, 14g, 14i

Exceptions: See below

The MCA reports that "in some individuals the 75 percent solution will cause little more than drying of the skin but in others burns may result." It also notes that "it has a relatively mild corrosive action to the skin (and) in concentrated solutions, may cause skin burns. In some people little, if any, effect other than cracking and drying around the fingernails will result." Sax lists phosphoric acid as an acute and chronic local irritant of moderate effect. The Industrial Bio-Test Labs give a rabbit acute dermal LD of 2740 mg/kg for the undiluted substance. The signs of intoxication included excitation, vocalization, hyperactivity and death. Autopsy revealed "no significant findings other than corrosive skin reactions." The substance is further noted as being so extremely corrosive that the abdominal musculature became visible and is assigned the highest possible skin irritation score of 8.0/8.0. The Hygienic Guide notes "75% phosphoric acid will cause destruction of body tissues and severe burns."

Phosphoric acid is a solid but is usually used industrially as a strong solution. Its melting point is 69.8 degrees F; it is not flammable, has a very low vapor pressure, and is miscible in all proportions with water.

As above, it is evident that strong solutions, and very likely the solid, can be extremely corrosive, and that more dilute solutions have less severe effects. Since phosphoric acid, based on comparison of ionization constants, can be considered to be a stronger acid than acetic acid, and since Patty notes that "concentrations from 80 percent to glacial (acetic acid) produce severe burns," it is concluded that the Hygienic Guide is correct in its statement that 75% solutions can cause severe burns. The data needed to allow classifications other than 1 and 5 for dilute solutions are less adequate. However, based on Grant's data (see discussion under "Eye"), a classification of 2 is given to solutions containing 1.6% or less ortho-phosphoric acid by weight. All other concentrations are assigned classifications of 1 and 5. Statements 5b and 7a are used instead of 5a and 6 because of the local warning properties of the substance. The quantities which would not be detected should not cause significant harm. For similar reasons, statements 15 and 20a are not specified.

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Ingestion - Classification: 0

Output statement numbers: None

Exceptions: None

The Hazard Process Index comments that exposure to phosphoric acid by ingestion can cause conjunctivitis, bloody diarrhea, nausea, vomiting, acidosis and shock. The Manufacturing Chemists' Association notes it "can cause local damage if taken internally in concentrated solutions, but it does not cause any systemic effect." The Industrial Bio-Test Labs list an acute oral rat LD of 1530 mg/kg; the signs of intoxication included hypoactivity, ruffed fur, sedation and blood in the urine and feces. They note, rats who survived incurred inflammation of the gastrointestinal tract and those who died were found to have hemorrhaging in the gastrointestinal tract. All rats fed 94 mg/kg/day in their diet for 28 days survived, appeared normal during the course of the investigation, and at autopsy showed no significant gross lesions. Only 1 of 10 rats died at a feeding level of 365.9 mg/kg/day and it showed no systemic signs of intoxication.

Extrapolating the data from the Industrial Bio-Test Labs to humans leads to the conclusion that ingestion should not pose a hazard in the industrial environment.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

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

Manufacturing Chemists' Association, Chemical Safety Data Sheet SD-70, 1958 (MCA)

FMC Corporation, Technical Bulletins (FMC)

Sources of data items Used:

- I. A. 1. Synonyms: MCA; FMC
2. Formula: NFPA-49
3. Molecular weight: FMC
- B. 1. Boiling point: MCA
2. Specific gravity: MCA; FMC
3. Vapor density: Calculated
4. Melting point: FMC; MCA
5. Vapor pressure: MCA
6. Solubility in water: NFPA-49
7. Evaporation rate: Not applicable
8. Appearance and odor: NFPA-49
- II. A. 1. Flash point: Not applicable
2. Autoignition temperature: Not applicable
3. Flammable limits: Not applicable
4. Extinguishing media: Not applicable
5. Special fire fighting procedures: NFPA-49
6. Unusual fire and explosion hazards: NFPA-49
- B. 1. Conditions contributing to instability: ADL
2. Incompatibilities: ADL
3. Hazardous decomposition products: NFPA-49
4. Special precautions: ADL
- III. A. Steps if released or spilled: NFPA-49; ADL

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B. Waste disposal method: MCA; ADL

V. Miscellaneous precautions: NFPA-49

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

Graphic Arts International Union, "Background for Bargaining 1974," GAIU, Washington, D. C. (GAIU)

International Labour Organization, "Encyclopedia of Occupational Health and Safety," Geneva, 1972 (ILO)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, Division of John Wiley, 2nd edition, 1972 (K-O)

"Merck Index of Chemicals and Drugs," Merck and Co., Inc., Rahway, N. J. 8th edition, 1968 (Merck)

Patty, F. A., "Industrial Hygiene and Toxicology," Vol. II, Interscience Publishers, 1962 (Patty)

"Phosphoric Acid," American Conference of Government Industrial Hygienists, Hygienic Guide Series, June 1957 (Hygienic Guides)

"Phosphoric Acid," Hazard Process Index, Hazard Entry No. 156, Contract HSM-99-73-62, National Institute of Occupational Safety and Health (HPI)

"Phosphoric Acid," Phos. File #13, FMC Corporation, Inorganic Chemicals, Division, New York, New York undated (FMC I)

"Phosphoric Acid," Technical Data No. 515-11A, FMC Chemicals, Inorganic Chemicals Division, New York, New York, 1972 (FMC II)

Schwartz, L., Tulipan, L. and Birmingham, D. J., "Occupational Diseases of the Skin," Lea and Febiger, 1957 (Schwartz)

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

U. S. Environmental Protection Agency, "Water Pollution Potential of Manufactured Products," Catalogue Sections II and III (EPA-R2-73-179 c and d), April 1973 (EPA)

References for Specific Use/Exposure

1. ILO, SRI
2. Patty, ILO
3. ADL estimate
4. SRI
5. HPI, SRI
6. SRI
7. HPI, SRI
8. HPI, K-O
9. K-O, EPA
10. EPA
11. SRI, FMC I
12. K-O, GAIU, Merck
13. HPI, SRI
14. FMC I, SRI
15. SRI
16. HPI, SRI
17. SRI
18. K-O
19. K-O
20. K-O
21. FMC I, Merck

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22. SRI

References for Specific Control Methods

1. Patty, Schwartz
2. Patty, Schwartz

Hygienic Guides and FMC II were the references used in the remaining, numbers 3 - 22, of the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Phosphoric Acid

D. O. L. STANDARD: 1 mg/M3

Eye Irritation Level: Phosphoric acid mist can cause irritation of the eyes and respiratory tract, according to the Hygienic Guides. No quantitative information is given, however. Deichmann and Gerarde note that since phosphoric acid "has a low vapor pressure, at room temperature (it) is not irritating to the eyes or respiratory tract unless introduced into the atmosphere as a spray or mist."

IDLH: According to the Manufacturing Chemists' Association (MCA), the phosphoric acid "does not cause any systemic effect, (and) . . . the chance of pulmonary edema from mist or spray inhalation is very remote." For the purposes of this standard, therefore, respirators have been selected on the basis of the protection factors afforded by each device. A rat LD50 of 1530 mg/kilogram would provide a calculated IDLH of about 10,000 mg/M3. Therefore, the IDLH based on protection factors should provide adequate protection.

Other Toxicological Information: According to the Manufacturing Chemists' Association (MCA), phosphoric acid "has a low vapor pressure and at room temperature is not irritating to the nose or eyes. It does not cause any systemic effect. There is no evidence that phosphorus poisoning can result from phosphoric acid . . . the chance of pulmonary edema resulting from mist or spray inhalation is very remote." Concerning the local effects, MCA states that "phosphoric acid, in concentrated solutions, may cause skin burns. In some people, little, if any, effect other than cracking and dryness around the fingernails will result. The very low vapor pressure precludes, except under very unusual circumstances, upper respiratory irritation." MCA notes that no chronic toxicity has been reported for phosphoric acid.

Deichmann and Gerarde and the Hygiene Guides state that phosphoric acid is "much less hazardous than other mineral acids such as nitric or sulfuric."

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	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of vapor and mist and skin contact with liquid during bright - dipping operations in manufacture of aluminum products	A,B	Process enclosure; local exhaust ventilation; personal protective equipment (goggles or face shield, gloves, protective clothing)
2.	Inhalation of vapor and mist and skin contact with liquid during surface treatment and rust proofing operations (cleaning, electropolishing, pickling) in manufacture of steel, brass, bronze, and copper products	A,B	Process enclosure; local exhaust ventilation; personal protective equipment (goggles or face shield, gloves, protective clothing)
3.	Skin contact with liquid during synthesis and handling of substance	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
4.	Skin contact with liquid during synthesis of intermediates in manufacture of soil fertilizers (double and triple superphosphate and ammonium phosphates)	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
5.	Skin contact with liquid during manufacture of livestock and poultry feed (primarily calcium phosphates)	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
6.	Skin contact with liquid during synthesis of detergent and soap builders and water - treatment chemicals (sodium phosphates and polyphosphates and potassium phosphates)	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
7.	Skin contact with liquid	B	Process enclosure; per-

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	during use as an acidulant and flavor in manufacture of carbonated beverages (colas and root beer) and jellies and preserves		sonal protective clothing (goggles or face shield, gloves, protective clothing)
8.	Skin contact with liquid during manufacture of food products, intermediates, and food additives (gelatin, sugar, baker's yeast; use as antioxidant and preservative; disodium orthophosphate, trisodium phosphate, sodium acid pyrophosphate, calcium phosphate)	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
9.	Skin contact with liquid during flame-retardant processing (wood, textiles, polyurethane foams) and production of flame retardant agents	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
10.	Skin contact with liquid during manufacture of cleaning preparations (liquid household detergents, dairy, metal, boiler, and glass cleaner and metal polishes; ink removers; and disinfectants)	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
11.	Skin contact with liquid during use as a bonding agent in manufacture of refractory bricks	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
12.	Skin contact with liquid during lithography and photoengraving operations	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing)
13.	Skin contact with liquid during use as a catalyst in synthesis of other chemicals (acetic anhydride;	B	Process enclosure; personal protective clothing (goggles or face shield, gloves, protective

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mono-, di-, and triethyl-
amines; ethyl benzene;
cumene; and polymerization
of olefins, caprolactam,
isoprene, propionitrile,
ethers)

clothing)

- | | | | |
|------|---|---|---|
| 14. | Skin contact with liquid during synthesis of textile and leather processing chemicals (sodium, calcium and potassium phosphates) | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |
| 15. | Skin contact with liquid during synthesis of processing chemicals for clays, ceramics, cements and clay thinning agents for drilling mud formulations (potassium, sodium, and calcium phosphates and sodium polyphosphates) | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |
| 16. | Skin contact with liquid during synthesis of pharmaceuticals and pharmaceutical intermediates (including disodium phosphate, tetrasodium pyrophosphate, dicalcium and potassium phosphates; extraction of penicillin) | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |
| 17. | Skin contact with liquid during use as a laboratory reagent | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |
| 18. | Skin contact with liquid during manufacture of opal glass | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |
| -19. | Skin contact with liquid during manufacture of dental cements and dentifrice abrasives | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |

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|-----|--|---|---|
| 20. | Skin contact with liquid during application of adhesive gum in manufacture of envelopes | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |
| 21. | Skin contact with liquid during processing of synthetic rubber | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |
| 22. | Skin contact with liquid during synthesis of phosphors in manufacture of electric lights | B | Process enclosure; personal protective clothing (goggles or face shield, gloves, protective clothing) |

- 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 -----

1,323 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

[illegible]