NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND

SUPPORTING DOCUMENTATION FOR

*** TRIORTHOCRESYL PHOSPHATE ***

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

The basic text of this document contains the draft technical standard approved by the Joint Review Committee of the NIOSH/OSHA Standards Completion Program and the supporting documentation for the substance TRIORTHOCRESYL PHOSPHATE.

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

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

(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of triorthocresyl phosphate not in excess of 0.1 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 triorthocresyl phosphate.

(b) Exposure determination and measurement. (1) Each employer who has a place of employment in which triorthocresyl phosphate is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of triorthocresyl phosphate at or above the action level. The determination shall be made each time there is a change in production, process, or control measures which could result in an increase in airborne concentrations of triorthocresyl phosphate.

(2) A written record of the determination shall be made and shall contain at least the following information:

(i) Any information, observations, or calculations which may indicate employee exposure to triorthocresyl phosphate;

(ii) Any measurements of triorthocresyl phosphate taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to triorthocresyl phosphate; and

(IV) Date of determination, work being performed at the time, location within work site, name, and social security number of each employee considered.

(3) If the employer determines that any employee may be exposed to triorthocresyl phosphate at or above the action level, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b) (3) of this section reveals employee exposure to triorthocresyl phosphate at or above the action level, the employer shall:

(i) Identify all employees who may be exposed at or above the action level; and

(ii) Measure the exposure of the employees so identified.

(5) If an employee exposure measurement reveals that an employee is exposed to triorthocresyl phosphate at or above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every two months.

(6) If an employee exposure measurement reveals that an employee is exposed to triorthocresyl phosphate above the permissible exposure, the employer shall:

(i) Measure the exposure monthly of the employee so exposed; and

(ii) Institute control measures as required by paragraph (d) of this section; and

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to triorthocresyl phosphate above the permissible exposure. The employee shall also be notified of the corrective action being taken to reduce the exposure to at or below the permissible exposure.

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to triorthocresyl phosphate

below the action level, the employer may terminate measurement for the employee.

(8) For purposes of this paragraph, employee exposure is that which would occur if the employee were not using a respirator.

(c) Methods of measurement. (1) An employee's exposure shall be obtained by any combination of long term or short term samples which represents the employee's actual exposure averaged over an eight-hour work shift (See Appendix B (IV) of this section).

(2) The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than that given in Table 1.

Table 1

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

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

(2) Employee exposures to airborne concentrations of triorthocresyl phosphate shall be controlled to at or below the permissible exposure by engineering and work practice controls:

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not technically feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. (i) When mechanical ventilation is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity, static pressure, or air volume, shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of triorthocresyl phosphate.

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

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

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

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

(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of triorthocresyl phosphate to at or below the permissible exposure; or

(iv) For operations which require entry into tanks or closed vessels; or

(v) In emergencies.

(5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

TABLE 2 RESPIRATORY PROTECTION FOR TRIORTHOCRESYL PHOSPHATE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Particulate Concentration	
0.5 mg/M3 or less	Any dust and mist respirator, except single use.
1 mg/M3 or less	Any dust and mist respirator, except single-use respirator or quarter-mask.
	Any fume respirator or high efficiency particulate filter respirator.
	Any supplied-air respirator.
	Any self-contained breathing apparatus.
5 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.
40 mg/M3 or less	A powered air-purifying respirator with a high efficiency particulate filter.
	A Type C supplied-air respirator operated in pressure - demand or other positive pressure or continuous-flow mode.
Greater than 40 mg/M3 or entry and escape from	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

unknown concentrations	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 dust and mist respirator, except single-use.
	Any escape self-contained breathing apparatus.

(6) Respirators shall be approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with $ 1910.134(b), (d), (e), and (f).

(e) Fire and safety. (1) The employer shall familiarize himself with the information contained in the Substance Technical Guidelines (Appendix B of this section) for triorthocresyl phosphate.

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

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

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

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

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use impervious clothing, gloves, face shields (eight-inch minimum) and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid triorthocresyl phosphate. Face shields shall comply with $ 1910.133(a)(2),(a)(4), (a)(5), and (a)(6).

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

(3) Employers shall ensure that non-impervious clothing which becomes contaminated with triorthocresyl phosphate be removed promptly and not reworn until the triorthocresyl phosphate is removed from the clothing.

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

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with triorthocresyl phosphate promptly wash or shower

with soap or mild detergent and water to remove any triorthocresyl phosphate from the skin.

(2) Employers shall ensure that employees do not eat or smoke in areas where liquid triorthocresyl phosphate is handled, processed or stored.

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

(i) Training and information. (1) Each employer who has a workplace in which triorthocresyl phosphate is present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

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

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

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

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

(iv) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to triorthocresyl phosphate.

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

(2) Preplacement medical examination. The employer shall make available to each employee who is exposed, or will be exposed to liquid triorthocresyl phosphate or airborne concentrations of triorthocresyl phosphate at or above the action level a preplacement medical examination which must include a medical history and physical examination with emphasis on the peripheral and central nervous systems.

(3) Periodic medical examination. The employer shall make available to each employee exposed to liquid triorthocresyl phosphate or airborne concentrations of triorthocresyl phosphate at or above the action level, without regard to the use of respirators, twelve months from the date of the employee's first exposure, and every twelve months thereafter, a periodic medical examination which must include a medical history and physical examination with emphasis on the peripheral and central nervous systems.

(4) Interim medical examination. The employer shall provide an interim medical examination for the employee if the employee informs the employer of any of the signs or symptoms of exposure to triorthocresyl phosphate which are listed in Appendix A which the employee suspects are caused by exposure to triorthocresyl phosphate.

(5) Informing the physician. The employer shall provide to the physician performing any medical examination required by this section the following information:

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

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

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurements which may indicate the affected employee's exposure;

(v) The affected employee's anticipated exposure level; and

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

(6) Where a medical examination is required by paragraphs (j)(2), (j)(3), or (j)(5) of this section, following such examination the employer shall obtain from the examining physician a written opinion which conforms with paragraph (j)(8) of this section.

(7) Physician's written opinion. 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 triorthocresyl phosphate or would directly or indirectly aggravate any detected medical condition;

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

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

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

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

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

(9) No medical procedure which would be performed persuant to paragraphs (j)(2) or (j)(3) of this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(10) 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.

(11) The employer shall provide emergency medical treatment for any employee injured through exposure to triorthocresyl phosphate.

(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 triorthocresyl phosphate.

(ii) This record shall include:

(A) The date of measurement;

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

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

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

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

(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) The name and social security number of the employee;

(B) Results of tests required by paragraph (j)(2) and (j)(3) of this section and results of any tests conducted pursuant to paragraphs (j)(4) of this section;

(C) Any employee medical complaints relative to exposure to triorthocresyl phosphate;

(D) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(E) Physician's written opinion; and

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

(iii) This record shall be maintained for the duration of and for five years after termination of the employment of the affected employee.

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

(ii) Each employee or former employee shall have access to the exposure determination and exposure measurement records required to be maintained by this section which indicate his own exposure to triorthocresyl phosphate.

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

(l) Employee observation of measurement. (1) The employer shall give each employee or his representative an opportunity to observe any measurement of his exposure to triorthocresyl phosphate which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to triorthocresyl phosphate requires entry into an area where the use of personal protective devices, including respirators, is required, the observer shall be provided with and required to use such equipment and comply with all other applicable safety procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

(i) Receive an explanation of the measurement procedure.

(ii) Visually observe all steps related to the measurement of the airborne concentration of triorthocresyl phosphate that are being performed at the place of exposure; and

(iii) Record the results obtained.

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

APPENDIX A

SUBSTANCE SAFETY DATA SHEET FOR TRIORTHOCRESYL PHOSPHATE

I. SUBSTANCE IDENTIFICATION

- A. Substance: Triorthocresyl phosphate
- B. Permissible Exposure: 0.1 milligram of triorthocresyl phosphate per cubic meter of air (mg/M3) averaged over an eight-hour work shift.
- C. Appearance and Odor: Colorless, odorless liquid

II. HEALTH HAZARD DATA

- A. Ways in which the chemical affects your body: Triorthocresyl phosphate can affect your body if you inhale it or if it comes in contact with your eyes or skin or if you swallow it. It may enter your body through your skin.
- B. Effects of Overexposure:

1. Exposure: Triorthocresyl phosphate may cause paralyses of the lower arms and legs if it is swallowed, inhaled (as a fog mist or aerosol), or absorbed through the skin. Nausea, vomiting, diarrhea and abdominal pain may occur shortly after exposure. These symptoms disappear and are followed, after a symptom free period of 3 to 28 days, by the paralytic effect.
2. 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 triorthocresyl phosphate.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If liquid triorthocresyl phosphate gets into your eyes, wash your 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.

B. Skin Exposure: If liquid triorthocresyl phosphate gets on your skin, immediately wash the contaminated skin using soap or mild detergent and water. If liquid triorthocresyl phosphate soaks through your clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.

C. Breathing: If you or any other person breathes in large amounts of triorthocresyl phosphate move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

D. Swallowing: When liquid triorthocresyl phosphate has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

E. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. Respirators: Respirators are not the best way to control exposure to triorthocresyl phosphate. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly.

Respirators should not be loosened or removed in work situations where there use is required. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Protective Clothing: You must wear impervious clothing, gloves, face shield or other appropriate protective clothing to prevent repeated or prolonged skin contact with liquid triorthocresyl phosphate. Replace or repair impervious clothing that has developed leaks.

C. Eye Protection: Not applicable.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

A. Triorthocresyl phosphate is a combustible liquid and its vapors can form explosive mixtures with air at elevated temperatures.

B. Triorthocresyl phosphate must be stored in tightly closed containers in a cool, well ventilated area.

C. Sources of ignition such as smoking and open flames are prohibited wherever triorthocresyl phosphate is handled, used or stored in a manner that could create a potential fire or explosion hazard.

D. You must promptly remove any non-impervious clothing that becomes contaminated with triorthocresyl phosphate and this clothing must not be reworn until the triorthocresyl phosphate is removed from the clothing.

E. If your skin becomes contaminated with triorthocresyl, you must promptly wash or shower with soap or mild detergent and water to remove the triorthocresyl phosphate from your skin.

F. You must not eat or smoke in areas where liquid triorthocresyl phosphate is handled, processed or stored.

G. If you handle liquid triorthocresyl, you must wash your hands thoroughly with soap or mild detergent and water before eating smoking or using toilet facilities.

H. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them.

I. Ask your supervisor where triorthocresyl phosphate is used in your work area and for any additional safety and health rules.

VI. ACCESS TO INFORMATION

A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for triorthocresyl phosphate. In addition, your employer must instruct you in the safe use of triorthocresyl phosphate, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to triorthocresyl phosphate. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.

C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of five years following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.

D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES FOR TRIORTHOCRESYL PHOSPHATE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: O-tritolyl phosphate; TCP; TOCP
2. Formula: $(CH_3C_6H_4O)_3PO$
3. Molecular weight: 368

B. Physical Data

1. Boiling point (760 mm Hg): 410 C (770 F) (decomposes)
2. Specific gravity (water = 1): 1.17
3. Vapor density (air = 1 at boiling point of triorthocresyl phosphate): Not applicable
4. Melting point: -33 C (-27 F)
5. Vapor pressure at 20 C (68 F): Very low (0.02 mm Hg at 150 C)
6. Solubility in water, % by weight at 20 C (68 F): 0.0003
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless, odorless liquid

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: 225 C (437 F) (closed cup)
2. Autoignition temperature: 385 C (725 F)
3. Flammable limits in air, % by volume: Data not available
4. Extinguishing media: Foam, carbon dioxide, dry chemical
5. Special fire-fighting procedures: Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.
6. Unusual fire and explosion hazards: Triorthocresyl phosphate is a combustible liquid. At elevated temperatures its vapors can form explosive mixtures with

air. All ignition sources must be controlled where triorthocresyl phosphate is used, handled or stored in a manner that could create a potential fire or explosion hazard. When triorthocresyl phosphate burns, a heavy sooty smoke forms.

7. For purposes of complying with the requirements of 29 CFR 1910.106, triorthocresyl phosphate is classified as a Class IIIB combustible liquid.

B. Reactivity

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

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

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

1. Ventilate area of spill or leak.
2. For small quantities, absorb on paper towels. Remove to a safe place (such as a fume hood) and burn the paper. Large quantities can be collected and atomized in a suitable combustion chamber, equipped with an appropriate effluent gas cleaning device.

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

C. Waste disposal methods: Liquid triorthocresyl phosphate may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in sealed containers in a secured sanitary landfill.
2. By atomizing in a suitable combustion chamber, equipped with an appropriate effluent gas cleaning device.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Several short time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or by collection of the particulates using a high efficiency membrane filter with subsequent chemical analyses. The method of measurement must determine

the concentration of triorthocresyl phosphate to plus or minus 35%.

B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. A. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of triorthocresyl phosphate to plus or minus 25%.

C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under the title "NIOSH Analytical Methods for Set P" (Order number 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 triorthocresyl phosphate in tightly closed containers in a cool, well ventilated area.

B. Employers should advise employees of all areas and operations where exposure to triorthocresyl phosphate could occur.

VI. COMMON OPERATION

Common operations in which exposure to triorthocresyl phosphate is likely to occur are: During its production; during its use as a flame-retarding plasticizer for plastics; as a lubricating oil additive; as a dust trap in air filters; as a component of hydraulic fluids; during use as a gasoline additive to control preignition; and during its use as a synthetic lubricant, waterproofing agent, in solvent mixtures, as an extraction solvent, and in grinding media for pigments.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; skin absorption; ingestion.

II. TOXICOLOGY

Triorthocresyl phosphate (TOCP) causes peripheral neuropathy with flaccid paralysis of the distal muscles of the upper and lower extremities followed in some cases by a spastic paralysis. In affected cats and hens, extensive damage is observed in the spinal cord and sciatic nerves; damage to the myelin sheath and Schwann cells is secondary to the destructive lesion in the axon, which starts at the distal end of the longer axons. Thousands of people have been poisoned by the accidental

ingestion of TOCP in contaminated foods and beverages; reports of intoxication from occupational exposure are rare. Shortly after ingestion there may be nausea, vomiting, diarrhea, and abdominal pain. After a symptom-free interval of 3 to 28 days, most patients complain of sharp, cramplike pains in the calf muscles, and some of numbness and tingling in the feet and sometimes the hands. Within a few hours there is increasing weakness of the legs and feet, progressing to bilateral footdrop. After an interval of another 10 days, weakness of the fingers and wristdrop develop, but the paralysis is not during your employment, and for a period of five years following your termination of employment. Your usually as severe as occurs in the feet and legs; this process does not extend above the elbows; the thigh muscles are infrequently involved. Sensory changes, if they occur, are minor. With severe intoxication, lesions of the anterior horn cells and the pyramidal tracts may also occur. Muscular weakness may increase over a period of several weeks or months; recovery may take months or years and in 25 to 30 percent of cases permanent residual effects remain, usually confined to the lower limbs. Fatalities are rare and occur principally in those who have taken large quantities in a short period of time; autopsy of 6 human cases revealed involvement of anterior horn cells and demyelination of nerve cells. The lethal dose for humans by ingestion is about 1.0 g/kg; severe paralysis has been produced by ingestion of 6 to 7 mg/kg. In workers engaged in the manufacture of aryl phosphates (including up to 20 percent TOCP) and exposed to concentrations of aryl phosphates at 0.2 to 3.4 mg/M3, there was some inhibition of plasma cholinesterase but no correlation of this effect with degree of exposure or with minor gastrointestinal or neuromuscular symptoms. No effects on the eyes or skin have been reported; TOCP is readily absorbed through the skin without local irritant effects.

III. SIGNS AND SYMPTOMS

Gastrointestinal disturbances; signs of peripheral neuropathy including cramplike pains in the calves, paresthesias in the feet and sometimes the hands, weakness, bilateral footdrop and wristdrop, paralysis.

IV. SPECIAL TESTS

Plasma cholinesterase activity may be depressed (70 percent or less of normal) but there is no correlation between this observation and degree of exposure or severity of symptoms.

V. TREATMENT

Remove from exposure. Immediately flush eyes with water and wash skin with soap or mild detergent and water. If swallowed and the person is conscious, immediately administer water orally and induce vomiting. Give artificial resuscitation and administer oxygen if indicated. Observed for delayed neuromuscular effects in extremities.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Triorthocresyl phosphate causes a delayed (3 to 28 days) paralysis of the distal muscles of the lower and, to a lesser extent, upper extremities. It is characterized by footdrop and wristdrop, with subsequent upper motor neuron involvement. There is little or no sensory disturbance. Recovery is prolonged and may not be complete. Skin absorption is known to occur. It is important that the physician become familiar with plant operating conditions in which exposure to triorthocresyl phosphate occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

The following medical procedures must be made available to each employee who is exposed to triorthocresyl phosphate:

1. A complete history and physical examination -- The purpose is to detect preexisting conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the peripheral and central nervous systems should be stressed.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Triorthocresyl Phosphate," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, pp. 271-272.

2. Hygienic Guide Series: "Triorthocresylphosphate," American Industrial Hygiene Association Journal, 24:534-536, 1963.

3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1853, 1914-1925, 1935-1937.

4. Hunter, D., et al: "Toxic Polyneuritis Arising During the Manufacture of Tricresyl Phosphate," British Journal of Industrial Medicine, 1:227-231, 1944.

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7. Tabershaw, I.R. and M. Kleinfeld: "Manufacture of Tricresyl Phosphate and Other Alkyl Phenyl Phosphates: An Industrial Hygiene Study. II. Clinical Effects of Tricresyl Phosphate," A.M.A. Archives of Industrial Health, 15:541-544, 1957.

8. Grant, W. Morton: Toxicology of the Eye (2d ed.), Charles C. Thomas, Springfield, Illinois, 1974, pp. 1047-1050.

9. Johnson, M.K.: "Delayed Neurotoxic Action of Some Organo-phosphorus Compounds," British Medical Bulletin, 25:231-235, 1969.

10. Vora, D.D., et al: "Toxic Polyneuritis in Bombay due to Ortho-Cresyl-Phosphate Poisoning," Journal of Neurology, Neurosurgery, and Psychiatry, 25:234-242, 1962.

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

REFERENCES AND SOURCES
TRIORTHOCRESYL PHOSPHATE
1910.1000

(f) Personal Protective Equipment, and, (h) Sanitation

Eye: Grant, "Toxicology of the Eye"

Skin: Hunter, "The Diseases of Occupations," 4th edition; Deichmann and Gerarde, "Toxicology of Drugs and Chemicals;" Patty, "Industrial Hygiene and Toxicology"

Ingestion: American Conference of Governmental Industrial Hygienists, "Documentation of the Threshold Limit Values for Substances in Workroom Air;" Thienes and Haley, "Clinical Toxicology;" Patty, "Industrial Hygiene and Toxicology;" Hunter, "The Diseases of Occupations," 4th edition; Deichmann and Gerarde, "Toxicology of Drugs and Chemicals;" Spector, "Handbook of Toxicology;" Christensen, "NIOSH Toxic Substances List;" American Industrial Hygiene Association, "Hygienic Guide Series"

COMMENTS

Eye - Classification: 0
Output statement numbers: None
Exceptions: None

According to Grant, a case of "a single accidental splash contact of tricresyl phosphate with a patient's eye has been briefly mentioned and noted not to have produced a burn of the eye." Other sources, cited below, indicate the substance is not a skin irritant.

There would appear to be no justification for assigning a classification other than zero to this compound.

Skin - Classification: 2
Output statement numbers: 2, 7a, 17g, 17i, 20a
Exceptions: None

Hunter reports that studies by Hodge and Steiner "estimated the amount of TOCP that can be absorbed through unbroken skin and how rapidly the absorption occurs." They found that between 0.1% and 0.4% of the applied dose to human skin is absorbed. Hodge and Steiner "consider that the magnitude of absorption of TOCP through human skin is such that a real hazard exists in industrial operations permitting a considerable or repeated exposure to this compound."

Deichmann and Gerarde note that "machine shop operators exposed to cutting oil sprays and mists develop acne folliculitis, pustular dermatitis, and keratosis. Men with greasy skin and excessive hair on their arms and legs are most frequently affected." They further note, however, that the additives of the cutting oils do contain amounts of sulphur and chlorine, which may be partially responsible, as well as amounts of TOCP.

Patty acknowledges that TOCP is not a "skin irritant" but is readily absorbed through the skin.

Triorthocresyl phosphate has a flash point of 437 degrees F. Its vapor pressure at 150 degrees C is 0.02 mm Hg and it is 0.0003% soluble in water.

Since the literature indicates that prolonged or repeated exposure is necessary for skin absorption to produce a significant effect, a classification of 2 is concluded to be appropriate. The toxic properties of this substance place it on the borderline in regards to the use of statements numbered 16 or 17. Statements 17 are used due to the potential for skin absorption.

Ingestion - Classification: 1
Output statement numbers: 19, 20a
Exceptions: None

According to the ACGIH, "poisoning by ingestion is at least as important as that by inhalation." In man, the oral toxicity is well known "because of the number of incidents in which TOCP has found its way into food and beverages." An estimated lethal dose for man by ingestion is 1.0 gm/kg. Thienes and Haley report that "others have had but mild symptoms from many times that dose, taken over a period of days." The ACGIH further reports that "serious paralysis has been produced in man by an oral dose of the order of 6 - 7 mg/kg. Animal studies have confirmed that TOCP is more toxic than the meta- and para-compounds, and that its main toxic effect is exerted primarily on the neuromuscular symptom."

Thienes and Haley further add that "absorption in man from the alimentary tract is adequate for poisoning." They give signs and actions of TOCP poisoning as "irritation of the stomach, soon after taking the material, with burning and sometimes colicky pains in the abdomen and nausea and vomiting. A few days (3 - 14) later, there is a tingling of the extremities and gradual onset of motor paralysis. The legs are involved more often than the arms. There is foot-drop, wrist-drop, loss of Plantar and Achilles reflexes, wasting of the interosseous muscles and loss of ability to support the weight of the body. The paralysis, which is usually bilaterally symmetrical, is generally thought to be due to a toxic action of the TOCP upon the motor nerve trunks, with secondary changes in the anterior horn cells of the spinal cord. Partial recovery may occur during a periods of a year or two, although paralysis below the knee rarely clears up." It is thought that TOCP is slowly hydrolyzed in the body, possibly in part in the nerve trunks. There is also evidence that there is transformation of TOCP in the liver to form a more toxic material than the parent. "Death is rarely, if ever, due to the poison, but rather to some intercurrent diseases." Patty further adds, "fatalities are quite rare and occur principally in those who have taken larger quantities in a short period of time.

According to Patty, in the group of compounds known to cause paralysis, TOCP "has been studied most extensively and is the one that has been stated to be the causative agent in various epidemics of poisoning in man. In all cases, these were associated with the ingestion of a material containing the ortho isomer, although in most cases this was present as

only a small proportion of the total ester."

Patty reports a case of "permanent paralysis in a man engaged in the manufacture of meta- and para-isomers of tricresyl phosphate." The man had worked a total of five months before symptoms of "anorexia, nausea and aching of the legs had developed." Patty further notes that a "recent study was made by Baldridge et al. of the exposure of humans to a triaryl phosphate used in hydraulic systems of aircraft carriers. The men exposed were studied carefully, and no cholinesterase changes or symptoms were noted in this short, "low level exposure."

Spector gives the oral LD50 for a rabbit at 100 mg/kg and the dog at 100 - 150 mg/kg. The NIOSH Toxic Substances List gives the LD50 for the rat at 3000 mg/kg.

Because of the serious consequences and wide spread examples of the effects of this compound's paralysis causing properties, a classification of 1 is concluded to be appropriate.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1975 (NFPA)

Monsanto Co., Material Safety Data Sheet (Mons)

Stauffer Chemical Co., Production Data Sheet, Lindol (Stauff)

FMC Corporation, Kronitex A A Data Sheet (FMC)

Sources of data items used:

I. A. 1. Synonyms: NFPA-325M, ADL
2. Formula: FMC
3. Molecular weight: FMC

B. 1. Boiling point: NFPA-325M, Mons
2. Specific gravity: Mons
3. Vapor density: None
4. Melting point: FMC
5. Vapor pressure: FMC
6. Solubility in water: Stauff
7. Evaporation rate: None
8. Appearance and odor: Stauff

II. A. 1. Flash point: NFPA-235M
2. Autoignition temperature: NFPA-325M
3. Flammable limits: None
4. Extinguishing media: Mons
5. Special fire fighting procedures: FMC, ADL
6. Unusual fire and explosion hazards: NFPA-325M, Stauff, Mons

B. 1. Conditions contributing to instability: ADL
2. Incompatibilities: None
3. Hazardous decomposition products: FMC, ADL
4. Special precautions: ADL

III. A. Steps if released or spilled: Stauff, FMC

C. Waste disposal method: Mons, ADL

V. Miscellaneous precautions: ADL

USE/EXPOSURE AND CONTROL DOCUMENT

Sources used in the preparation of this document include:

Deichmann, W. B. and Gerarde, H. W., "Toxicology of Drugs and Chemicals," Academic Press, New York, 1969 (Deichmann)
"Documentation of Threshold Limit Values," American Conference of Governmental Industrial Hygienists, 1971 (ACGIH)
Gafafer, W. M. - editor, "Occupational Diseases - A Guide to Their Recognition," U. S. Department Of HEW, 1966 (Gafafer)
Hamilton, A. and Hardy, H. L., "Industrial Toxicology," Publishing Sciences Group, Inc., 3rd edition, 1974 (Hamilton and Hardy)
Hawley, G. G. - editor, "The Condensed Chemical Dictionary," Van Nostrand Reinhold Company, 8th edition, 1971 (Hawley)
Hunter, D., "The Diseases of Occupations," Little, Brown and Company, Boston, 4th edition, 1968 (Hunter)
International Labour Organization, "Encyclopedia of Occupational Health and Safety," McGraw Hill, New York, 1971 (ILO)
Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, Division of John Wiley and Sons, Inc., 2nd edition, 1968 (K-O)
Patty, F. A., "Industrial Hygiene and Toxicology," Vol. II, Interscience Publishers, 1962 (Patty)
Piper, R., "Paint Hazards," Chemistry and Industry, Vol. 7, February 1967 (Piper)
Plunkett, E. R., "Handbook of Industrial Toxicology," Chemical Publishing Company, Inc., New York, 1966 (Plunkett)
Stanford Research Institute, "Chemical Economics Handbook," Menlo Park, California, January 1971 (CEH)
Stanford Research Institute, "Chemical Origins and Markets," Menlo Park, California, 4th edition, 1967 (Origins)
Tabershaw, I. R., Kleinfeld, M. and Feiner, B., "Manufacture of Tricreysl Phosphate and Other Alkyl Phenyl Phosphates: An Industrial Hygiene Study," A. M. A. Archives of Industrial Health, Vol. 15, June 1957 (Tabershaw)
"Tricresyl Phosphate," Chemical Profiles: Oil, Paint and Drug Reporter, Schnell Publishing Company, October 1972 (Profiles)
"Triorthocreysl Phosphate," Hygienic Guide Series, American Industrial Hygiene Association, September - October 1963 (AIHA)

References for Specific Use/Exposure

Hamilton and Hardy, CEH, Piper, Profiles, Origins, Hawley, Hunter, K-O, ILO, Plunkett and Gafafer were the references used in numbers 1 - 3.

4. Hamilton and Hardy, CEH, Origins, Hunter, ILO, Gafafer
5. Tabershaw, CEH, Profiles, Origins, Hawley, ILO, Gafafer
6. Tabershaw, Profiles, Hawley, Deichmann, ILO, Plunkett, Gafafer
7. Origins, Hawley, Plunkett, Gafafer
8. Profiles, Hawley
9. Hawley, ILO, Gafafer
10. Hunter, ILO
11. Hunter, ILO, Plunkett
12. Plunkett
13. Tabershaw

References for Specific Control Methods

AIHA, ACGIH, Patty, Hunter and ILO were the references used in all the Specific Control Methods.

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

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Triorthocresyl phosphate

D. O. L. STANDARD: 0.1 mg/M3

Eye Irritation Level: Triorthocresyl phosphate (TOCP) is not known to be an eye irritant.

IDLH: 40 mg/M3

Basis for IDLH Value: There are no acute inhalation toxicity data available upon which to base an IDLH concentration for TOCP. The chosen IDLH (40 mg/M3) has been estimated from oral toxicity data given in the Documentation of TLV's. The Documentation states that "serious paralysis has been produced in man by an oral dose of the order of 6 - 7 mg/kg."

Other Toxicological Information: The AIHA Hygienic Guides state that "TOCP is rarely encountered industrially as the pure isomer, and the evidence is that triarylphosphates containing one or two orthoalkyl groups are as toxic as TOCP. A limit on 'ortho content' is the best safeguard against a toxic potential. The meta and para isomers are relatively nontoxic . . . The ortho isomers are highly hazardous in single or repeated doses by any route of exposure. TOCP is absorbed readily from the digestive tract and through the skin. Vapor pressures of triarylphosphates are low, and at ordinary temperatures there is little vapor hazard. However, inhalation of fog, mist or aerosol could be the equivalent of ingestion. Thousands of people have been poisoned by ingestion of TOCP in contaminated foods and beverages, but despite the industrial uses of millions of pounds of triaryl-phosphates over several decades, reports of occupational cases number fewer than ten.

"The principal effect is a delayed, bilateral and symmetrical, flaccid paralysis of the distal muscles of the lower and, to a lesser extent, upper extremities, characterized by foot- and wrist-drop, with subsequent upper motor neuron signs. There is little or no sensory disturbance. Shortly after ingestion, there may be gastrointestinal symptoms including nausea, vomiting, diarrhea and abdominal pain. Remis these is followed by a symptom-free interval of 3- 28 days, the length c is probably dependent upon the 3 - 28 days, the length of which is proba dependent upon the size of the total dose, and the period of time over which it was ingested. While many paralytics have recovered completely, and others have improved sufficiently to be rehabilitated, prognosis is poor. The majority of victims never regain normal function of the central nervous system."

Patty states that "the minimum paralytic dose in man is uncertain, but it can be estimated to be somewhere between 10 and 30 mg/kg of tri-o-cresyl phosphate in an adult, based on studies by Smith."

The Documentation of TLV's states that TOCP "may be absorbed through the skin and may also exert its toxic action when swallowed. Consequently, the possibility of poisoning by ingestion or skin absorption is at least as important as that by inhalation. The oral toxicity in man is well known because of a number of incidents in which TOCP has found its way into foods or beverages. It is estimated that the lethal dose for man by ingestion is 1.0 g/kg. Serious paralysis has been produced in man by an oral dose of the order of

6 - 7 mg/kg. Animal studies have confirmed that triorthocresyl phosphat is more toxic than the meta- and para-compounds, and that its main toxic effect is exerted primarily on the neuro-muscular system.

"There have been only a few reports of occupational intoxication from TOCP. Hunter and associates described three cases of polyneuritis in workers engaged in its manufacture under blackout conditions. Air tests in different areas revealed concentrations below 2.5 mg/M3; below 1 mg/M3; and between 0.5 and 1.7 mg/M3. Absorption through the skin was not ruled out.

"At present, a TLV of 0.1 mg/M3 is recommended. It may be noted that men exposed over a period of several months at 1.5 mg/M3 of commercial hydraulic fluid equivalent to 21% triorthocresyl phosphate in toxic acitivity showed no physical or neurological abnormalities on careful medical examination.

"Tabershaw and associates also found no adverse effect on health from exposure to various triaryl phosphates, containing up to 20% TOCP, in concentrations ranging from 0.27 to over 3 mg/M3. There was a decrease in plasma cholinestrase, however, in a significant number of workers.

VAPOR PRESSURE: At 25 C: 1.7 x 10e-6 mm Hg; at 150 C: 2 x 10e-2 mm Hg
SATURATED CONCENTATION: At 25 C: Approximately .0022 ppm (0.034 mg/M3);
At 150 C: Approximately 26 ppm (390 mg/M3)

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

USE/EXPOSURE AND CONTROL DOCUMENT
TRIORTHOCRESYL PHOSPHATE

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of aerosol and skin contact with liquid during use as a flame retardant and plasticizer in formulating chlorinated rubber, nitrile rubber and resins such as polyvinyl chloride, polystyrene, acrylics, cellulose esters and alkyds	A,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
2.	Inhalation of aerosol and skin contact with liquid during hot extrusion, molding or other bulk forming of plasticized polyvinyl chloride, polystyrene, cellulose esters and acrylics	A,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
3.	Inhalation of aerosol and skin contact with liquid during hot spray application of coatings and adhesives based on plasticized cellulose esters and alkyds	A,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
4.	Skin contact with liquid during use as a gasoline additative to control preignition	D	Personal protective equipment (goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
5.	Inhalation of aerosol and skin contact with liquid during use as a hydraulic fluid and a heat exchange medium	A,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, goggles, gloves, boots, protective clothing and barrier creams); meticulous personal

			hygiene
6.	Skin contact with liquid during use as a synthetic lubricant	D	Personal protective equipment (goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
7.	Skin contact with liquid during use as a waterproofing agent	D	Personal protective equipment (goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
8.	Skin contact with liquid during use as a primary component of adhesives for air filter media	D	Personal protective equipment (goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
9.	Skin contact with liquid during use in solvent mixtures for nitrocellulose and other natural resins	D	Personal protective equipment (goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
10.	Skin contact with liquid during use as an extraction solvent in the recovery of phenol from gas-plant effluents and coke-oven waste waters	D	Personal protective equipment (goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
11.	Skin contact with liquid during use in grinding media for pigments	D	Personal protective equipment (goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
12.	Inhalation of aerosol and skin contact with liquid during use as an intermediate in the synthesis of pharmaceuticals	A,D	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment (respiratory protective devices, goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene
13.	Inhalation of aerosol and vapor, and skin contact	A,D	General dilution ventilation; process enclosure;

with liquid during the production of triorthocresyl phosphate by the reaction of alkyl phenols and phosphorous oxychloride	local exhaust ventilation; personal protective equipment (respiratory protective devices, goggles, gloves, boots, protective clothing and barrier creams); meticulous personal hygiene

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 ------

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