

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** TIN, ORGANIC COMPOUNDS ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for TIN, ORGANIC COMPOUNDS

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 TIN, ORGANIC COMPOUNDS.

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 organic tin compounds (as tin) not in excess of 0.1 milligrams 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 organic tin compounds averaged over an eight-hour work shift.

(b) Initial determination and exposure measurement. (1) Each employer who has a place of employment in which organic tin compounds is released into the workplace air shall determine if there is any possibility that any employee may be exposed to airborne concentrations of organic tin compounds above the permissible level. The initial determination shall be made each time there is a change in production, process, or control measures which may result in an increase in airborne concentrations of organic tin compounds.

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

(i) Any information, observations, or calculations which may indicate employee exposure to organic tin compounds;

(ii) Any measurements of organic tin compounds taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to organic tin compounds; and

(iv) Date of initial determination, work being performed at the time, location within work site, and employees considered.

(3) If the employer determines that any employee may be exposed to organic tin compounds above the permissible exposure, 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 organic tin compounds above the action level, the employer shall:

(i) Identify all employees who may be exposed above the permissible level; and

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

(5) If an employee exposure measurement reveals that an employee is exposed to organic tin compounds above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every three months.

(6) If an employee exposure measurement reveals that an employee is exposed to organic tin compounds 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 organic tin compounds above the permissible exposure. The employee shall also be notified of the results of the exposure measurements and of the corrective action being taken to reduce the exposure to below the permissible exposure.

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

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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 (Percent of True Value)
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Above permissible exposure	± 25
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At or below permissible exposure and above the action level	± 35
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At or below the action level	± 50
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(d) Compliance. (1) No employee shall be exposed to organic tin compounds above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of organic tin compounds 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 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. When local exhaust is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity or static pressure 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 organic tin compounds.

(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 not feasible; or

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(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of organic tin compounds 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 ORGANIC TIN COMPOUNDS (AS TIN)

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Particulate Concentration	
1 mg/M3 or less	Any chemical cartridge respirator with organic vapor cartridge(s) and dust and mist filter(s). Any supplied-air respirator. Any self-contained breathing apparatus.
5 mg/M3 or less	Any chemical cartridge respirator with a full facepiece, organic vapor cartridge(s) and high efficiency filter(s). Any supplied-air respirator with a full facepiece, helmet or hood. Any self-contained breathing apparatus with a full facepiece.
100 mg/M3 or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
200 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 200 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

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operated in pressure-demand or other positive pressure mode.

Escape

Any escape self-contained breathing apparatus.

A gas mask providing protection against organic vapors and particulates.

(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 organic tin compounds.

(2) Sources of ignition such as smoking or open flames are prohibited where organic tin compounds present a fire or explosion hazard.

(3) Organic tin compounds shall be stored so as not to come in contact with strong oxidizers.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use appropriate protective clothing and equipment necessary to prevent any possibility of skin contact with triphenyltin chloride or liquids containing triphenyltin chloride. Face shields shall comply with § 1910.133 (a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employers shall provide and ensure that employees use appropriate protective clothing and equipment necessary to prevent repeated or prolonged skin contact with dibutyltin di-2-ethylhexoate or liquids containing dibutyltin di-2-ethylhexoate, liquid bis(tri-n-butyltin) oxide, solid or liquid dibutyltin diacetate, liquid tetrabutyltin, or liquid stannous 2-ethylhexoate. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (a)(6).

(3) Employers shall provide and ensure that employees use appropriate protective clothing and equipment necessary to prevent skin contact with dibutyltin dichloride or liquids containing dibutyltin dichloride, where skin contact may occur. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (a)(6).

(4) Employers shall ensure that employees whose clothing has had any possibility of being contaminated with solid triphenyltin chloride or dibutyltin dichloride change into uncontaminated clothing before leaving the work premises.

(5) Employers shall ensure that employees whose clothing may have become contaminated with solid dibutyltin di-2-ethylhexoate change into uncontaminated clothing before leaving the work premises.

(6) Employers shall ensure that clothing contaminated with dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyltin diacetate, tetrabutyltin or stannous 2-ethylhexoate is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of the contaminant from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the contaminant, the employer shall inform the person performing the operation of the hazardous properties of the contaminant.

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(7) Where there is any possibility of exposure of an employee's body to triphenyltin chloride or liquids containing triphenyltin chloride, employers shall provide facilities for quick drenching of the body within the immediate work area for emergency use.

(8) Where exposure of an employee's body to dibutyltin dichloride or liquids containing dibutyltin dichloride may occur, employers shall provide facilities for quick drenching of the body within the immediate work area for emergency use.

(9) Employers shall ensure that non-impervious clothing which becomes contaminated with triphenyltin chloride or dibutyltin dichloride be removed immediately and not reworn until the contaminant is removed from the clothing.

(10) Employers shall ensure that non-impervious clothing which becomes contaminated with dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, dibutyltin diacetate, tetrabutyltin or stannous 2-ethylhexoate be removed promptly and not reworn until the contaminant is removed from the clothing.

(11) Employers shall provide and ensure that employees use safety goggles which comply with § 1910.133 (a)(2)-(a)(6) where there is any possibility of triphenyltin chloride or liquids containing triphenyltin chloride contacting the eyes.

(12) Employers shall provide and ensure that employees use safety goggles which comply with § 1910.133(a)(2)-(a)(6) where dibutyltin di-2-ethylhexoate or liquids containing dibutyltin di-2-ethylhexoate, dibutyltin dichloride or liquids containing dibutyltin dichloride, liquid bis(tri-n-butyltin) oxide, solid or liquid dibutyltin diacetate, liquid tetrabutyltin, or liquid stannous 2-ethylhexoate may contact the eyes.

(13) Where there is any possibility that an employee's eyes may be exposed to triphenyltin chloride or liquids containing triphenyltin chloride, employers shall provide an eye-wash fountain within the immediate work area for emergency use.

(g) Spills and disposal. In the event that organic tin compounds are 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 triphenyltin chloride or dibutyltin dichloride immediately flush the skin with large quantities of water to remove any contaminant from the skin.

(2) Employers shall ensure that all employees subject to skin contact with solid dibutyltin di-2-ethylhexoate, triphenyltin chloride, or dibutyltin dichloride wash with soap or mild detergent and water any areas of the body which may have contacted a contaminant at the end of each workday.

(3) Employers shall ensure that employees whose skin becomes contaminated with dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, dibutyltin diacetate, tetrabutyltin or stannous 2-ethylhexoate promptly wash or shower with soap and mild detergent and water to remove any contaminant from the skin.

(4) Employers shall ensure that employees do not eat or smoke in areas where dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, dibutyltin dichloride, dibutyltin diacetate, or tetrabutyltin are handled, processed, or stored.

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(5) Employers shall ensure that employees who handle dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyltin diacetate, tetrabutyltin or stannous 2-ethylhexoate 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 organic tin compounds are 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 organic tin compounds above the action level without regard to the use of respirators, or employees who may have any possibility of skin contact with solid triphenyltin chloride or liquids containing triphenyltin chloride, or who may have skin contact with solid dibutyltin dichloride or liquids containing dibutyltin dichloride, or who may have repeated or prolonged skin contact with solid dibutyltin di-2-ethyl diacetate liquid bis(tri-n-butyltin) oxide, dibutyltin diacetate, tetrabutyltin, stannous 2-ethylhexoate, or liquids containing these compounds, or who may have any possibility of eye contact with triphenyltin chloride or liquids containing triphenyltin chloride or who may have eye contact with dibutyltin di-2-ethylhexoate, dibutyltin dichloride, bis(tri-n-butyltin) oxide, dibutyltin diacetate, tetrabutyltin, stannous 2-ethylhexoate, or liquids containing these compounds, or employees who work where organic tin compounds present a fire or explosion hazard shall annually:

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

(ii) Advise affected employees as to the signs and symptoms of exposure to organic tin compounds.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of overexposure to organic tin compounds 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 organic tin compounds.

(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) Preplacement medical examination. The employer shall make available to each employee who is exposed, or will be exposed, to airborne concentrations of organic tin compounds above the action level, without regard to the use of respirators, or employees who may have any possibility of skin contact with solid triphenyl tin chloride or liquids containing triphenyl tin chloride, or who may have skin contact with solid dibutyl tin dichloride or liquids containing dibutyl tin dichloride, or who may have repeated or prolonged skin contact with solid dibutyl tin di-2-ethyl diacetate, liquid bis (tri-N-butyl tin) oxide, liquid dibutyl tin diacetate, liquid tetrabutyl tin, liquid stannous 2-ethyl hexoate, or liquids containing these compounds or who may have any possibility of eye contact with triphenyl tin chloride or liquids containing triphenyl tin chloride or who may have eye contact with dibutyl tin di-2-ethyl hexoate,

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dibutyl tin dichloride, bis (tri-N-butyl tin) oxide, dibutyl tin diacetate, tetrabutyl tin, stannous 2-ethyl hexoate, or liquids containing these compounds a preplacement medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the central nervous system, eyes, liver, urinary tract and skin;

(ii) A complete blood count to include at least red and white cell count, a differential smear, hemoglobin and hematocrit;

(iii) Urinalysis to include specific gravity, albumin, glucose and a microscopic on centrifuged sediment;

(iv) A profile of liver function.

(3) Periodic medical examination. The employer shall make available to each employee exposed to airborne concentrations of organic tin compounds above the action level, without regard to the use of respirators, or employees who may have any possibility of skin contact with solid triphenyl tin chloride or liquids containing triphenyl tin chloride, or who may have skin contact with solid dibutyl tin dichloride or liquids containing dibutyl tin dichloride, or who may have repeated or prolonged skin contact with solid dibutyl tin di-2-ethyl diacetate, liquid bis (tri-N-butyl tin) oxide, liquid dibutyl tin diacetate, liquid tetrabutyl tin, liquid stannous 2-ethyl hexoate, or liquids containing these compounds or who may have any possibility of eye contact with triphenyl tin chloride or liquids containing triphenyl tin chloride or who may have eye contact with dibutyl tin di-2-ethyl hexoate, dibutyl tin dichloride, bis (tri-N-butyl tin) oxide, dibutyl tin diacetate, tetrabutyl tin, stannous 2-ethyl hexoate, or liquids containing these compounds twenty-four months from the date of the employee's first exposure, and every twenty-four months thereafter, a periodic medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the central nervous system, eyes, liver, urinary tract and skin;

(ii) A complete blood count to include at least red and white cell count, a differential smear, hemoglobin and hematocrit;

(iii) Urinalysis to include specific gravity, albumin, glucose and a microscopic on centrifuged sediment;

(iv) A profile of liver function.

(4) Alternative medical procedures. If the examining physician chooses to use alternative medical procedures to those specified in paragraphs (j)(2) and (j)(3) of this section, the employer may accept such alternative medical procedures as meeting the requirements of this section provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical procedures, the rationale for substitution, and evidence that they will be equally effective;

(ii) Informs each exposed worker of the fact that alternative medical procedures to those required in paragraphs (j)(2) and (j)(3) of this section are to be made available.

(5) 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 organic tin compounds which are listed in Appendix A which the employee suspects are caused by exposure to organic tin compounds.

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(6) 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 organic tin compounds;

(ii) A description of the affected employee's duties as they relate to his exposure to organic tin compounds;

(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.

(7) 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.

(8) Physician's written opinion. (i) The physician's written opinion by the examining physician shall specifically state:

(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 organic tin compounds;

(B) Any recommended limitations upon the employee's exposure to organic tin compounds, 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 the employee's employment.

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

(9) Results of tests. Where a preplacement or periodic medical examination is required by paragraphs (j)(2) or (j)(3) of this section, following such examination the employer shall obtain from the examining physician for inclusion in the employee's medical record:

(i) A recording of the results of the blood tests, liver function tests and urinalysis;

(ii) Where alternative medical procedures have been performed in accordance with paragraph (j)(4) of this section, a recording of such alternative procedures.

(10) No employee shall be exposed to organic tin compounds in such a way as would put the employee at increased risk of material impairment of his health from such exposure. The employer shall base this decision on any information available including the physician's written opinion.

(11) No medical procedure which would be performed pursuant 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.

(12) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of

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such refusal and obtain a signed statement from the employee indicating that the employee understands the risk involved by refusal to be examined.

(13) The employer shall provide emergency medical treatment for any employee injured through exposure to organic tin compounds.

(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 organic tin compounds.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to organic tin compounds 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 organic tin compounds;

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(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 organic tin compounds.

(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 each employee or his representative an opportunity to observe any measurement of his exposure to organic tin compounds which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to organic tin compounds 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 organic tin compounds that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendix for organic tin compounds is neither intend, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent the information supplements this regulation for organic tin compounds it is advisory in nature.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR ORGANIC TIN COMPOUNDS

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I. SUBSTANCE IDENTIFICATION

- A. Substance: Organic tin compounds
- B. Permissible exposure: 0.1 milligram of organic tin compounds per cubic meter of air (mg/M3) averaged over an eight-hour workshift.
- C. Appearance and odor: a) Dibutyltin di-2-ethylhexoate: Waxy solid with a weak odor; b) Bis(tri-n-butyltin) oxide: Colorless to yellow liquid; c) Triphenyltin chloride: Colorless to yellow solid; d) Dibutyltin dichloride: Light tan or colorless solid or semi-solid; e) Dibutyltin diacetate: Colorless liquid with weak vinegar odor; f) Tetra-butyltin: Colorless liquid with a distinct characteristic odor; g) Stannous 2-ethylhexoate: Pale yellow viscous liquid with a characteristic odor.

II. HEALTH HAZARD DATA

- A. Ways in which the chemical affects your body: Organic tin compounds can affect your body if you inhale them or if they come in contact with your eyes or skin. They may also affect your body if you swallow them or they may be absorbed through the skin.
- B. Effects of Overexposure:
 - 1. Little is known of the toxicity of monoalkyl tin compounds except that the toxicity of monoethyl tin chloride is low. Dialkyl tin compounds have caused irritation of the skin and damage to the liver and bile ducts in animals. This has resulted in animal deaths from liver failure and peritonitis. Swallowing diethyl tin has caused permanent damage to the nervous system and deaths in humans. Trialkyl and tetraalkyl tin compounds have caused nervous system damage in animals. Trialkyl and dibutyl tins have caused skin burns in humans. Tetramethyl and tetraethyl tin have caused headache and vomiting in humans. Tributyl tin compounds have caused severe skin burns in humans.
 - 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 organic tin compounds.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If organic tin compounds get 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 these chemicals.
- B. Skin Exposure: If dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyl diacetate, tetra-butyltin, or stannous 2-ethylhexoate get on your skin, immediately flush with large amounts of water and then wash with soap or mild detergent and water. If dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyl diacetate, tetra-butyltin, or stannous 2-

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ethylhexoate soak through your clothing, remove the clothing immediately flush with large amounts of water and then wash with soap or mild detergent and water. Get medical attention immediately.

- C. Breathing: If you or any other person breathes in large amounts of organic tin compounds 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 organic tin compounds have 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 organic tin compounds. 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 their use is required. If you can smell dibutyltin di-2-ethylhexoate while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.
- B. Protective Clothing: You must wear appropriate protective clothing and equipment to prevent any possibility of skin contact with triphenyltin chloride or liquids containing triphenyltin chloride, to prevent repeated or prolonged skin contact with dibutyltin di-2-ethylhexoate or liquids containing dibutyltin di-2-ethylhexoate, liquid bis(tri-n-butyltin) oxide, solid or liquid dibutyltin diacetate, liquid tetrabutyltin, or liquid stannous 2-ethylhexoate, and to prevent skin contact with dibutyltin dichloride or liquids containing dibutyltin dichloride where skin contact may occur. Replace or repair impervious clothing that has developed leaks.

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- C. Eye Protection: You must wear dust-resistant safety goggles where there is any possibility of triphenyltin chloride contacting your eyes, and where dibutyltin di-2-ethylhexoate, dibutyltin dichloride, or solid dibutyltin diacetate, may contact your eyes. You must wear splash-proof safety goggles where there is any possibility of liquids containing triphenyltin chloride contacting your eyes or where liquids containing dibutyltin di-2-ethylhexoate or dibutyltin dichloride and liquid bis(tri-n-butyltin), liquid dibutyltin diacetate, liquid tetrabutyltin and liquid stannous 2-ethylhexoate may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE

- A. Dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyltin diacetate, tetrabutyltin, or stannous 2-ethylhexoate are combustible. Their vapors can form explosive mixtures with air at elevated temperatures.
- B. Dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyltin diacetate, tetrabutyltin, or stannous 2-ethylhexoate must be stored in tightly closed containers in a cool, well ventilated area away from strong oxidizers.
- C. Sources of ignition such as smoking and open flames are prohibited wherever dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyltin diacetate, tetrabutyltin, or stannous 2-ethylhexoate are handled, used, or stored in a manner that could create a potential fire or explosion hazard.
- D. If your work clothing has had any possibility of being contaminated with solid triphenyltin chloride or dibutyltin dichloride, you must change into uncontaminated clothing before leaving the work premises.
- E. If your work clothing may have become contaminated with solid dibutyltin di-2-ethylhexoate, you must change into uncontaminated clothing before leaving the work premises.
- F. You must immediately remove any non-impervious clothing that becomes contaminated with triphenyltin chloride or dibutyltin dichloride and this clothing must not be reworn until the contaminant is removed from the clothing.
- G. You must promptly remove any non-impervious clothing that becomes contaminated with dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, dibutyltin diacetate, tetrabutyltin, or stannous 2-ethylhexoate and this clothing must not be reworn until the contaminant is removed from the clothing.
- H. If your skin becomes contaminated with triphenyltin chloride or dibutyltin dichloride, you must immediately wash or shower to remove any contaminant from your skin.
- I. If your skin becomes contaminated with dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, dibutyltin diacetate, tetrabutyltin, or stannous 2-ethylhexoate, you must promptly wash or shower with soap or mild detergent and water to remove any contaminant from your skin.

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- J. If you are subject to skin contact with solid dibutyltin di-2-ethylhexoate, triphenyltin chloride, or dibutyltin dichloride, at the end of each workday you must wash or shower using soap or mild detergent and water any areas of the body which may have contacted a contaminant.
- K. You must not eat or smoke in areas where dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, dibutyltin dichloride, dibutyltin diacetate, or tetrabutyltin are handled, processed, or stored.
- L. If you handle dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyltin diacetate, tetrabutyltin, or stannous 2-ethylhexoate, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.
- M. Fire extinguishers, quick drenching facilities, and eye flushing facilities, where provided, must be readily available and you should know where they are and how to operate them.
- N. Ask your supervisor where dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyltin diacetate, tetrabutyltin, or stannous 2-ethylhexoate are 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 organic tin compounds. In addition, your employer must instruct you in the safe use of organic tin compounds emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to organic tin compounds. 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 physician's written opinion for any physical examination required by this standard.

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NOTE: The information contained in the following appendix for organic tin compounds is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent the information supplements this regulation for organic tin compounds, it is advisory in nature.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR ORGANIC TIN COMPOUNDS

(This standard for organic tin compounds should not be interpreted to apply only to those listed below for which substance specific information has been provided)

a. Dibutyltin di-2-ethylhexoate

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Dibutyltin dioctoate
2. Formula: $(C_4H_9)_2Sn(C_8H_{15}O_2)_2$
3. Molecular weight: 522.7

B. Physical Data

1. Boiling point (760 mm Hg): Decomposes
2. Specific gravity (water = 1): 1.07
3. Vapor density (air = 1 at boiling point of Dibutyltin di-2-ethylhexoate): Not applicable
4. Melting point: 54 C (129 F)
5. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
6. Solubility in water, grams of dibutyltin di-2-ethylhexoate per 100 grams of water at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Waxy solid with a weak odor

b. Bis(tri-n-butyltin) oxide

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: TBTO
2. Formula: $((C_4H_9)_3Sn)_2O$
3. Molecular weight: 595.4

B. Physical Data

1. Boiling point (760 mm Hg): 254 C (489 F) at 50 mm Hg
2. Specific gravity (water = 1): 1.17
3. Vapor density (air = 1 at boiling point of Bis(tri-n-butyltin) oxide): Not applicable
4. Melting point: Data not available
5. Vapor pressure at 20 C (68 F): Much less than 1 mm Hg

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6. Solubility in water, grams of bis(tri-n-butyltin) oxide per 100 grams of water at 20 C (68 F): Less than 20 ppm
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless to yellow liquid with weak

c. Triphenyltin chloride

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: None
2. Formula: $(C_6H_5)_3SnCl$
3. Molecular weight: 385.5

B. Physical Data

1. Boiling point (760 mm Hg): 240 C (464 F) at 13 mm Hg
2. Specific gravity (water = 1): Greater than 1
3. Vapor density (air = 1 at boiling point of Triphenyltin chloride): Not applicable
4. Melting point: 106 C (223 F)
5. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
6. Solubility in water, grams of triphenyltin chloride per 100 grams of water at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless to yellow solid with a characteristic odor

d. Dibutyltin dichloride

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: None
2. Formula: $(C_4H_9)_2SnCl_2$
3. Molecular weight: 303.8

B. Physical Data

1. Boiling point (760 mm Hg): 135 C (275 F) at 10 mm Hg
2. Specific gravity (water = 1): 1.36
3. Vapor density (air = 1 at boiling point of Dibutyltin dichloride): Not applicable
4. Melting point: 43 C (109 F)
5. Vapor pressure at 20 C (68 F): 2 mm Hg/100 C (212 F)
6. Solubility in water, grams of dibutyltin dichloride per 100 grams of water at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance: Light tan or colorless solid or semi-solid

e. Dibutyltin diacetate

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: None
2. Formula: $(C_4H_9)_2Sn(C_2H_3O_2)_2$
3. Molecular weight: 351

B. Physical Data

1. Boiling point (760 mm Hg): 144 C (291 F) at 10 mm Hg
2. Specific gravity (water = 1): 1.32
3. Vapor density (air = 1 at boiling point of Dibutyltin diacetate): Not applicable
4. Melting point: 10 C (50 F)
5. Vapor pressure at 20 C (68 F): 1.3 mm Hg

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6. Solubility in water, grams of dibutyltin diacetate per 100 grams of water at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless liquid with a weak vinegar o

f. Tetra-butyltin

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Tetra-n-butyltin
2. Formula: $(C_4H_9)_4Sn$
3. Molecular weight: 347.2

B. Physical Data

1. Boiling point (760 mm Hg): 145 C (293 F) at 10 mm Hg
2. Specific gravity (water = 1): 1.06
3. Vapor density (air = 1 at boiling point of Tetra-butyltin): Not applicable
4. Melting point: Less than -70 C (less than -94 F)
5. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
6. Solubility in water, grams of tetra-butyltin per 100 grams of (68 F): Slight
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless liquid with a distinct characteristic odor

g. Stannous 2-ethylhexoate

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Stannous octoate; tin octoate
2. Formula: $Sn(C_8H_{15}O_2)_2$
3. Molecular weight: 404.7

B. Physical Data

1. Boiling point (760 mm Hg): Decomposes at 200 C (392 F)
2. Specific gravity (water = 1): 1.26
3. Vapor density (air = 1 at boiling point of Stannous 2-ethylhexoate): Not applicable
4. Melting point: Less than -25 C (less than -13 F)
5. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
6. Solubility in water, grams of stannous 2-ethylhexoate per 100 grams of water at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Pale yellow viscous liquid with a characteristic odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: a) Dibutyltin di-2-ethylhexoate - data not available; b) Bis(tri-n-butyltin) oxide - greater than 100 (212 F); c) Triphenyltin chloride - data not available; d) Dibutyltin dichloride - 168 C (334 F); e) Dibutyltin diacetate - 143 C (289 F); f) Tetra-butyltin - 124 C (255 F) g) Stannous 2-ethylhexoate - 142 C (287 F)
2. Autoignition temperature: Data not available
3. Flammable limits in air, % by volume: Data not available (probably because too high boiling points)
4. Extinguishing media: Water, foam, dry chemical and carbon d

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5. Special fire-fighting procedures: Use water spray to cool containers exposed to a fire.
6. Unusual fire and explosion hazards: All ignition sources must be controlled where combustible tin compounds are used, handled or stored in a manner that could create a potential fire or explosion hazard.

B. Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors may be released in a fire involving organic tin compounds
4. Special precautions: Organic tin compounds will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If organic tin compounds are spilled or leaked, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation, or for disposal in a secured sanitary landfill. Liquids containing organic tin compounds should be absorbed in vermiculite, dry sand, earth or a 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: Organic tin compounds may be disposed of in sealed containers in a secured sanitary landfill.

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 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 collection of the particulates and vapors using a high efficiency membrane filter with subsequent chemical analysis of the sample. Detector tubes certified by NIOSH under 42 CFR part 84 or other direct-reading devices calibrated to measure organic tin compounds may be used. The method of measurement must determine the concentration of organic tin compounds to plus or minus 35% of the true value.
- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described above. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry

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by the American Industrial Hygiene Association. The method of measurement must determine the concentration of organic tin compounds to plus or minus 25% of the true value.

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 organic tin compounds in tightly closed containers in a cool, well ventilated area.

B. Employers should advise employees of all areas and operations where their exposure to organic tin compounds could occur.

VI. COMMON OPERATIONS

Common operations in which high exposures to dibutyltin di-2-ethylhexoate, bis(tri-n-butyltin) oxide, triphenyltin chloride, dibutyltin dichloride, dibutyl diacetate, tetrabutyltin, or stannous 2-ethylhexoate may occur are: During their use as an ingredient in economic poisons, antifouling paints, fungicides, biocides, and rodent repellants; as intermediates in the manufacture of other organo-tin compounds, especially stabilizers for poly (vinyl chloride); as catalysts in the synthesis of silicone resins and polyurethane foams; and as corrosion inhibitors.

NOTE: The information contained in the following appendix for organic tin compounds is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent the information supplements this regulation for organic tin compounds, it is advisory in nature.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; skin absorption.

II. TOXICOLOGY

The organic tin compounds, chiefly solids and liquids, cause irritation of the eyes, throat, and skin; some produce cerebral edema, while others cause hepatic necrosis. Oral administration of a preparation of organic tin containing diethyltin di-iodide and up to 10 per cent triethyltin for treatment of human furunculosis resulted in 217 cases of poisoning of which 100 were fatal. After a

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latent period of 4 days there was severe persistent headache followed by vertigo, visual disturbances including photophobia, abdominal pain, vomiting, and urinary retention; the more severe cases showed transient or permanent paralysis and psychic disturbances. Residual symptoms in those who recovered included persistent headache, diminished visual acuity, partial paresis, focal anesthesia, and in 4 severe cases, flaccid paraplegia with incontinence. The most significant lesion found at necropsy was cerebral edema. Repeated oral administration to rats of 50 mg/kg of dibutyltin chloride resulted in inflammation of bile ducts and hepatic necrosis; repeated skin applications of 10 mg/kg caused severe local skin injury and bile duct damage. Triethyltin sulfate administered repeatedly to rats at 10 mg/kg caused tremors and paresis which in some animals progressed to complete paralysis and death; it was equally toxic by mouth and by injection. In mice, tributyltin chloride had a marked hemolytic action, while dibutyl and tetrabutyl tin were less markedly hemolytic. Workers exposed to the vapor or fume of butyltin compounds developed sore throat and cough several hours after exposure. Chemical burns from organic tin compounds may result from only brief contact with the skin; pain is usually moderate and itching is the chief symptom; healing is usually complete within 7-10 days. When a worker was splashed in the face with a tributyltin compound, lacrimation and severe conjunctivitis appeared within minutes, despite immediate lavage, and persisted for 4 days; at the end of 7 days the eyes appeared normal.

III. SIGNS AND SYMPTOMS

Severe persistent headache, vertigo; eye irritation; psychic and neurological disturbances; sore throat, cough; abdominal pain, vomiting; urinary retention; partial paresis, focal anesthesia; skin burns; pruritis from prolonged or repeated skin contact; by analogy to effects caused in animals, hemolysis and hepatic necrosis may occur.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Immediately flush skin and eyes with water. Follow by washing skin with soap or mild detergent and water. If swallowed and the person is conscious, immediately administer water and induce vomiting. Give artificial resuscitation if indicated. Careful monitoring for delayed onset of pulmonary edema, for skin effects and liver damage should be maintained.

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VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Trialkyltin compounds cause central nervous system damage and have resulted in death in humans when ingested; tri- and dialkyltin compounds are irritants of the eyes, throat, and skin. Skin absorption is known to occur. It is important that the physician become familiar with plant operating conditions in which exposure to tin 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 organic compounds of tin:

1. A complete history and physical examination -- The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the central nervous system, eyes, liver and urinary tract should be stressed. The skin should be examined for evidence of chronic disorders.
2. Urinalysis -- Since some organic tin compounds may cause urinary retention, a urinalysis shall be obtained to include at a minimum specific gravity, albumin, glucose and a microscopic on centrifuged sediment.
3. Liver function tests -- Organic tin compounds cause hepatic necrosis in animals. A profile of liver function shall be obtained by using a medically acceptable array of biochemical tests.
4. A complete blood count -- Organic tin compounds cause hemolysis in animals. A complete blood count must be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

C. PERIODIC EXAMINATIONS

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

VII. REFERENCES

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1. American Conference of Governmental Industrial Hygienists: "Tin (Organic Compounds as Sn)," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 258.
2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1148-1153.
3. Browning, Ethel: Toxicity of Industrial Metals (2d ed.), Butterworths, London, 1969, pp. 323-330.
4. Lyle, W.H.: "Lesions of the Skin in Process Workers Caused by Contact with Butyl Tin Compounds," British Journal of Industrial Medicine, 15:193-196, 1958.
5. Barnes, J.M. and H.B. Stoner: "The Toxicology of Tin Compounds," Pharmacological Reviews, 11:211-231, 1959.

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REFERENCES AND SOURCES
ORGANIC TIN COMPOUNDS

1910.1000

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

Eye: Grant, "Toxicology of the Eye;" "Encyclopedia of Occupational Health and Safety," International Labour Office; Browning, "Toxicity of Industrial Metals"

Skin: Browning, "Toxicity of Industrial Metals;" ACGIH, "Documentation in Support of Threshold Limit Values for Substances in Workroom Air;" Deichmann and Gerarde, "Toxicology of Drugs and Chemicals;" Patty, "Industrial Hygiene and Toxicology;" Stauden, "Kirk-Othmer Encyclopedia of Chemical Technology"

Ingestion: Browning, "Toxicity of Industrial Metals;" Patty, "Industrial Hygiene and Toxicology;" ACGIH, "Documentation in Support of Threshold Limit Values for Substances in Workroom Air;" Mazayev, Kozolev, A. A., and Skhachkhova, I. N., "Experimental Investigation of the Toxic Effects of Tetraethyltin and Dichlorodibutyltin on the Animal Organism," Jour. of Hygiene, Epidemiology, Microbiology, and Immunology, vol. 15, pg. 115-120, 1971; Christensen, "NIOSH Toxic Substances List"

COMMENTS

Eye - Classification: See below

Output statement numbers: See below

Exceptions: None

Of dibutyltin dichloride, Grant states "one instance of eye is reported in a worker who accidentally splashed the liquid in his face and eyes. Despite immediate washing with water, lacrimation conjunctival hyperemia appeared within minutes and persisted for days. At the end of a week the skin was still erythematous, but eyes appeared normal."

In the case of dibutyl and tributyl tin chloride, the ILO reports "acute conjunctivitis has been observed as a result of eye splash even when followed by immediate lavage."

Of organic tin compounds in general, Browning notes "the eyes are rarely involved, but accidental splashing can cause lachrymation and intense suffusion of the conjunctiva which persists for several days, but with no permanent injury."

In the following section concerning skin contact, it is shown that bis(tri-n-butyltin) oxide is a primary skin irritant, that diacetate is not capable of causing skin burns on single application while dibutyltin dichloride is, and that triphenyltin chloride is strongly vesicant and can cause serious burns.

From this information, it is concluded that triphenyltin chloride warrants classifications of 1 and 5, while classifications of 2 and 6 are necessary and sufficient for the other organic tin compounds of interest. Statements 9 - 13 are therefore utilized as appropriate for these compounds with no exceptions.

Skin - Classification: See below

Output statement numbers: See below

Exceptions: See below

Browning states for dibutyltin chloride that "skin application of 10 mg/kg over a period of 12 days caused severe local damage to

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typical bile duct injury. Other dialkyl salts (dimethyl, di-n-pr tin chloride, etc.) had similar effects, but the dioctyl and othe higher homologues had no demonstrable toxicity to rats, rabbits, guinea pigs either by administration or application to the skin i large doses." Writing of skin lesions, she adds "acute burns fro organic tin compounds may result from only short contact with the especially of the tributyl and dibutyl compounds. The lesion, wh produced experimentally by painting tributyltin monochloride . . appeared after a delay of 2 - 3 hours and consisted of reddening swelling of the hair follicles; this became more intense over the next 8 hours There was little oedema, the surface of the remained dry After a week on faint erythema and sealing remained. With severe accidental burns there is never great pain itching is the principal symptom and healing is usually complete within a week or 10 days. Subacute lesions are especially characterized by itching . . . owing to contamination of the clot by vapour or spilling. The lesion is a faint erythematous erupti which disappears rapidly on removal from contact."

The ACGIH states of bis(tri-n-butyltin) oxide that "the substance is a primary skin irritant capable of penetrating the intact skin; furthermore, it may be capable of inducing sensitiz Lyle found skin lesions relatively common among men handling tri-tin compounds. There was no evidence of systemic poisoning . . .

Deichmann and Gerarde report that "chemical burns of the ski have been reported in workers handling dibutyltin dichloride and tributyltin chloride. Skin irritation may not be apparent for at least an hour, and sometimes not before 8 hours. Sensitization c the skin has not been reported." Other tin compounds listed as b capable of causing burns in man on single application include tri acetate, laurate, and oxide. Compounds not capable of this actio noted to be tetrabutyltin and dibutyltin diacetate, dilaurate, ox and maleate."

Patty writes "lower homologs caused severe dermal lesions in animals but dipropyl and higher homologs caused relatively little

Stauden reports that triphenyltin chloride "is strongly vesi and can cause serious burns," that dibutyltin dichloride "has a vesicant action," and that bis(tri-n-butyltin) oxide "shows essen acute dermal toxicity (for over 10,000 mg/kg)." For the latter c he adds that "the pure material is slightly irritating to the ski in formulations shows little physiological reactions to mammals."

Dibutyltin di-2-ethylhexoate is insoluble in water, melts at 129 degrees F, and has a vapor pressure of less than 1 mm Hg at 20 degrees C. Bis(tri-n-butyltin) oxide is a colorless to yellow liquid which boils at 489 degrees F at 50 mm Hg, is less than 20 soluble in water, has a flash point greater than 212 degrees F, a vapor pressure very much less than 1 mm Hg at 20 degrees C. Triphenyltin chloride is insoluble in water, has a melting point of 223 degree and a vapor pressure less than 1 mm Hg at 20 degrees C. Dibutyltin dichloride is insoluble in water, melts at 109 degrees F, and has vapor pressure of 2 mm Hg at 100 degrees C. Dibutyltin diacetate at 50 degrees F, is insoluble in water, has a flash point of 289 and a vapor pressure of 1.3 mm Hg at 20 degrees C. Tetrabutyltin

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colorless liquid which is slightly soluble in water, has a boiling point of 293 degrees F at 10 mm Hg, a flash point of 255 degrees F, and a vapor pressure less than 1 mm Hg at 20 degrees C. Stannous 2-ethylhexanoate is a viscous liquid which is insoluble in water, has a boiling point of 291 degrees F at 10 mm Hg, a flash point of 287 degrees F, and a vapor pressure less than 1 mm Hg at 20 degrees C.

Bis(tri-n-butyltin) oxide has been said by Stauden to be only slightly irritating to the skin and to exhibit essentially no acute dermal toxicity. The ACGIH, on the other hand, reports the compound to be a primary skin irritant capable of penetrating the skin and causing sensitization. A classification of 2 is concluded to be necessary and adequate in either case to prevent significant effects from excessive contact.

Triphenyltin chloride is reported to be a strong vesicant which can cause serious burns. Classifications of 1 and 5 are therefore concluded to be most appropriate for this compound.

Dibutyltin dichloride can cause acute chemical burns of a relatively non-severe nature. Classifications of 2 and 6 are concluded to be adequate if statement 2 is utilized to prevent contact where it "may occur" and if statement 8b is specified. Additionally, statement 14i and 14j are specified instead of 17g and 17i since Browning indicates that dibutyltin chloride is readily absorbed through the skin and causes bile duct injury. However, statement 14i is modified to read that the skin be immediately flushed with water should it become contaminated with either triphenyltin chloride or dibutyltin dichloride.

Dibutyltin diacetate, according to Deichmann and Gerarde, is capable of causing burns upon single application. While this statement appears to be inconsistent with the general statements of Brown and Patty, the specificity of Deichmann and Gerarde leads to the conclusion that classifications of 2 and 6 should be adequate for this compound with no exceptions.

Tetrabutyltin is also noted by Deichmann and Gerarde as not being capable of causing chemical burns upon single application. Consequently it is assigned a classification of 2 with no exceptions.

The specific effects of dibutyltin di-2-ethylhexanoate and stannous 2-ethylhexanoate were not addressed in any of the literature searched. Based simply on general comments that lower homologs cause severe lesions while dipropyl and higher homologs cause relatively little damage, it is concluded that classifications of 2 and 6 are appropriate for these compounds, if only statements 2, 17g, and 17i are specified.

Ingestion - Classification: See below

Output statement numbers: See below

Exceptions: None

Browning reports generally that "the full toxicity of tin is observed almost exclusively from its organic compounds - the alkyl derivatives. The alkyl derivatives are highly toxic and one of them, diethyl tin, has proved lethal to human beings with symptoms of cerebral oedema and severe gastro-intestinal disturbance." Of dibutyltin chloride, she reports "the essential lesion following oral dose (50 mg/kg body weight) is congestion and inflammation of the lower part of the bile duct, followed by escape of bile into the adjoining parts of the pancreas. Repeated dosage caused more

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extensive damage to the bile duct and necrotic changes in the liver when death would result either from this injury or from the general toxic effect of the compound."

According to Patty, "tetraalkyl Sn acts toxicologically similar to trialkyl Sn. . . . This is explained by the discovery that tetraalkyl Sn derivatives are inert physiologically until degraded to trialkyl Sn by a liver enzyme. Trialkyl Sn compounds differ from dialkyl Sn in that their toxicity is manifested by an apparent brain damage. Ten to 20 ppm triethyl Sn in the diet of rats is sufficient to induce progressive weakness but recovery usually occurred even from severe poisoning, although some chronically poisoned animals developed lesions from which they did not recover. The toxicity of the dialkyl Sn compounds is characterized by . . . production of a lesion of the bile duct and liver, which may result in death"

According to the ACGIH, "acute and subacute toxicity studies with rats, rabbits and guinea pigs with bis(tri-n-butyltin) oxide . . . indicated that this is a moderately toxic material. Gross signs of intoxication produced by this material are comparable to . . . all tin compounds in general, although bis(tri-n-butyltin) oxide appears to be one of the less toxic members of the class Stoner found triphenyl tin compounds highly toxic by intraperitoneal injection . . . but less poisonous by ingestion. One ppm in the diet inhibited the growth of guinea pigs. Yoshikawa and Ishii reported that low levels of dibutyl tin compounds affected mice more than tributyl compounds or tetrabutyl tin. The same authors found the hemolytic action of tributyl tin chloride much greater than that of dibutyl tin compounds, while tetrabutyl tin had scarcely any hemolytic action."

Christensen reports an oral rat LD50 of 194 mg/kg for bis(tri-n-butyltin) oxide. For dibutyltin diacetate, he lists an oral mouse LD50 of 46 mg/kg and rat LD50's of 32 mg/kg and 110 mg/kg. Dibutyltin dichloride has a listed oral rat LD50 of 150 mg/kg and oral rabbit LDLo of 50 mg/kg. Dibutyltin di-2-ethylhexoate is stated to have an oral rat LD50 of 200 mg/kg. For tetraethyltin, which is considered to be of similar toxicity to tetrabutyltin, he gives oral LD50's of 16, 7, and 37 mg/kg for the rat, rabbit, and guinea pig respectively.

In a study of tetraethyltin and dibutyltin dichloride, Mazay found both compounds to be of high acute toxicity for warm-blooded animals. Both compounds possess pronounced cumulative properties and primarily disturb the CNS. Study of their effect on conditioned reflex activity showed that they are capable of disturbing this activity even if administered in small doses.

Bis(tri-n-butyltin) oxide is specifically noted to be a moderately toxic compound which is less toxic than others of its class but is nevertheless, is generally comparable to other alkyl tin compound effects. Since it is a liquid, the compound is concluded to need a classification of 2.

Triphenyltin chloride is reported to be a severe vesicant. It is also stated that 1 ppm of a triphenyltin compound in the diet of guinea pigs inhibits growth, it is assigned a classification of 1.

Dibutyltin dichloride, by repeated oral dosage, can cause extensive damage to the bile duct and necrotic changes in the liver. Classification

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of 1 and 5 are therefore concluded to be most appropriate for this compound. Like dibutyltin dichloride, dibutyltin diacetate is a dibutyl compound which is generally reported to have similar effects. It is assigned classifications of 1 and 5.

Tetraalkyl tin compounds are stated to be degraded to trialkyl compounds by liver enzymes. Based upon this action, the report of Mazayev et al. and the low LD50's listed for tetraethyltin, it is concluded that a classification of 1 is necessary for tetrabutyltin.

Except for an oral rat LD50 of 200 mg/kg given for dibutyltin di-2-ethylhexoate, information for this compound and stannous 2-ethylhexoate could not be found in the literature. Nevertheless by analogy to organic tin compounds in general, it is concluded that classifications of 2 and/or 6 are necessary for these compounds.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

M & T Chemicals, Inc., Material Safety Data Sheets and Technical Bulletins (M&T)
Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd ed., vol. 20, p. 318 (M&T)
Chemical Rubber Co., "Handbook of Chemistry and Physics," 54th ed. (CRC)

Sources of data items used:

- I. A.1. Synonyms: M&T, K-O
- 2. Formula: M&T, K-O
- 3. Molecular weight: CRC, ADL
- B.1. Boiling point: M&T, CRC
- 2. Specific gravity: M&T, CRC
- 3. Vapor density: Not applicable
- 4. Melting point: CRC, K-O, M&T
- 5. Vapor pressure: M&T
- 6. Solubility in water: M&T, K-O
- 7. Evaporation rate: Not applicable
- 8. Appearance and odor: M&T, K-O
- II. A.1. Flash point: M&T
- 2. Autoignition temperatures: Data not available
- 3. Flammable limits: Data not available
- 4. Extinguishing media: M&T
- 5. Special fire fighting procedures: M&T, ADL
- 6. Unusual fire and explosion hazards: M&T
- B.1. Conditions contributing to instability: ADL
- 2. Incompatibilities: ADL
- 3. Hazardous decomposition products: M&T
- 4. Special precautions: ADL
- III. A. Steps if released or spilled: M&T, ADL
- C. Waste disposal method: M&T, ADL
- V. Miscellaneous precautions: ADL
- VI. Common operations: K-O, M&T

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

- Browning, E., "Toxicology of Industrial Metals," Butterworth and Company, Ltd., 2nd edition, 1969 (Browning)
- Considine, D. M., "Chemical and Process Technology Encyclopedia," McGraw Hill, 1974 (Considine)
- Hawley, G. G., "The Condensed Chemical Dictionary," Van Nostrand Reinhold Co., 8th edition, 1971 (Hawley)

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

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 1st edition, 1954 (Chem Tech); 2nd edition, 1972 (K-O)

References for Specific Use/Exposure

1. Browning, Considine, K-O
2. Considine, Hawley, K-O
3. Considine, ILO, K-O
4. Considine, K-O
5. Considine, K-O
6. Chem Tech, Considine, Hawley
7. Considine, K-O
8. Browning, Considine
9. ADL estimate

References for Specific Control Methods

ADL estimate and ILO were the references used in all, numbers 1 - 9, of the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Organic tin compounds

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

WARNING PROPERTIES:

Eye Irritation Level: According to Browning, concerning the toxicity of organic tin, "the eyes are rarely involved, but accidental splashing can cause lachrymation and intense suffusion of the conjunctiva which persists for several days, but with no permanent injury."

Grant lists several toxic effects produced by triethyltin on the eye, but these injuries are caused by systemic poisoning, not by a local effect on the eye.

IDLH: 200 mg/M3

Basis for IDLH Value: Patty, Browning, and Deichmann and Gerarde all indicate that the trialkyltin compounds are generally the most toxic of the organic tin compounds. The only available acute inhalation toxicity data upon which to base an IDLH are given in the NIOSH Toxic Substances List which obtained the information from a 1942 publication of the National Defense Research Committee, Office of Scientific Research and Development. The Toxic Substances List gives the following LCLO concentrations for tri-n-butyltin iodide, triethyltin bromide, and tri-n-propyltin bromide respectively: 1340 mg/M3, 1640 mg/M3, 1650 mg/M3. The LCLO is "the lowest concentration of a substance, other than an LC50 in air which has been reported to have caused death in man or to have caused death in animals when they have been exposed for 24 hours or less." Since the exposure could have been for a period up to 24 hours, the IDLH (200 mg/M3) is likely to be conservative, but because of the protection factors afforded by the respiratory devices, this is the highest concentration permissible before requiring the positive pressure self-contained breathing apparatus or the positive pressure combination supplied-air and self-contained device, both of which offer the greatest protection.

Other Toxicological Information: The Documentation of TLV's states that "the organic compounds of tin are numerous, embracing both the alkyl

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and aryl classes, each of which include mono-, di-, tri-, and tetra-derivatives. In addition these groups vary widely in their toxic reactions and effects, which makes the establishment of an over-all TLV a difficult matter."

Browning reports that "the results of extensive investigations by Barnes and his co-workers into the toxic effects of alkyl tin compounds have shown that the lower alkyl derivatives, especially triethyl tin, have a specific effect on the central nervous system, producing cerebral edema. The dialkyl compounds do not elicit this particular response but are severe skin irritants and have an inflammatory action on the bile ducts." The toxic action of dialkyl tin, Patty reports, "may result in death from hepatic failure or peritonitis." According to Browning, the higher homologues of the trialkyl salts, which are principally poisonous to the central nervous system, "are less toxic than triethyl- and trimethyl-tin. The tetra ethyl compounds have a delayed reaction owing to the fact that they become biologically active only after their conversion (by an enzyme system in the liver) to the trialkyl tins. Stoner et al. found that triethyltin sulphate was equally lethal by intravenous, intraperitoneal and oral administration. The lethal dose, intravenous and intraperitoneal, for rats was 10 mg/kg within 4 or 5 days; by the intraperitoneal route 40 mg per kg was fatal in 2 hours.

"The predominant acute symptom was generalized weakness of the limbs, progressing to complete paralysis, with sometimes continuous generalized tremors. The typical response of rabbits to a less than lethal intravenous dose (4 mg per kg) was initial prostration, partial paralysis and final encephalopathy." As Browning reports, "Barnes and Stoner remark that triethyl tin is ten times as toxic to rats by the oral route as diethyltin . . ."

Patty states that "little is known of the toxicity of monoalkyl Sn derivatives except that the toxicity of monoethyl Sn trichloride is low," and that "tetraalkyl Sn acts toxicologically similar to trialkyl Sn; workers handling tetramethyl and tetraethyl Sn suffered from the same symptoms as those exposed to triethyl Sn. This is explained by the discovery that tetraalkyl Sn derivatives are inert physiologically until degraded to trialkyl Sn by a liver enzyme."

Deichmann and Gerarde, in summarizing the toxicity of organic tin compounds, state that "higher molecular weight organotin compounds have considerably lower mammalian toxicity. Tetra-butyl tin, for example, shows little acute oral toxicity in rats. In general, the trialkyltin compounds are the most toxic, the dialkyl and tetraalkyl compounds are moderately toxic, and the monoalkyls approach the inorganic tin compounds in toxicity."

The Documentation of TLV's states that "many of these organic tin compounds have not yet been fully investigated. In view of the paucity of data, and by analogy with mercury, thallium and selenium compounds, a TLV of 0.1 mg/M3 is recommended to prevent systemic toxicity."

Due to the significant vapor pressure of some organic tin compounds, sorbents are required in combination with the respirator particulate filter.

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USE/EXPOSURE AND CONTROL DOCUMENT
ORGANIC TIN COMPOUNDS

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of dust or vapor and skin contact with dust, solid or liquid during use as a stabilizer against the degradation effects of light, heat and oxygen. (They are used mostly for polyvinyl chloride but also for neoprene, chlorinated polyethylenes, vinyl copolymers, silicones and polyamides). Some organotin compounds which may be used - dibutyltin maleate, dibutyltin dilaurate, dibutyltin S,S'-bis (alkylmercaptoacetates)	A,B	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles, protective clothing)
2.	Inhalation of dust or vapor and skin contact with dust, solid or liquid during use as a catalyst of inorganic and organic reactions (condensation, esterification, halogenation, hydrogenation, oxidation and polymerization - curing). Some organotin compounds which may be used - dibutyltin diacetate, dibutyltin oxide, dibutyltin di(2-ethylhexoate). Organotin catalysts have their widest application in the manufacture of silicones	A,B	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles, protective clothing)
3.	Inhalation of vapor or dust and skin contact with dust, solid or liquid during compounding and use as a biocide - insecticide, bactericide, fungicide, molluscicide (wood preservatives, sanitizing agents, antifouling agent in	A,B	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles, protective clothing)

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marine paints, control of fungi on textiles, leather and plastics). Some of the organotin compounds which may be used - bis(tributyltin) oxide, tributyltin benzoate, tributyltin chloride, triethyltin chloride

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| 4. | Inhalation of vapor or dust and skin contact with dust, solid or liquid during the synthesis and processing of organotin compounds. Tin (organic compounds) are those organic compounds containing at least one carbon to tin linkage. There are four main syntheses for these compounds | A,B | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles, protective clothing) |
| 5. | Inhalation of vapor, spray or dust and skin contact with spray, dust, solid or liquid during compounding and use as a U.S. Food and Drug sanctioned chemical (dioctyltin maleate - stabilizer in polyvinyl chloride food packaging materials, tricyclohexyltin hydroxide - insecticide on apples, citrus fruit and pears, triphenyltin hydroxide - agricultural fungicide) | A,B | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles, protective clothing) |
| 6. | Inhalation of vapor or dust and skin contact with dust, solid or liquid during compounding and use as a lubricant and fuel additive (tetraphenyltin and tributyltin - scavengers for hydrogen chloride in dielectric fluids, stabilizers in chlorinated transformer oils; hexa-n-butyliditin - synthetic lubricant; dibutyltin sulfide - lubricating additive) | A,B | Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles, protective clothing) |

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| 7. | Inhalation of vapor and skin contact with liquid during compounding and use as a rodent repellant (tributyltin chloride - formulated into coatings for wire and cable to protect exposed wire or cable from rodents) | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles, protective clothing) |
| 8. | Skin contact with liquid during use in veterinary medicine (dibutyltin dilaurate - poultry anthelmintic) | B | General dilution ventilation |
| 9. | Inhalation of dust or vapor and skin contact with dust, solid or liquid during cleaning and maintenance of storage vessels and during clean up of accidental spills | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles, protective clothing, respiratory protective devices) |

- 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 -----

1,828 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

[illegible]