

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** LEAD AND INORGANIC LEAD COMPOUNDS ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for LEAD AND INORGANIC LEAD 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 LEAD AND INORGANIC LEAD 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 lead and inorganic lead compounds not in excess of 0.2 milligrams per cubic meter (mg/M3) averaged over an eight-hour work shift (time weighted average), as stated in § 1910.1000, Table Z-2.

(2) "Action level" means one half of the permissible exposure for lead and inorganic lead compounds for an eight-hour work shift.

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

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

(i) Any information, observations, or calculations which may indicate employee exposure to lead and inorganic lead compounds;

(ii) Any measurements of lead or inorganic lead compounds taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to lead or inorganic lead compounds; 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 lead and inorganic lead compounds 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 exposure of the employee during an eight-hour work shift.

(4) If the exposure measurement taken pursuant to paragraph (b)(3) of this section reveals employee exposure to lead and inorganic lead compounds 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 lead and inorganic lead compounds 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 lead and inorganic lead 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.

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to lead and inorganic lead compounds 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.

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(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to lead and inorganic lead compounds 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 samples which represents the employee's actual exposure averaged over the time periods appropriate to the permissible exposure (See Appendix B (IV) of this section).

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

Table 1

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

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

(2) Employee exposures to airborne concentrations of lead and inorganic lead 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 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 lead and inorganic lead compounds.

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

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(iii) Spray finishing operations shall be performed in accordance with §1910.94(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 lead and inorganic lead 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 LEAD AND INORGANIC LEAD COMPOUNDS

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Dust or Mist Concentration	
1 mg/M3 or less	Any dust and mist respirator, except single-use.
2 mg/M3 or less	Any dust and mist respirator, except single-use or quarter mask respirator.
Dust, Mist or Fume Concentration	
2 mg/M3 or less	Any fume respirator or high efficiency particulate filter respirator.
	Any supplied-air respirator.
	Any self-contained breathing apparatus.
10 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.
200 mg/M3 or less	A powered air-purifying respirator with a high efficiency particulate filter.

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	A Type C supplied-air respirator operated in pressure - demand or other positive pressure or continuous-flow mode.
400 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 400 mg/M3 or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied - air respirator with a full facepiece operated in pressure - demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	A high efficiency particulate filter respirator. 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 lead and inorganic lead compounds.

(2) For the purpose of compliance with § 1910.157, lead is classified as a Class D fire hazard, except that §1910.157(2)(b)(v) shall not apply.

(3) Sources of ignition such as smoking or open flames are prohibited where lead or inorganic lead compounds present 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 powdered lead or solids or liquids containing inorganic lead compounds. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that clothing contaminated with lead or inorganic lead compounds is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of the substance from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the substance, the employer shall inform the

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person performing the operation of the hazardous properties of the substance.

(3) Employers shall ensure that non-impervious clothing which becomes contaminated with lead or inorganic lead compounds be removed promptly and not reworn until the substance is removed from the clothing.

(4) Employers shall provide and ensure that employees use safety goggles (cup-cover type dust and splash safety goggles) which comply with § 1910.133(a)(2)-(a)(6) where solids or liquids containing inorganic lead compounds may contact the eyes.

(g) Spills and disposal. In the event that lead or inorganic lead compounds are spilled the employer shall immediately provide available ventilation and then clean up the spill.

(h) Sanitation. (1) Employers shall ensure that all employees subject to skin contact with powdered lead or solids or liquids containing inorganic lead compounds wash with soap or mild detergent and water any areas of the body which may have contacted any such substance at the end of each work day.

(2) Employers shall ensure that employees whose skin becomes contaminated with lead or inorganic lead compounds promptly wash or shower with soap or mild detergent and water to remove any such substance from the skin.

(3) Employers shall ensure that employees do not eat or smoke in areas where powdered lead or solids or liquids containing inorganic lead compounds are handled, processed or stored.

(4) Employers shall ensure that employees who handle powdered lead or solids or liquids containing inorganic lead compounds wash their hands thoroughly with soap or mild detergent and water before eating or smoking.

(i) Training and information. (1) Each employer who has a workplace in which lead or inorganic lead 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 lead and inorganic lead compounds above the action level or employees who may have skin or eye contact with powdered lead or solids or liquids containing inorganic lead compounds, or employees who work where a spill of lead or inorganic lead compounds may occur, shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for lead and inorganic lead compounds (Appendix A of this section);

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

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

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(2) The employer shall make available to each employee who is to be exposed to lead or inorganic lead compounds or liquids containing inorganic lead compounds or airborne concentrations of lead or inorganic lead compounds at or above the action level a medical examination which shall include the following:

(i) A medical history and physical examination with emphasis on the gastrointestinal tract, nervous system, kidneys, blood and gingival tissues.

(ii) Blood tests to include at least red and white cell count, a differential smear, hemoglobin and determination of lead in the blood.

(iii) Urinalysis to include specific gravity, albumin, glucose, a microscopic on centrifuged sediment and determination of lead in the urine.

(3) The employer shall obtain from the physician, as a record of the examination, the following information:

(i) A written opinion which conforms with paragraph (j)(7) of this section.

(ii) A record of the results of the blood tests and urinalysis.

(4) The employer shall make available to each employee, exposed to lead or inorganic lead compounds in excess of the action level at 12 months from the date of the employee's first exposure, a medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the gastrointestinal tract, nervous system, kidneys, blood and gingival tissues at every 12 months thereafter.

(ii) Blood tests to include at least red and white cell count, a differential smear, hemoglobin and determination of lead in the blood at every 12 months thereafter.

(iii) Urinalysis to include specific gravity, albumin, glucose, a microscopic on centrifuged sediment and determination of lead in the urine at every 12 months thereafter.

(iv) Determination of blood lead, every 6 months (when indicated by results of blood tests and urinalysis).

(v) Determination of urine lead, every 3 months (when indicated by results of blood tests and urinalysis).

(5) The employer shall obtain from the physician, as a record of the periodic examination, the following information:

(i) A written opinion which conforms with paragraph (j)(7) of this section.

(ii) A record of the results of the blood tests and urinalysis.

(iv) A record of the results of the blood lead determination and urine lead determination when indicated.

(6) The employer shall provide to the examining physician the following information:

(i) A copy of this regulation with its Appendixes A, B, and C for lead or inorganic lead compounds;

(ii) A description of the employee's duties as they relate to his exposure to lead or inorganic lead 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; and

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

(7)(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 lead or inorganic lead compounds or would directly or indirectly aggravate any detected medical condition;

(B) Any recommended limitations upon the employee's exposure to lead or inorganic lead 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 diagnosis unrelated to exposure to lead or inorganic lead compounds.

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

(8) No employee shall be exposed to lead or inorganic lead compounds or liquids containing inorganic lead compounds or airborne concentrations of lead or inorganic lead compounds 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) The employer shall provide emergency and follow-up medical examinations and treatment for any employee injured through exposure to lead or inorganic lead compounds.

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

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

(ii) Informs each exposed employee of the fact that alternative medical examinations to those required in paragraphs (j)(2) or (4) of this section are to be made available.

(11) 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 risks involved by refusing to be examined.

(12) No medical procedure which would be performed pursuant to this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(k) Recordkeeping. (1) Exposure determination. (i) The employer shall keep an accurate record of all determinations required to be made pursuant to paragraph (b)(1) of this section.

(ii) This record shall include the written determination required in paragraph (b)(2) of this section.

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

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(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to lead and inorganic lead compounds.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to lead and inorganic lead compounds which are being monitored;

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

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

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

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

(B) Any employee medical complaints relative to exposure to lead and inorganic lead compounds;

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

(D) Physician's written opinion; and

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

(iii) This record shall be maintained for the duration 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.

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

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

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

(2) When observation of measurement of employee exposure to lead and inorganic lead 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 lead and inorganic lead compounds 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 LEAD AND INORGANIC LEAD COMPOUNDS

I. SUBSTANCE IDENTIFICATION

A. Substance: Lead and inorganic lead compounds

B. Permissible Exposure: 0.2 milligram of lead and lead inorganic compounds per cubic meter of air (mg/M3) averaged over an eight-hour work shift.

C. Appearance and Odor: metallic lead: dull metallic solid with no odor; lead monoxide: Yellow to brown solid with no odor; lead oxide: Orange to red solid with no odor

II. HEALTH HAZARD DATA

A. Ways in which the chemical affects your body: Lead and inorganic lead compounds can affect your body if you inhale them or if they come in contact with your eyes or skin or if

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you swallow them. They may enter your body through your skin.

B. Effects of Overexposure:

1. Short-term Exposure: Solutions of lead salts may cause eye irritation.
2. Long-term Exposure: Repeated or prolonged exposure to lead or inorganic lead compounds may cause weakness, weight loss, tiredness and anemia. It may also cause gastrointestinal problems with constipation and abdominal cramping. A black line on your gums may be produced. Tremors may occur. Weakness or paralysis of the muscles of the wrists or ankles may be present. Brain damage may develop with headache, vomiting and convulsion. This occurs mainly in children--rarely in adults. Kidney damage may also occur. Lead can pass from an exposed mother to her unborn child and cause lead poisoning and, in some cases, death.
3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to lead or inorganic lead compounds.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If solid or liquids containing inorganic lead compounds get into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.
- B. Skin Exposure: If powdered lead or solids or liquids containing inorganic lead compounds get on your skin, promptly flush the contaminated skin with soap or mild detergent and water. If powdered lead or solids or liquids containing inorganic lead compounds penetrate through your clothing, remove the clothing promptly and wash the skin with soap or mild detergent and water. If irritation is present after washing, get medical attention.
- C. Breathing: If you or any other person breathes in large amounts of lead or inorganic lead 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 powdered lead or solids or liquids containing inorganic lead 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

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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 lead and inorganic lead 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 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 powdered lead or solids or liquids containing inorganic lead compounds. Replace or repair impervious clothing that has developed leaks.
- C. Eye Protection: You must wear splash-proof safety goggles where liquids containing inorganic lead compounds may contact your eyes. You must wear dust-resistant safety goggles where solids containing inorganic lead compounds may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Lead dust is combustible and it can form explosive mixtures with air. However, its "explosion hazard index" is very weak.
- B. Powdered lead and inorganic lead compounds 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 lead 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 lead or inorganic lead compounds and this clothing must not be reworn until the lead is removed from the clothing.
- E. If your skin becomes contaminated with lead or inorganic lead compounds, you must promptly wash or shower with soap or mild detergent and water to remove the lead from your skin.
- F. If you are subject to skin contact with powdered lead or solid or liquids containing inorganic lead compounds, at the end of each work day you must wash with soap or mild detergent and water any areas of your body that may have contacted any such substance.

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- G. You must not eat or smoke in areas where powdered lead or solids or liquids containing inorganic lead compounds are handled, processed or stored.
- H. If you handle powdered lead or solids or liquids containing inorganic lead compounds, you must wash your hands thoroughly with soap or mild detergent and water before eating or smoking.
- I. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them.
- J. Ask your supervisor where lead and inorganic lead compounds 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 lead and inorganic lead compounds. In addition, your employer must instruct you in the safe use of lead and inorganic lead compounds, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to lead and inorganic lead 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 of the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of exposure determinations, exposure measurements, and medical surveillance. Your employer is required to make records of exposure determinations and your exposure measurements available to you or your representative upon your request. Your employer is required to release your medical records to your physician upon your written request.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR LEAD AND INORGANIC LEAD COMPOUNDS

(The standard for lead and inorganic lead compounds should not be interpreted below for which substance specific information has been provided.)

I. PHYSICAL AND CHEMICAL DATA (metallic lead)

- A. Substance Identification
 - 1. Synonyms: None
 - 2. Formula: Pb
 - 3. Molecular weight: 207.2
- B. Physical Data

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1. Boiling point (760 mm Hg): 1740 C (3164 F)
2. Specific gravity (water = 1): 11.3
3. Vapor density (air = 1 at boiling point of metallic lead): Not applicable
4. Melting point: 327 C (620 F)
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, % by weight at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Dull metallic, odorless solid

II. PHYSICAL AND CHEMICAL DATA (lead monoxide)

A. Substance Identification

1. Synonyms: Litharge
2. Formula: PbO
3. Molecular weight: 223.2

B. Physical Data

1. Boiling point (760 mm Hg): Sublimes below 888 C (1630 F)
2. Specific gravity (water = 1): 9.5
3. Vapor density (air = 1 at boiling point of lead monoxide): Not applicable
4. Melting point: 888 C (1630 F)
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, % by weight at 20 C (68 F): 0.0017
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Yellow to brown, odorless solid

III. PHYSICAL AND CHEMICAL DATA (lead oxide)

A. Substance Identification

1. Synonyms: Red lead; minium
2. Formula: Pb_3O_4
3. Molecular weight: 685.6

B. Physical Data

1. Boiling point (760 mm Hg): Decomposes at 500 C (932 F)
2. Specific gravity (water = 1): 8.9
3. Vapor density (air = 1 at boiling point of lead oxide): Not applicable
4. Melting point: 500 C (932 F) decomposes
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, % by weight at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Orange to red, odorless solid

IV. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA (Lead and inorganic lead compounds)

A. Fire

1. Flash point: Not applicable
2. Minimum ignition temperature for lead: 790 C (1454 F) (cloud); 290 C (554 F) (layer)
3. Minimum explosive dust concentration for lead: Data not available
4. Extinguishing media: (lead) - dry sand, dry dolomite, dry g
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.

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6. Unusual fire and explosion hazards: Lead dust is combustible and it can form explosive mixtures with air. However, its "explosion hazard index" is very weak. All ignition sources must be controlled where lead is used, handled or stored in a manner that could create a potential fire or explosion hazard. Lead nitrate is a strong oxidizing material capable of increasing the flammability of combustible, organic or other readily oxidizable materials. Lead azide is an example of a lead inorganic compound that is an explosive which must be stored, handled, and used in accordance with 29 CFR 1910.109.

B. Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Contact of lead with strong oxidizers may cause fires and explosions. Contact of lead oxides with hydrogen peroxide or active metals such as sodium and potassium may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as lead oxide fume and carbon monoxide) may be released in a fire involving lead and inorganic lead compounds.
4. Special precautions: None.

V. SPILL AND DISPOSAL PROCEDURES (Lead and inorganic lead compounds)

- A. If powdered lead or inorganic lead compounds are spilled, the following steps should be taken:
1. Ventilate area of spill.
 2. Collect spilled material in the most convenient and safe manner for reclamation, or for disposal in a secured sanitary landfill. Liquids containing inorganic lead 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 until cleanup has been completed.
- C. Waste disposal methods: Lead and inorganic lead compounds may be disposed of in a secured sanitary landfill.

VI. MONITORING AND MEASUREMENT PROCEDURES (Lead and inorganic lead compounds)

- A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average 8-hour exposure may be determined from a single eight-hour sample or two 4-hour samples. Several short time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or by collection of particulates using a high efficiency membrane filter with subsequent chemical analyses. The method of measurement must determine

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the concentration of lead and inorganic lead compounds 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 lead and inorganic lead compounds 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 O" (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.

VII. MISCELLANEOUS PRECAUTIONS (Lead and inorganic lead compounds)

A. Store powdered lead and inorganic lead compounds in tightly closed containers in a well ventilated area.

B. Employers should advise employees of all areas and operations where exposure to lead and inorganic lead compounds could occur.

VIII. COMMON OPERATIONS (Lead and inorganic lead compounds)

Common operations in which exposure to lead and inorganic lead compounds is likely to occur are: During the metallurgy of lead; during their use in storage batteries, bearings and other alloys and solders; during the manufacture of pigments, ammunition, lead alkyl antiknock compounds, galvanizing baths, and ballast weights; during the production of lead compounds and their use in battery plates, glass and ceramics, as driers for varnishes, as intermediates for other lead compounds; and in the manufacture of magnets.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; ingestion.

II. TOXICOLOGY

Prolonged absorption of lead or its inorganic compounds from inhalation of vapor, fume, or dust, and to a lesser degree from ingestion, results in severe gastrointestinal disturbances and anemia; with more serious intoxication there is neuromuscular dysfunction, while the most severe lead exposure may result in encephalopathy. The onset of symptoms of lead poisoning or plumbism is often abrupt; presenting

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complaints are often weakness, weight loss, lassitude, insomnia and hypotension. Associated with these, is a disturbance of the gastrointestinal tract which includes constipation, anorexia, and abdominal discomfort, or actual colic. Physical signs are usually facial pallor, malnutrition, abdominal tenderness, and pallor of the eye grounds. The anemia often associated with lead poisoning is of the hypochromic, normocytic type with reduction in mean corpuscular hemoglobin; stippling of erythrocytes and reticulocytosis is evident. On gingival tissues, a line or band of punctate blue or blue-black pigmentation (lead line) may appear; this is evidence of only lead absorption rather than poisoning. Occasionally the alimentary symptoms are relatively slight and are overshadowed by neuromuscular dysfunction with signs of motor weakness which may progress to paralysis of the extensor muscles of the wrist, and less often of the ankles. Encephalopathy, the most serious result of lead poisoning, frequently occurs in children due to the ingestion of inorganic lead compounds, but rarely in adults, except from exposure to organic lead. Nephropathy has been associated with lead poisoning.

Following absorption, inorganic lead is distributed in the soft tissues and in the bones with the highest soft tissue concentrations being in the kidneys and the liver. In the blood nearly all circulating inorganic lead is associated with the erythrocytes. Over a period of time the lead is redistributed, being deposited especially in bone and also in teeth and hair. Lead absorption is cumulative; elimination of lead from the body is slow, requiring considerably longer than the period of storage of toxic amounts. Asymptomatic lead workers, when subjected to a sudden increase in exposure to, and absorption of lead, may respond with an episode of typical lead poisoning. The upper limits of lead levels classified as normal are 40 ug/100 ml blood and 80 ug/liter of urine; the lower limit of values classified as excessive are 80 ug/100 ml blood and 150 ug/liter of urine, and when at or above these levels immediate action must be taken to reduce the worker's absorption of lead. One observer has noted increased tremor and decreased eye-hand coordination in workers with blood lead levels between 70 and 79 ug/100 ml blood.

Although epidemiologic studies have not shown any relation between lead exposure and the incidence of cancer, there are several reports that lead administered to animals in high doses is carcinogenic. Lead penetrates the placental barrier and has caused congenital abnormalities in animals; excessive exposure to lead during pregnancy has resulted in neurologic disorders in infants, although the possibility of postnatal exposure of the infants to lead could not be excluded. In battery workmen with a mean occupational exposure to lead of 8.5 (1 to 23) years and with blood lead concentrations of 53 to 75 ug/100 ml of blood there was an increased frequency of abnormalities of sperm including hypospermia as compared with a control group.

Lead acetate, formerly applied in aqueous solutions to the eye as an astringent has induced opacities and lead incrustation of the cornea and conjunctiva; when left untreated they have been observed to cause long-lasting irritation.

III. SIGNS AND SYMPTOMS

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Weakness, lassitude, insomnia; facial pallor and pallor of the eye grounds; anorexia, weight loss, malnutrition; constipation, abdominal discomfort and tenderness, colic; hypotension; anemia; lead line on gingival tissues; tremor, signs of motor weakness including paralysis of the extensor muscles of wrist and less often of the ankles; encephalopathy; nephropathy; eye irritation from splashes of solutions.

IV. SPECIAL TESTS

The concentration of lead in the blood is the best indication of exposure to inorganic lead; blood lead is less variable than urinary lead. Other indicators of lead exposure relate to the inhibition by lead of delta-aminolevulinic acid dehydrase (ALA-D), an enzyme involved in porphyrin synthesis. The reduced enzyme action leads to an increase in levels of delta-aminolevulinic acid (ALA) in blood and urine. The blood and urine levels of coproporphyrin III are also usually elevated. ALA-D, ALA, and coproporphyrin III assays, and blood examinations for hemoglobin, reticulocytes, and stippled red cells are useful in the assessment of worker health, but no one of these measurements alone is an accepted specific index of lead absorption. Measurements of erythrocyte protoporphyrin levels in blood are also useful measures of lead absorption.

V. TREATMENT

Remove from exposure. If a solution is splashed in the eye or on the skin, promptly flush eyes and skin with water. If swallowed and the person is conscious, induce vomiting. The physician should become familiar with the currently accepted methods of treatment including the use of EDTA.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Prolonged exposure to lead or its inorganic compounds causes severe gastrointestinal disturbances and anemia. Further consequences are neuromuscular disturbances, encephalopathy, and possible nephropathy. Lead is teratogenic in mammalian animals; the advisability of exposure of women of child-bearing age to lead should be considered. Emergence of new health information related to lead suggests that blood lead levels in individual workers should be kept under 60 ug/100 ml, that urine lead levels be kept under 100 ug/liter, and that urine ALA levels be kept under 500 ug/100 ml. Persons with anemia or the sickle cell trait may be at increased risk from exposure. Several sources of information such as clinical symptoms, laboratory data, and exposure history are necessary to evaluate the extent of lead absorption and the onset of intoxication. It is important that the physician become familiar with plant operating conditions in which exposure to lead and inorganic lead compounds occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic

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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 lead and inorganic lead compounds:

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 gastrointestinal tract, nervous system, kidneys, blood, and gingival tissues should be stressed.
2. Blood tests -- Lead and its inorganic compounds have been shown to cause anemia in humans. 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 and a determination of lead in the blood.
3. Urinalysis -- Since kidney damage has been observed in humans exposed to inorganic lead, a urinalysis shall be obtained to include at a minimum specific gravity, albumin, glucose, a microscopic examination of centrifuged sediment and a determination of lead in the urine.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis. In addition, blood lead analysis shall be conducted semiannually, or determination of lead or ALA in the urine shall be conducted quarterly on every worker. If a worker's urine lead or ALA level is found to be elevated, calculated to a specific gravity of 1,024, then a blood sample shall be obtained and analyzed within two weeks.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Lead," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, pp. 328-330.
2. Hygienic Guide Series: "Lead and its Inorganic Compounds," American Industrial Hygiene Association Journal, 19:154-155, 1958.
3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 941-985.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for LEAD AND INORGANIC LEAD COMPOUNDS

4. National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: Behavioral Effects of Occupational Exposure to Lead, HEW Publication No. (NIOSH) 75-164, U.S. Government Printing Office, Washington, D.C., 1975.
5. Kehoe, R.A.: "Occupational Lead Poisoning. 1-Clinical Types," Journal of Occupational Medicine, 14:298-300, 1972.
6. Kehoe, R.A.: "Occupational Lead Poisoning. 2-Chemical Signs of the Absorption of Lead," Journal of Occupational Medicine, 14:390-396, 1972.
7. Williams, M.K., et al: "An Investigation of Lead Absorption in an Electric Accumulator Factory with the Use of Personal Samplers," British Journal of Industrial Medicine, 26:202-216, 1969.
8. Lane, R.E., et al: "Diagnosis of Inorganic Lead Poisoning: A Statement," British Medical Journal, 4:501, 1968.
9. Goodman, Louis S. and Alfred Gilman: The Pharmacological Basis of Therapeutics (4d ed.), The Macmillan Company, New York, 1970, pp. 977-986.
10. Hernberg, S., et al: "Erythrocyte delta-aminolevulinic Acid Dehydratase in New Lead Exposure," Archives of Environmental Health, 25:109-113, 1972.
11. National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: Criteria for a Recommended Standard...Occupational Exposure to Inorganic Lead, HSM 73-11010, U.S. Government Printing Office, Washington, D.C., 1972.
12. Committee on Biologic Effects of Atmospheric Pollutants, Division of Medical Sciences, National Research Council: Lead-Airborne Lead in Perspective, National Academy of Sciences, Washington, D.C., 1972, pp. 102, 117, 168-177, 281-313.
13. Ferm, V.H. and S.J. Carpenter: "Developmental Malformations Resulting from the Administration of Lead Salts," Experimental and Molecular Pathology, 7:208-213, 1967.
14. Lancranjan, I., et al: "Reproductive Ability of Workmen Occupationally Exposed to Lead," Archives of Environmental Health, 30:396-401, 1975.
15. Haley, T.J.: Air Quality Monograph No. 69-7, A Review of the Toxicology of Lead, American Petroleum Institute, New York, 1969, pp. 15-20, 31-53.
16. Mao, P. and J.J. Molnar: "The Fine Structure and Histochemistry of Lead-Induced Renal Tumors in Rats," American Journal of Pathology, 50:571-581, 1967.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for LEAD AND INORGANIC LEAD COMPOUNDS

17. Boyland, E., et al: "The Induction of Renal Tumours by Feeding Lead Acetate to Rats," British Journal of Cancer, 16:283-288, 1962.
18. DiPalma, J.R.: Drill's Pharmacology in Medicine (3d ed.), McGraw-Hill Book Company, New York, 1965, pp. 845-859.
19. Grant, W. Morton: Toxicology of the Eye (2d ed.), Charles C. Thomas, Springfield, Illinois, 1974, pp. 618-629.
20. Palmisano, P.A., et al: "Untaxed Whiskey and Fetal Lead Exposure," Journal of Pediatrics, 75:869-872, 1969.
21. Vitale, L.F., et al: "Blood Lead--An Inadequate Measure of Occupational Exposure," Journal of Occupational Medicine, 17:155-156, 1975.
22. Angle, C.R. and M.S. McIntire: "Lead Poisoning During Pregnancy," American Journal of Diseases of Children, 108:436-439, 1964.
23. Sakurai, H., et al: "Biological Response and Subjective Symptoms in Low Level Lead Exposure," Archives of Environmental Health, 29:157-163, 1974.
24. Tomokuni, K., et al: "Erythrocyte Protoporphyrin Test for Occupational Lead Exposure," Archives of Environmental Health, 30:588-590, 1975.
25. Occupational Safety and Health Administration, U.S. Department of Labor: Lead - Occupational Exposure; Proposed Standard, Federal Register, Vol. 40, No. 193, pp. 45934-45949, 1975.

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REFERENCES AND SOURCES
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1910.93

- (f) Personal Protective Equipment, and, (h) Sanitation
Eye: Grant, "Toxicology of the Eye"
Skin: Hine, Cavalli and Beltran, "Percutaneous Absorption of Lead from Industrial Lubricants;" Sax, "Dangerous Properties of Industrial Materials;" Johnstone and Miller, "Industrial Toxicology;" Patty, "Industrial Hygiene and Toxicology"
Ingestion: Sax, "Dangerous Properties of Industrial Materials;" NIOSH, "Hazard Process Index, Hazard Entry No. 104, HSM-99-73-62;" New York State Dept. of Labor, Division of Industrial Hygiene and Safety Standards, "Studies in Lead Poisoning;" U. S. Dept. of Health, Education and Welfare, National Institute for Occupational Safety and Health, "Working with Lead in Industry;" Lilis, Gavrilesco, Nestoresco, Dumitriu and Roventa, British Journal Industrial Medicine, 1968, 25, 196, "Nephropathy in Chronic Lead Poisoning;" U. S. Department of Health, Education and Welfare, Public Health Service, "Survey of Lead in the Atmosphere of Three Urban Communities;" U. S. Environmental Protection Agency, "Environmental Lead and Public Health;" Browning, "Toxicity of Industrial Metals;" "The Merck Index - An Encyclopedia of Chemicals and Drugs," eighth edition

COMMENTS

Eye - Classification: 2 and 6

Output statement numbers: 10 and 12 combined

Exceptions: None

Grant reports, "lead metal foreign bodies in the eye or in the orbit in human beings have been considered to cause little reaction and rarely any toxic effect." He further states that experiments by Francois and associates "concluded that lead fragments in patients were well tolerated in the eye and in the orbit." Experiments by Skrzypczak came to the same conclusion, and reports by Bohm indicated eyes splashed with molten lead showed little reaction to lead particles.

When referring to the inorganic compounds, Grant says, "lead chloride and lead sulfate placed in the anterior chamber of rabbits have caused a moderate purulent reaction and general inflammation of the eye." He adds that "lead chloride if given access in sufficient amount to the corneal stroma of rabbit eyes can cause general inflammation of the eye." Also noted is that "the epithelium normally presents a barrier to penetration of lead salts into the cornea, but the epithelium may be injured by the high concentrations."

For lead arsenate, he notes that two patients have "alleged" it caused conjunctival injury "but this compound is practically insoluble in water, and testing topically on rabbit eyes showed it to cause no injury."

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Though there are a large number of inorganic compounds of lead used in industry and a considerable amount of data concerning the hazards of inhalation or ingestion, there are little data concerning them in regard to eye contact. Since metallic lead is shown to be non-hazardous and the salts noted cause a presumably reversible general inflammation, the compounds, but not the metals, are assigned classifications of 2 and 6.

Skin - Classification: 2 and 6

Output statement numbers: 2, 7a, 15, 17g, 17i, 20b

Exceptions: See below

Hine et al. report that "the inorganic compounds of lead, whether in solid form, solutions, or dispersions, do not penetrate the normal or abraded human skin to any practical or important extent. Even under conditions of injury to the skin, percutaneous absorption has a theoretical rather than practical significance."

According to Sax, "in the case of inorganic forms of lead this route is of no practical importance."

Where lead arsenate is used, however, Johnstone and Miller say that most of the dusts containing arsenic can cause dermatitis, most commonly observed "effects of exposure to arsenic is an irritation of the skin manifested by dry eczema, ulcers inflammation of the mucous membranes, loss of hair and trophic changes in the nails."

Patty reports in general for all lead compounds "certain of these compounds may injure or irritate the skin under suitable conditions. . . ."

Virtually all sources reviewed discussed solely the effects of inhalation or ingestion. Aside from comments concerning lead arsenate, a substance covered by arsenic compound standards, no specific indication could be found that these substances are harmful by skin contact. Nevertheless, because of the large number of compounds covered by this standard, and the desire to prevent ingestion by preventing extensive contact with them, classifications of 2 and 6 are concluded to be appropriate. This conclusion, in regard to local effects, is supported by Patty's general statement.

Because of the high hazard of ingestion, statement 15 is specified. Since massive forms of metallic lead are not so easily ingested as powdered lead, the standard is specifically directed towards the powdered form of the substance.

Ingestion - Classification 1 and 5

Output statement numbers: 19, 20b

Exceptions: None

Much has been written on the toxicology of lead and its compounds. Sax rates the toxic hazard of lead metal on a scale of 0 to 3 (0 being the least toxic) as 0 for acute local, 0 for chronic local and 3 for chronic systemic effects and states that lead "may cause death or permanent injury after very short exposure to small quantities."

According to the Hazard Process Index, the mode of entry by ingestion is by compounds being entrapped in the upper respiratory tract or introduced by food, fingers, tobacco or

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other objects.

The New York State Department of Labor states that the "larger part of the lead which enters the stomach is not absorbed but passes through the gastro-intestinal tract without injury to the body and is eliminated in the feces. The remainder is absorbed into the portal circulation which carries it to the liver," part may be stored in the liver, part is excreted and part passes through the liver into the general circulation. Sax says, "for this reason, larger amounts of lead are necessary to cause poisoning if absorption is by this route, and a longer period of exposure is usually necessary to produce symptoms."

The Hazard Process Index states that "lead is a cumulative poison. Increasing amounts build up in the body and eventually a point is reached where symptoms and disability occur."

According to HEW, "lead poisoning may be acute or chronic. The symptoms of acute lead poisoning are experienced by a burning sensation in the mouth, stomach pain, nausea, vomiting and constipation or diarrhea. Cases showing these symptoms may progress to headaches, muscular cramps, anemia, paralysis and collapse, possibly resulting in death. In industry, lead poisoning is more frequently chronic than acute."

Lilis, Gavrilesco, Nestoresco, Dumitriu and Roventa state that "the importance of the duration of exposure and repeated episodes" to lead poisoning can lead to a "progressive impairment of renal function. The return to normal was slower at each fresh episode and finally was no longer attained. . ."

HEW states that "lead poisoning may also develop within several weeks when the quantity of somewhat soluble lead ingested per day by an adult is of the order of 6 - 10 mg . . ."

The Hazard Process Index says "of the various lead compounds, the carbonate, the monoxide, and the sulfate are considered to be more toxic than metallic lead or other lead compounds. Lead arsenate is very toxic, due to the presence of the arsenic radical."

The EPA states, "Kehoe showed that a healthy adult man could eat 1 mg of lead chloride per day for several years without apparent ill health, even though his body pool and blood lead were increasing. In contrast, a subject eating 3 mg of lead chloride per day developed signs and symptoms of clinical lead poisoning with 8 weeks."

According to Browning, "lead intoxication rarely occurs at all and only in its mildest manifestations among regularly employed industrial workers if the mean urinary lead concentrations of representative groups of such workmen is kept below 0.01 mg/l." The Merck Index gives a diagnosis of lead poisoning as lead content in the blood of "greater than 0.05 mg%" and urine "greater than 0.08 mg/liter."

There is little doubt that classifications of 1 and 5 are warranted because of the severe biochemical changes, both permanent and fatal, caused by ingestion of lead or its inorganic compounds.

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SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

- Manufacturing Chemists' Association, Chemical Safety Data Sheet SD-64 (MCA)
- National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1975 (NFPA)
- Kirk - Othmer, "Encyclopedia of Chemical Technology," 2nd edition, Vol. 12, p. 207 (K-O)
- "Lange's Handbook of Chemistry," 11th edition (Lange)
- K. N. Palmer, "Dust Explosions and Fires," Chapman and Hall, London, 1973 (Palmer)

Sources of data items used:

- I. A. 1. Synonyms: K-O
2. Formula: K-O, Lange
3. Molecular weight: Lange
- B. Physical Data
1. Boiling point: K-O
2. Specific gravity: MCA
3. Vapor density: Not applicable
4. Melting point: K-O, MCA
5. Vapor pressure: ADL
6. Solubility in water: K-O
7. Evaporation rate: Not applicable
8. Appearance and odor: MCA
- II. A. 1. Flash point: Not applicable
2. Minimum ignition temperature for lead: Not applicable
3. Minimum explosive dust concentration for lead: Not applicable
4. Extinguishing media: ADL
5. Special fire fighting procedures: MCA
6. Unusual fire and explosion hazards: Palmer, MCA
- B. 1. Conditions contributing to instability: ADL
2. Incompatibilities: NFPA-491M
3. Hazardous decomposition products: ADL
4. Special precautions: None
- III. A. Steps if released or spilled: MCA, ADL
C. Waste disposal method: MCA
- V. Miscellaneous precautions: ADL

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

- "Application of Red Lead Paint," Michigan's Occupational Health, 8:5 - 6, 1963 (Michigan)
- Berg, B. A. and Zenz, C., "Environmental and Clinical Control of Lead Exposure in a Non-Ferrous Foundry," American Industrial Hygiene Association Journal, 28:175 - 183, 1967 (Berg)
- Browning, E., "Toxicity and Metabolism of Industrial Solvents," Elsevier Publishing Co., 1965 (Browning)
- Frank, R. W., "Health Control in the Ceramic Industry," Industrial Medicine and Surgery, March, p. 102 - 105, 1959 (Frank)
- Giel, C. P., Kleinfeld, M. and Messite, J., "Lead Toxicity in a Storage Battery Plant," Archives of Industrial Health, 13:321 - 325, 1956 (Giel)
- Goss, A. E. and Ross, A. M., Jr., "Effective Control of Lead Dust in the Manufacture of Vinyl Plastics," American Industrial Hygiene Association Quarterly, March, p. 41 - 49, 1953 (Goss)

NIOSH/OSHA Draft Technical Standard
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- Gunter, B. J., "Health Hazard Evaluation/Toxicity Determination Report 74-38-64", Gates Rubber Co., Braided Hose Division, Denver, Colorado, NIOSH, 1973 (Gunter)
- International Labor Organization, "Encyclopedia of Occupational Health and Safety," Geneva, 1972 (ILO)
- Lauer, D. J., "Clinical Lead Intoxication from Brass-Foundry Operations," Archives of Industrial Health, 11:107 - 112, 1955 (Lauer)
- "Lead," Hygienic Information Guide No. 8, Commonwealth of Pennsylvania, Department of Health, July, 1969 (Penn)
- Maloof, C. C., Bauley, H. and Boylen, G. W., "The Engineering and Medical Control of a Lead Hazard - A Plant Study," American Industrial Hygiene Quarterly, March:64 - 68, 1954 (Maloof)
- McBride, W. W. and Proctor, E. G., "Lead Poisoning in Demolition Work," Industrial Medicine and Surgery, January:31 - 32, 1962 (McGride)
- McClung, H. B., "Lead Exposure at Refinishing Operations," American Industrial Hygiene Association Journal, 3:169, 1952 (McClung)
- McCormick, W. E., "Industrial Health Problems in the Rubber Industry," American Industrial Hygiene Association Quarterly, 13:37 - 41, 1952 (McCormick)
- "Merck Index of Chemicals and Drugs," Merck and Co., Inc., Rahway, N. J., 8th edition, 1968 (Merck)
- Patty, F. A., "Industrial Hygiene and Toxicology," Vol. II, Interscience Publishers, 1962 (Patty)
- Piper, R., "The Hazards of Painting and Varnishing, 1965, British Journal of Industrial Medicine, 22:247 - 259, 1965 (Piper)
- Ruhf, H. W., "Studies on the Lead Hazards in Certain Phases of Printing I - Actual Lead Exposures as Measured by the Amount of Lead in Printing Atmospheres," Journal of Industrial Hygiene and Toxicology, 22:445 - 463, 1940 (Ruhf)
- Ruhf, R. C., "Lead Exposure Control in the Production of Leaded Steel," American Industrial Hygiene Association Journal, 24:63 - 67, 1963 (Ruhf)
- Siegel, G. S., "Lead Exposure Among Decorative and House Painters," Archives of Environmental Health, 6:720 - 723, 1963 (Siegel)
- Stalker, W. W., "A Study of the Hazards of Exposure to Metallic Fumes and Dust in Brass Foundries," Journal of Industrial Hygiene and Toxicology, 29:96 - 106, 1947 (Stalker)
- Stern, A. C., and Horvitz, "Industrial Hygiene in the Paint Factory," New York State Department of Labor Monthly Review, 32:5 - 8 1953 (Stern)
- Storlazzi, E. D., "Hygiene of Welding in U.S. Naval Shipyards," Archives of Industrial Health, 19:307 - 311, 1959 (Storlazzi)
- Ziegfield, R. L., "Importance and Uses of Lead," Archives of Environmental Health, 8:202- 212, 1964 (Ziegfield)
- Zimmer, F. E., "Lead Poisoning in Scrap-Metal Workers," J.A.M.A., 175:238 - 240, 1961 (Zimmer)

References for Specific Use/Exposure

1. Ziegfield, ILO
2. ILO, Giel
3. Browning, Patty, Ruhf
4. Siegel, Berg, ILO
5. McBride, Zimmer, Storlazzi
6. Lauer, Stalker

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7. Siegel, Piper, Michigan, McClung
8. Ziegfield
9. Ziegfield, Ruhf
10. Ziegfield
11. Ziegfield
12. Piper, Patty, Stern
13. Merck, ILO
14. Patty, Ziegfield
15. Patty, Frank
16. Merck
17. Maloof, Goss
18. Gunter, McCormick

References for Specific Control Methods

1. ILO, Penn
2. Giel, ILO
3. Ruhf, Penn
4. Penn, ILO
5. Storlazzi
6. Penn, ILO
7. Michigan

Penn and ILO were the references used in numbers 8 - 10.

11. Penn, ILO
12. Patty
13. Penn, ILO
14. Pennsylvania, ILO
15. Patty
16. Penn, ILO
17. Goss
18. Penn, ILO

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Lead and inorganic lead compounds

D. O. L. STANDARD: 0.2 mg/M3 shall not be exceeded

Eye Irritation Level: Lead and its inorganic compounds are not known to be eye irritants.

IDLH: There are no acute toxicity data available concerning the physiological effects caused by the inhalation of lead and its inorganic compounds. The AIHA Hygienic Guides, however, state that the severity of the health hazard for a brief exposure is only moderate. If the IDLH were estimated from the rat intraperitoneal LD₅₀ of 100 mg/kg for lead cyanide (NIOSH Toxic Substances List), a value of 700 mg/M3 would be obtained as the IDLH. Using these data for lead cyanide rather than the other data given in the NIOSH Toxic Substances List yields the most conservative estimation of the IDLH concentration, as shown below in the table. Because of the protection factor by the respiratory devices, however, 400 mg/M3 is the concentration above which only the most highly reliable, positive pressure devices are permitted.

Other Toxicological Information: The AIHA Hygienic Guide states that the severity of the hazard for a brief exposure to lead and its inorganic compounds is moderate, but for a prolonged exposure is high. "Lead dust and the dusts and fumes of all but the most insoluble compounds (e.g. sulfide, chromate) are readily absorbed on inhalation, and to a lesser degree after ingestion. Lead and its inorganic compounds are not ordinarily absorbed through the skin . . . The early symptoms

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of lead intoxication are most commonly gastrointestinal disorders, colic, constipation, etc. The presence of stippled cells (except in tetraethyl lead poisoning), followed in time by anemia, may be noted. Weakness, which may go on to paralysis chiefly of the extensor muscles of the wrists and less often of the ankles, is noticeable in the serious cases. Involvement of the brain (encephalopathy), the most serious result of lead poisoning, is frequently noted in children, but rarely (except from organic lead) in adults . . . (The short exposure tolerance (is) not known quantitatively but is a factor of dosage X time) . . . (The) atmospheric concentration immediately hazardous to life (is) not known, in cases of inorganic compounds. The minimum lethal dose of a soluble salt, by ingestion, is about 10 gm."

Browning states that there are some differences between "the cerebral syndrome (encephalopathy) of inorganic lead poisoning and that caused by tetraethyl lead; the inorganic lead prognosis is more favorable, its effects are less permanent and more subjective, and it is rarely accompanied by the objective signs of loss of vision, paresis and aphasia." Concerning the anemia caused by inorganic lead poisoning, Browning states that the "anemia is not usually severe but is hypochromic."

The NIOSH Toxic Substances gives the following toxicological data for some of the inorganic compounds of lead. The column at the right contains the IDLH concentrations of lead estimated from the data below, based upon a 70 kg person who breathes approximately 10 M3/day.

Substance	Species	Route of Exposure	Description of Exposure	Dose	Estimated IDLH (mg/M3)
Lead sulfide	rat	intraperitoneal	LD50	1600 mg/kg	11,200
Lead chloride	guinea pig	oral	LDL0	2000 mg/kg	14,000
Lead cyanide	rat	intraperitoneal	LDL0	100 mg/kg	700
Lead fluoride	guinea pig	oral	LDL0	4000 mg/kg	28,000
Lead fluorosilicate	rat	oral	LDL0	250 mg/kg	1,750
Lead monoxide	rat	intraperitoneal	LD50	450 mg/kg	3,150
Lead tetroxide	guinea pig	intraperitoneal	LD50	220 mg/kg	1,540

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USE/EXPOSURE AND CONTROL DOCUMENT
LEAD AND INORGANIC LEAD COMPOUNDS

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of dust and fume and ingestion of dust during primary (ore) and secondary (scrap) smelting of lead	A,C	Process enclosure; local exhaust ventilation; dust control; respirator; protective clothing
2.	Inhalation of dust and fume and ingestion of dust during melting and pouring of battery grids and pasting and trimming operations in manufacture of storage batteries	A,C	Process enclosure; local exhaust ventilation; dust control; respirator; protective clothing
3.	Inhalation of dust and fume and ingestion of dust during melting and pouring of lead and alloys containing lead (including leaded iron and steel, bearing metals in manufacture of bearings, babbit, manufacture of lead shot and ammunition, nuclear and radiation shielding)	A,C	Local exhaust ventilation; respirator
4.	Inhalation of fume and dust and ingestion of dust during spraying of molten lead or lead alloy (metallizing operations as in lead wire manufacture)	A,C	Local exhaust ventilation; process enclosure; respirator
5.	Inhalation of fume and dust and ingestion of dust during welding, burning, and cutting operations in construction, demolition, or repair of metal structures containing lead or painted with lead-containing surface coating (including ships, bridges, building structures)	A,C	Local exhaust ventilation; respirator

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| 6. | Inhalation of dust and fume and ingestion of dust during melting and pouring of brass | A,C | Local exhaust ventilation; respirator |
| 7. | Inhalation of mist and dust and ingestion of dust during spray painting, rubbing down, or sanding operations in application or removal of surface coatings containing lead pigments or driers (including protective paints for iron and steel) | A,C | Material substitution; local exhaust ventilation; respirator |
| 8. | Inhalation of dust and ingestion of dust during synthesis and handling of lead compounds (including white lead, red lead, litharge, black oxides, lead silicates and chromates, tetraethyl lead, and lead arsenate) | A,C | Process enclosure; local exhaust ventilation; respirator; dust control |
| 9. | Inhalation of dust and fume and ingestion of dust during typecasting and remelting of type metal in printing (including linotype, monotype, stereotype, and electrotype printing) | A,C | Process enclosure; local exhaust ventilation; respirator; dust control |
| 10. | Inhalation of dust and fume and ingestion of dust during filling and grinding operations in automobile body manufacture or repair | A,C | Process enclosure; local exhaust ventilation; respirator; dust control |
| 11. | Inhalation of dust and fume and ingestion of dust during production of and fabrication of metal products from sheet andterne metal and foil (including roofing, flashing, storage tanks, reaction vessels) | A,C | Process enclosure; local exhaust ventilation; respirator; dust control |

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| 12. | Inhalation and ingestion of dust during use of lead compounds as pigments and driers in weighing and mixing operations in manufacture of surface coatings (including paints and varnishes) | A,C | Local exhaust ventilation; respirator |
| 13. | Inhalation of fume and dust and ingestion of dust during fabrication of piping for water, sewer, and chemical plants, collapsible tubes, electrical conduct and cable | A,C | Process enclosure; local exhaust ventilation; respirator |
| 14. | Inhalation of dust and fume and ingestion of dust during soldering in fabrication of metal articles (including radiators, tin cans, and other receptacles) | A,C | Process enclosure; local exhaust ventilation; respirator |
| 15. | Inhalation of dust and fume and ingestion of dust during manufacture of ceramics and glass (including glass tableware, optical and specialty glass, electrical ceramics, glazed brick and light-weight ceramics, porcelain finishes) | A,C | Local exhaust ventilation; respirator |
| 16. | Inhalation of dust and ingestion of dust during synthesis and handling of pigments and dyes | A,C | Process enclosure; local exhaust ventilation; respirator |
| 17. | Inhalation of dust and ingestion of dust (lead carbonates and silicates) during weighing and blending operations in plastics manufacture (including vinyl plastics and plastic sheeting) | A,C | Process enclosure; local exhaust ventilation; respirator |

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| 18. | Inhalation of dust and
ingestion of dust during
use as an activator (litharge)
or pigment (lead chromate)
in rubber manufacture | A,C | Process enclosure; local
exhaust ventilation;
respirator |
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- A -- Inhalation
- B -- Skin and eye contact resulting
in local irritation
- C -- Ingestion
- D -- Skin contact resulting in
absorption and subsequent
systemic poisoning