

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** CADMIUM DUST ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for CADMIUM DUST

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 CADMIUM DUST.

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 cadmium dust (as cadmium) not in excess of 0.2 milligrams per cubic meter (mg/M3), averaged over an eight-hour work shift (time weighted average) and not in excess of 0.6 milligrams per cubic meter (mg/M3) at anytime during an eight-hour work shift as stated in § 1910.1000, Table Z-2.

(2) "Action level" means one-half of the permissible exposure for cadmium dust averaged over an eight-hour work shift.

(b) Initial determination and exposure measurement. (1) Each employer who has a place of employment in which cadmium dust is released into the workplace air shall determine if there is any possibility that any employee may be exposed to airborne concentrations of cadmium dust 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 cadmium dust.

(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 cadmium dust;

(ii) Any measurements of cadmium dust taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to cadmium dust; 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 cadmium dust 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 cadmium dust 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 cadmium dust 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 cadmium dust 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 cadmium dust 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 cadmium dust below the action level, the employer may terminate measurement for the employee.

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

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

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

Table 1

Concentration	Required Accuracy (Percent of True Value)
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Above permissible exposure	± 25
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At or below permissible exposure	
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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 cadmium dust above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of cadmium dust 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 cadmium dust. § 1910.94(d).

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

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

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

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

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- (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. When an employee informs his employer that he is experiencing eye irritation from cadmium dust while wearing a respirator allowed in Table 2, the employer shall provide and ensure that the employee use an equivalent respirator with a full facepiece, helmet or hood.

TABLE 2 RESPIRATORY PROTECTION FOR CADMIUM DUST (AS CADMIUM)

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Dust Concentration	
1 mg/M3 or less	Any dust respirator, except single-use.
2 mg/M3 or less	Any dust respirator, except single-use or quarter-mask respirator. Any high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
10 mg/M3 or less	A high efficiency particulate 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.
50 mg/M3 or less	A powered air-purifying respirator with a high efficiency particulate filter. A Type C supplied-air respirator operated in pressure demand or other positive pressure or continuous-flow mode.
Greater than 50 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

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	operated in pressure-demand or other positive pressure mode
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any dust respirator, except single-use. Any escape self-contained breathing apparatus.

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

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

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

(2) For the purpose of compliance with § 1910.309, locations classified as hazardous locations due to the presence of cadmium dust shall be Class II, Group G.

(3) For the purpose of compliance with § 1910.157, cadmium dust is classified as a Class D fire hazard with the exception that § 1910.157 (b)(2)(n) shall not apply.

(4) For the purpose of compliance with § 1910.178, locations classified as hazardous locations due to the presence of cadmium dust shall be Class II, Group G.

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

(6) Cadmium dust shall be stored so as not to come in contact with strong oxidizers, and elemental sulfur, selenium and tellurium.

(f) Personal protective equipment. (1) Employers shall ensure that employees whose clothing has had any possibility of being contaminated with cadmium dust change into uncontaminated clothing before leaving the work premises.

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

(3) Employers shall provide and insure that employees use dust-resistant safety goggles which comply with § 1910.133 (a)(2)-(a)(6) where there is any possibility of cadmium chloride dust contacting the eyes.

(4) Where there is any possibility that an employee's eyes may be exposed to cadmium chloride dust employers shall provide an eye wash fountain within the immediate work area for emergency use.

(g) Spills and disposal. In the event that cadmium dust is spilled the employer shall immediately eliminate potential sources of ignition, provide available ventilation and then clean up the spill.

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(h) Sanitation. (1) Employers shall ensure that all employees subject to skin contact with cadmium dust wash with soap or mild detergent and water any areas of the body which may have contacted cadmium dust at the end of each workday.

(2) Employers shall ensure that employees do not eat or smoke in areas where cadmium dust is handled, processed, stored, or generated.

(3) Employers shall ensure that employees who handle cadmium dust 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 cadmium dust is present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to cadmium dust above the action level without regard to the use of respirators, or employees who may have any possibility of eye contact with cadmium chloride dust or employees who work where a spill of cadmium dust may occur shall annually:

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

(ii) Advise affected employees as to the signs and symptoms of exposure to cadmium dust.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of overexposure to cadmium dust 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 cadmium dust.

(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 cadmium dust above the action level, without regard to the use of respirators, or employees who may have any possibility of eye contact with cadmium chloride dust, a preplacement medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the lungs, kidneys, prostate and blood;

(ii) Forced vital capacity (FVC) and forced expiratory volume-one second (FEV (1 second)) tests;

(iii) 14" x 17" chest roentgenogram;

(iv) Urinalysis to include specific gravity, albumin, glucose, a microscopic on centrifuged sediment and examination for specific low molecular weight proteins.

(3) Periodic medical examination. The employer shall make available to each employee exposed to airborne concentrations of cadmium dust above the action level, without regard to the use of respirators, or employees who may have any possibility of eye contact with cadmium chloride dust, twelve months from the date of the employee's first exposure, and every twelve months thereafter, a periodic medical examination which must include the following:

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(i) A medical history and physical examination with emphasis on the lungs, kidneys, prostate and blood;

(ii) Forced vital capacity (FVC) and forced expiratory volume-one second (FEV (1 second)) tests;

(iii) A 14" x 17" chest roentgenogram, if pulmonary function tests show significant abnormalities;

(iv) Urinalysis to include specific gravity, albumin, glucose, a microscopic on centrifuged sediment and examination for specific low molecular weight proteins.

(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 cadmium dust which are listed in Appendix A which the employee suspects are caused by exposure to cadmium dust.

(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 cadmium dust;

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

(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 cadmium dust;

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

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(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 pulmonary function tests and the urinalysis;

(ii) The 14" x 17" chest roentgenogram when required, or a medically acceptable copy;

(iii) 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 cadmium dust 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 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 cadmium dust.

(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 cadmium dust.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to cadmium dust 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 thirty years.

(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of

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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 cadmium dust;
- (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 thirty 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 cadmium dust.

(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 cadmium dust which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to cadmium dust 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:

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- (i) Receive an explanation of the measurement procedure.
- (ii) Visually observe all steps related to the measurement of the airborne concentration of cadmium dust that are being performed at the place of exposure; and
- (iii) Record the results obtained.

NOTE: The information contained in the following appendix for cadmium dust 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 cadmium dust, it is advisory in nature.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR CADMIUM DUST (as Cadmium)

I. SUBSTANCE IDENTIFICATION

- A. Substance: Cadmium dust
- B. Permissible Exposure: 0.2 milligram of cadmium dust per cubic meter of air (mg/M3) averaged over an eight-hour work shift but 0.6 mg/M3 shall not be exceeded during an eight-hour work shift.
- C. Appearance and Odor: 1) Cadmium metal dust: Odorless, gray powder; 2) Cadmium oxide dust: Odorless, brown solid or blue-black solid; 3) Cadmium sulfide dust: Yellow-orange solid; 4) Cadmium chloride dust: Colorless solid.

II. HEALTH HAZARD DATA

- A. Ways in which the chemical affects your body: Cadmium dust can affect your body if you inhale it. It may also affect your body if you swallow it.
- B. Effects of Overexposure:
 - 1. Short-term Exposure: Cadmium dust may cause irritation of the nose and throat. If enough has been inhaled, after a delay of several hours you may also develop cough, chest pain, sweating, chills, shortness of breath and weakness. Death may occur. Ingestion of cadmium dust may cause nausea, vomiting, diarrhea and abdominal cramps.
 - 2. Long-term Exposure: Repeated or prolonged exposure to cadmium dust may cause loss of sense of smell, ulceration of the nose, shortness of breath (emphysema), kidney damage, and mild anemia. Exposure to cadmium has also been reported to cause an increased incidence of cancer of the prostate in man. Injections of cadmium

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sulfate in animals have been reported to cause malformation of their offspring.

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 cadmium dust.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If cadmium dust gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.
- B. Skin Exposure: If cadmium dust gets on your skin, wash the contaminated skin using soap or mild detergent and water. Be sure to wash your hands well before eating or smoking and at the close of work.
- C. Breathing: If you or any other person breathes in large amounts of cadmium dust 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 cadmium dust or liquids containing cadmium dust have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
- 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 emergency rescue equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to cadmium dust. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where there use is required. If you experience difficulty breathing while wearing a respirator, tell your employer.
- B. Protective Clothing: None required.

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- C. Eye Protection: You must wear splash-proof safety goggles where there is any possibility of cadmium chloride dust contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Cadmium dust is a combustible solid.
- B. Cadmium dust must not come in contact with strong oxidizers, or elemental sulfur selenium and tellurium.
- C. Sources of ignition such as smoking and open flames are prohibited wherever cadmium dust is 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 cadmium dust, you must change into uncontaminated clothing before leaving the work premises.
- E. If you are subject to skin contact with cadmium dust, at the end of each workday you must wash with soap or mild detergent and water any areas of the body which may have contacted cadmium dust.
- F. You must not eat or smoke in areas where cadmium dust is handled, processed or stored.
- G. If you handle cadmium dust, you must wash your hands thoroughly with soap or mild detergent and water before eating or smoking.
- H. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them.
- I. Ask your supervisor where cadmium dust may be inadvertently released 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 cadmium dust. In addition, your employer must instruct you in the safe use of cadmium dust, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to cadmium dust. 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 thirty years following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.
- D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

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NOTE: The information contained in the following appendix for cadmium dust 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 cadmium dust, it is advisory in nature.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR CADMIUM DUST (as Cadmium)

This standard for cadmium dust should not be interpreted to apply only to the listed below for which substance specific information has been provided.

- a. Cadmium metal dust
 - I. PHYSICAL AND CHEMICAL DATA
 - A. Substance Identification
 - 1. Synonyms: None
 - 2. Formula: Cd
 - 3. Molecular weight: 112.4
 - B. Physical Data
 - 1. Boiling point (760 mm Hg): 767 C (1412 F)
 - 2. Specific gravity (water = 1): 8.642
 - 3. Vapor density (air = 1 at boiling point of cadmium metal dust): Not applicable
 - 4. Melting point: 321 C (609 F)
 - 5. Vapor pressure at 20 C (68 F): Essentially zero
 - 6. Solubility in water, grams of cadmium per 100 grams of water at 20 C (68 F): Insoluble
 - 7. Evaporation rate (butyl acetate = 1): Not applicable
 - 8. Appearance and odor: Odorless, gray powder
- b. Cadmium oxide dust
 - I. PHYSICAL AND CHEMICAL DATA
 - A. Substance Identification
 - 1. Synonyms: None
 - 2. Formula: CdO
 - 3. Molecular weight: 128.4
 - B. Physical Data
 - 1. Boiling point (760 mm Hg): 900 C (1652 F) (sublimes and de
 - 2. Specific gravity (water = 1): 6.95 or 8.15
 - 3. Vapor density (air = 1 at boiling point of cadmium oxide dust): Not applicable
 - 4. Melting point: 900 C (1652 F) (sublimes and decomposes)
 - 5. Vapor pressure at 20 C (68 F): Essentially zero
 - 6. Solubility in water, grams of cadmium oxide per 100 grams of water at 20 C (68 F): .0005

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7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Odorless, brown solid or blue-black solid

c. Cadmium sulfide dust

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Greenockite
2. Formula: CdS
3. Molecular weight: 144.5

B. Physical Data

1. Boiling point (760 mm Hg): sublimes in N_2 at 980 C (1796 F)
2. Specific gravity (water = 1): 4.82
3. Vapor density (air = 1 at boiling point of cadmium sulfide): Not applicable
4. Melting point: 1750 C (3182 F) at 100 atm.
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, grams of cadmium sulfide per 100 grams water at 20 C (68 F): 0.0001
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Yellow-orange solid

d. Cadmium chloride dust

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: None
2. Formula: CdCl_2

B. Physical Data

1. Boiling point (760 mm Hg): 960 C (1760 F)
2. Specific gravity (water = 1): 4.047
3. Vapor density (air = 1 at boiling point of cadmium sulfide): Not applicable
4. Melting point: 568 C (1054 F)
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, grams of cadmium chloride per 100 gram at 20 C (68 F): 140
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless solid

II. FIRE, EXPLOSION AND REACTIVITY HAZARD

A. Fire

1. Flash point: Not applicable
2. Autoignition temperature: 250 C (482 F) (layer) (cadmium metal)
3. Minimum explosive dust concentration: Data not available
4. Extinguishing media: Dry powder for metal fires
5. Special fire-fighting procedures: None
6. Unusual fire and explosion hazards: Cadmium dust is a combustible solid. All ignition sources must be controlled where cadmium dust is used, handled or stored in a manner that could create a potential fire or explosion hazard.
7. For purposes of complying with 29 CFR 1910.309, the classification of hazardous locations as described in Article 500 of the National Electrical Code for cadmium dust shall be Class II, Group G.

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B. Reactivity

1. Conditions contributing to instability: None hazardous.
2. Incompatibilities: Contact of cadmium metal dust with strong oxidizers or with elemental sulfur, selenium, and tellurium may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as cadmium oxide fume) may be released in a fire involving cadmium dust.
4. Special precautions: None.

III. SPILL AND DISPOSAL PROCEDURES

- A. If cadmium dust is released in hazardous concentrations, the following steps should be taken:
1. Remove all ignition sources.
 2. Ventilate area of release.
 3. Collect released material in the most convenient and safe manner for reclamation or for disposal in sealed containers in a secured sanitary landfill.
- B. Persons not wearing protective equipment should be restricted from areas of releases until cleanup has been completed.
- C. Waste disposal methods: Cadmium dust may be disposed of in sealed containers in a secured sanitary landfill.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. EXPOSURE ABOVE THE ACTION LEVEL:

1. Eight-Hour Exposure Evaluation: 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 analysis under this section 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 analysis. The method of measurement must determine the concentration of cadmium dust to plus or minus 35%.
2. Ceiling Evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of cadmium dust. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totaling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

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- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. A. When sampling for peak or ceiling exposure evaluations, more than three (3) measurements should be taken during the work shift so that increased confidence may be placed in the judgement that the employee has or has not, in fact, been exposed in excess of the permissible limit. 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 cadmium dust 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 W" (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

Employers should advise employees of all areas and operations where their exposure to cadmium dust could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to cadmium dust is likely to occur for cadmium metal dust are: During the manufacture of solders, fusible alloys, brazing alloys and storage battery plates; and for cadmium oxide dust: During cadmium use as an ascaricide, in glass manufacture and as a component of nickel-cadmium batteries.

NOTE: The information contained in the following appendix for cadmium dust 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 cadmium dust, it is advisory in nature.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Cadmium dust causes both acute and chronic effects. It is less toxic than cadmium fume because dust has a larger particle size than fume; at higher concentrations of the dust, physiologic effects similar to those arising from fume exposure could be expected to occur. The acute effects primarily involve the lungs but also may affect other organ systems.

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Most acute intoxications have been caused by inhalation of cadmium fume at concentrations which did not provide warning symptoms of irritation. The average concentrations of fume responsible for fatalities have been 40 to 50 mg/M3 for 1 hour, or 9 mg/M3 for 5 hours. Non-fatal pneumonitis has been reported from concentrations of 0.5 to 2.5 mg/M3, while relatively mild cases have been attributed to even lower concentrations. Following an asymptomatic latent period of 4 to 10 hours, there is characteristically nasopharyngeal irritation followed by a feeling of chest constriction or substernal pain, with persistent cough and dyspnea; there also may be headache, chills, muscle aches, nausea, vomiting, and diarrhea. Pulmonary edema may then develop and progress rapidly, with decreased vital capacity and markedly reduced carbon monoxide diffusing capacity. Cyanosis may be intense. In about 20 percent of the cases the dyspnea is progressive, accompanied by wheezing or hemoptysis, and may result in death within 7 to 10 days after exposure; at autopsy the lungs are markedly congested, and there is an intra-alveolar fibrinous exudate, as well as alveolar cell metaplasia. Among survivors, the subsequent course is unpredictable: most cases resolve slowly, but respiratory symptoms may linger for several weeks, while impairment of pulmonary function may persist for months. In experimental animals, cadmium exposure has caused pulmonary fibrosis, but this has not been documented in humans. In one fatal human case, in addition to lung abnormalities, there was renal cortical necrosis. Absorbed cadmium is retained to a large extent by the body and excretion is very slow. Continued exposure to lower levels of cadmium in air has resulted in chronic poisoning characterized by irreversible lung injury of an emphysematous type, with abnormal lung function and urinary excretion of a specific low molecular weight protein which may be associated with renal dysfunction. Clinical evidence of the cumulative effects of cadmium may appear after exposure has terminated; the disease then tends to be progressive. The frequency of occurrence of proteinuria increases with length of exposure: those exposed to cadmium compounds for less than 2 years had no proteinuria, whereas most of those exposed for 12 years or more had proteinuria with little other evidence of renal damage. The urinary excretion of cadmium bears no known relationship to the severity or duration of exposure and is only a confirmation of absorption. Other consequences of cadmium exposure are rhinitis, occasional ulceration of the nasal septum; damage to the olfactory nerve; and anosmia. The long-term ingestion of water, beans, and rice contaminated with cadmium has been proposed as the probable cause of a crippling condition among Japanese women who have had multiple pregnancies; severe pain in the back and joints, a waddly gait, osteomalacia, spontaneous fractures and occasional fatal renal failure are characteristics of the disorder, which has been termed "itai-itai." Rats, injected subcutaneously with cadmium metal suspended in fowl serum produced rhabdomyosarcomata; with cadmium sulfate in sterile distilled water, sarcomata; and with cadmium chloride solution, pleomorphic sarcomata at the injection site. Increased incidence of prostatic cancer has been reported following occupational exposure to cadmium. Cadmium

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sulfate injected into the lingual vein of female hamsters on day 8 of pregnancy caused a high incidence of resorption and malformed offspring; acute necrosis of rat testes follows large doses orally or parenterally but testicular effects have not been reported in humans.

III. SIGNS AND SYMPTOMS

Delayed onset of pulmonary edema, dyspnea, cough, feeling of chest constriction, substernal pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; prolonged exposure may result in emphysema, proteinuria, anosmia, and mild anemia.

IV. SPECIAL TESTS

Urinalysis for cadmium may be done. The presence of excessive quantities of cadmium in urine may indicate occupational absorption but quantities cannot be correlated with the degree of exposure or to the presence or absence of intoxication. Cadmium may not be present in urine after an exposure which caused acute poisoning. Heavy cigarette smoking may result in increased cadmium intake but the effect on urinary excretion is unclear. Specific low molecular weight proteins (B2 microglobulins) may be screened for in the urine by use of 3% sulfosalicylic acid or other techniques as an indication of renal effects of chronic cadmium poisoning.

V. TREATMENT

If there has been known exposure to cadmium oxide or if symptoms of cough, chest tightness, or respiratory distress appear after suspected exposure, place patient at bed rest. A 14" x 17" chest x-ray should be taken immediately for comparison with subsequent x-rays. Oxygen therapy should be instituted for as long as is necessary. Close observation should be continued for several days. Consideration should be given to the use of corticosteroids.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Cadmium dust is toxic to the lungs but usually has poor warning properties. Acute exposure will cause pulmonary edema which may be life-threatening. Cadmium sulfate administered intravenously is teratogenic in some mammalian species. The advisability of exposing women of child bearing capacity to cadmium should be considered. It is important that the physician become familiar with plant operating conditions in which exposure to cadmium dust 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

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The following medical procedures must be made available to each employee who is exposed to cadmium dust:

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 respiratory system, kidneys, prostate and blood should be stressed.
2. Urinalysis -- Since kidney damage has been observed in humans exposed to cadmium, a urinalysis shall be obtained to include at a minimum specific gravity, albumin, glucose and a microscopic on centrifuged sediment. In addition, the urine shall be examined for low molecular weight proteins by use of 3% sulfosalicylic or other acceptable techniques.
3. 14" x 17" chest roentgenogram -- Cadmium causes human lung damage. Surveillance of the lungs is indicated.
4. FVC and FEV (1 sec) -- Cadmium is reported to cause decreased pulmonary function. Periodic surveillance is indicated.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis, except that an x-ray is required only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Cadmium and Compounds-as Cd," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, pp. 35-36.
2. Hygienic Guide Series: "Cadmium," American Industrial Hygiene Association Journal, 23:518-521, 1962.
3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1011-1016.
4. Browning, Ethel: Toxicity of Industrial Metals (2d ed.), Butterworths, London, 1969, pp. 98-108.
5. Bonnell, J.A.: "Cadmium Poisoning," Annals of Occupational Hygiene, 8:45-49, 1965.
6. Dunphy, B.: "Acute Occupational Cadmium Poisoning: A Critical Review of the Literature," Journal of Occupational Medicine, 9:22-26, 1967.

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7. Louria, D.B., et al: "The Human Toxicity of Certain Trace Elements," Annals of Internal Medicine, 76:307-319, 1972.
8. Tsuchiya, K.: "Proteinuria of Workers Exposed to Cadmium Fume," Archives of Environmental Health, 14:875-880, 1967.
9. Heath, J.C., et al: "Cadmium as a Carcinogen," Nature, 193:592-593, 1962.
10. Haddow, A., et al: "Cadmium Neoplasia: Sarcomata at the Site of Injection of Cadmium Sulphate in Rats and Mice," British Journal of Cancer, 18:667-673, 1964.
11. Gunn, S.A., et al: "Specific Response of Mesenchymal Tissue to Cancerigenesis by Cadmium," Archives of Pathology, 83:493-499, 1967.
12. Holmberg, R.E., Jr. and V.H. Ferm: "Interrelationships of Selenium, Cadmium, and Arsenic in Mammalian Teratogenesis," Archives of Environmental Health, 18:873-877, 1969.
13. Emmerson, B.T.: "Ouch-Ouch' Disease: The Osteomalacia of Cadmium Nephropathy," Annals of Internal Medicine, 73:854-855, 1970.
14. Fassett, D.W.: "Cadmium: Biological Effects and Occurrence in the Environment," Annual Review of Pharmacology, 15:425-435, 1975.
15. Karolinska Institute: Cadmium in the Environment, II, Prepared for Environmental Protection Agency, National Technical Information Service, Springfield, Virginia, 1973, 147 pp. PB-221 198.

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REFERENCES AND SOURCES
CADMIUM DUST

1910.1000

- (f) Personal Protective Equipment, and, (h) Sanitation
Eye: Grant, "Toxicology of the Eye"
Skin: Sax, "Dangerous Properties of Industrial Materials"
Ingestion: ANSI, "American National Standard Acceptable Concentra-
tions;" Patty, "Industrial Hygiene and Toxicology;" Stauden,
"Kirk-Othmer Encyclopedia of Chemical Technology;"
Gleason, "Clinical Toxicology of Commercial Products"

COMMENTS

Eye - Classification: See below

Output statement numbers: See Below

Exceptions: See below

There is no indication in the literature that direct eye contact with significant amounts of dusts of metallic cadmium or insoluble cadmium salts would cause injury other than mechanical irritation. However, Grant states that: "Topically 0.05 to 0.1 M aqueous cadmium chloride solutions applied to rabbit eyes for ten minutes after removal of the corneal epithelium to facilitate penetration has caused total opacification of the cornea. The severity of reaction was not reduced by irrigation of the eyes with 0.03 M sodium EDTA solution (pH 8) immediately after the exposure. He further states: "Unlike the soluble salts of cadmium described above, the sulfide pigments are insoluble, and cadmium yellow has been introduced by tattooing into normal and scarred corneas of rabbits and patients, producing permanent coloration of the cornea but no irritation." A classification of zero is proper for insoluble cadmium salts and metallic cadmium dust, however, a classification of five is required when cadmium chloride is encountered and standards 11 and 13 are specified for this compound.

Skin - Classification: 0

Output statement numbers: None

Exceptions: None

There is no indication in the literature that skin contact with metallic cadmium dust would cause any injury other than mechanical irritation to the skin. A classification of zero therefore, concluded to be most appropriate for these substances

Ingestion - Classification: 5

Output statement numbers: 5a, 6, 15, 19, 20b

Exceptions: See below

ANSI reports that "chronic poisoning may produce a variety of symptoms such as gastric distress, weakness and fatigue, loss of appetite, anemia, and yellow ring on teeth. The production of hypertension has been also reported. Since serious poisoning can occur from the ingestion of cadmium and its compounds, the need for hygienic measures to prevent the contamination of food and tobacco is indicated."

According to Patty, "when incorporated in the diet of rats, the largest dose of Cd tolerated without production of vomiting was 20 ppm. Cd prevented the growth of rats and

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induced fatalities at a level of 250 ppm in the diet. Dietary levels as low as 15 ppm Cd were toxic to rats in a series of studies at 45, 75 and 135 ppm Cd; anemia was a consistent finding at the lowest level; at 135 Cd early deaths occurred.

Stauden states that "death due to cadmium ingestion is rare as it acts as an emetic and, usually, not enough of the metal is absorbed to cause severe damage."

Gleason reports for cadmium salts that "although as little as 10 mg of cadmium salts have often produced severe toxic symptoms when ingested, a toxicity rating of 5 (extremely toxic, probable LD 5-50 mg/kg for humans) is probably a reasonable estimate of cadmium's lethality by the oral route."

These and other sources reviewed indicate that good personal hygiene measures are required to ensure that ingestion of cadmium does not cause intoxication. The substance is, therefore, assigned a classification of 5 and statements 6 and 15 are specified for additional protection.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

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

Palmer, K. N., "Dust Explosions and Fires," Chapman and Hall, London, 1973 (Palmer)

"Lange's Handbook of Chemistry," 11th edition (Lange)

American Smelting and Refining Co., Material Safety Data Sheet for Cadmium Oxide (Amer)

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, vol. 3, p. 884 and p. 907 (K-O)

"Gmelin's Handbuch der Anorganischen Chemie," vol. 22, supplement, p. 436 (Gmelin)

Sources of data items used:

- | | | |
|-----|----|---|
| I. | A. | 1. Synonyms: ACGIH |
| | | 2. Formula: Lange |
| | | 3. Molecular weight: Lange |
| | B. | 1. Boiling point: Lange, K-O |
| | | 2. Specific gravity: Lange |
| | | 3. Vapor density: Not applicable |
| | | 4. Melting point: Lange, K-O |
| | | 5. Vapor pressure: ADL |
| | | 6. Solubility in water: Lange, Gmelin |
| | | 7. Evaporation rate: Not applicable |
| | | 8. Appearance and odor: Lange, K-O |
| II. | A. | 1. Flash point: Not applicable |
| | | 2. Autoignition temperature: Palmer |
| | | 3. Minimum explosive dust concentration: Not applicable |
| | | 4. Extinguishing media: Amer |
| | | 5. Special fire fighting procedures: Amer |
| | | 6. Unusual fire and explosion hazards: Palmer |
| | B. | 1. Conditions contributing to instability: ADL |
| | | 2. Incompatibilities: NFPA-491M |
| | | 3. Hazardous decomposition products: ADL |
| | | 4. Special precautions: None |

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- III. A. Steps if released or spilled: Amer, ADL
C. Waste disposal method: Amer
V. Miscellaneous precautions: ADL

USE/EXPOSURE AND CONTROL DOCUMENT

Sources used in the preparation of this document include:

- "Cadmium," Chemical Data Sheet No. 12, Massachusetts Department of Labor and Industries, June 1969 (Data Sheet)
"Cadmium," Hygienic Information Guide No. 1, Commonwealth of Pennsylvania, Department of Environmental Resources, 9/73 (Hyg. Info.)
Considine, D. M., "Chemical and Process Technology Encyclopedia," McGraw Hill, 1974 (Considine)
Hamilton, A. and Hardy, H. L., "Industrial Toxicology," Publishing Science Group, Inc., 3rd ed., 1974 (H/H)
International Labor Office, "Encyclopedia of Occupational Health and Safety," 1972 (ILO)
Jacobs, M. B., "The Analytical Chemistry of Industrial Poisons, Hazards, and Solvents," Interscience Publishers, 1949 (Jacobs)
Johnstone, S. J. and Johnstone, M. G., "Minerals for the Chemical and Allied Industries," John Wiley & Sons, Inc., 2nd ed., 1961 (Johnstone)
Kirk, R., and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 2nd ed., Vol. 3, 1964 (K-O)
"Mineral Facts and Problems," Staff, Bureau of Mines, U. S. Department of the Interior, 1970 edition (Mineral Facts)
McCaul, "Building a Shorter Life," Environment 13 (7), 3-15 (1971) (McCaul)
Patty, F. A., "Industrial Hygiene and Toxicology," Vol. II, Interscience Publishers, 1962 (Patty)
Stanford Research Institute, "Chemical Economics Handbook," 5/76 (SRI)
References for Specific Use/Exposure were:

1. H/H, Mineral Facts, SRI
2. Considine, K-O, SRI
3. Considine, Mineral Facts
4. Considine, Data Sheet, McCaul, SRI
5. Mineral Facts, Patty, SRI
6. Considine
7. Considine, Jacobs, Johnstone
8. Considine, H/H

The references for the Specific Control Methods were:

1. Hyg. Info., ILO
2. Hyg. Info.
3. Hyg. Info., ILO
4. Hyg. Info.
5. Hyg. Info., ILO
6. Hyg. Info., ILO
7. Hyg. Info., ILO
8. Hyg. Info.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Cadmium dust

D. O. L. STANDARD: 0.2 mg/M3, where 0.6 mg/M3 shall not be exceeded

Irritation Levels: Grant states that "cadmium is a very toxic metal which gives off fumes when burned or heated strongly. Characteristically these fumes cause dryness and irritation of the throat, followed in a few hours by nausea and diarrhea. Smarting of the eyes occurs

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relatively infrequently, and no injury to the eyes of human beings has been reported. Neither eye nor respiratory irritation is enough to prevent exposures which may cause serious systemic poisoning and damage to the lungs."

For the purposes of this standard, quarter- and half-facepiece respirators are permitted unless eye irritation occurs. If eye irritation occurs, a full facepiece respirator must be worn.

IDLH: 50 mg/M3

Basis for IDLH Value: Dose response relations for cadmium are scarce and uncertain. For rabbits, Friberg reports an LC50 of about 8000 mg-min/M3 for 30 minute exposures; this represents a concentration of about 266 mg/M3. As serious irreversible renal cortical changes can precede death when cortical concentrations exceed 0.4 mg/g, tissue wet-weight, an IDLH value of 50 mg/M3 is appropriate. This concentration would result in a human lung cadmium burden in 30 minutes of no more than 8 or 9 mg. This concentration approximately is that at which incipient morphologic changes occur in the kidneys of cadmium exposed workers.*

Other Toxicological Information: Gleason states that "the dangerous actions following inhalation of dust or fumes (of cadmium) are largely limited to the lungs and respiratory mucosa. Edema and necrosis of the pulmonary epithelium are described, and in the dog three clinical stages have been recognized: 1) acute pulmonary edema developing within 24 hours and reaching its maximum within 3 days; 2) proliferative interstitial pneumonitis lasting from approximately the third to the tenth day; and 3) permanent lung damage consisting of perivascular and peribronchial fibrosis. A similar sequence is implied by human autopsy material. A severe disabling emphysema without clinical or histological evidence of chronic bronchitis was the uniform syndrome exhibited by five men chronically poisoned with cadmium fumes. Acute renal necrosis, however, can sometimes be precipitated by inhaled cadmium fumes. Fumes may be anticipated to be more toxic than dusts or aerosols, but all are highly dangerous. Finely divided cadmium of a critical particle size is inflammable and may generate lethal fumes of cadmium oxide. The inhalation of 40 mg of cadmium with the pulmonary retention of 4 mg has been estimated to be fatal in man."

The AIHA Hygienic Guides state that "from study of an accident which caused two deaths and twelve other cases of acute intoxication, it was concluded that the lethal dose (single exposure) for man of thermally generated cadmium oxide fume is not over 2900 minutes - mg/M3 (sometimes referred to as CT value: the product of the concentration in milligrams per cubic meter and the exposure time in minutes.) The doses which caused incapacitation must have been considerably less. Acute non-fatal intoxication occurred in four workers whose maximum exposure was 8 hours to concentrations of cadmium metalizing fume which must have exceeded the 1.1 mg/M3 measured after the installation of local exhaust ventilation."

Patty also states that "the estimated CT value for 2 fatal human exposures was between 2500 and 2900 mg min/cu meter. The corresponding CT value for dogs exposed to CdCl2 aerosol was 9600; death in all cases resulted from pulmonary injury."

The Documentation of TLV's points out that "while Princi

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found no evidence of chronic injury in workers exposed to concentrations of cadmium fume ranging from 1.0 to 6.6 mg/M3, and cadmium oxide dust at 17 mg/M3, Friberg reported proteinuria, emphysema and other complaints in workers with exposure of 20 years to concentrations between 3 and 15 mg/M3 of the dust of cadmium and its oxide. Similar findings were reported by Baader and Massione and Faconti, but no data on the concentrations of cadmium in workroom air were given . . .

"The present evidence indicates that serious chronic effects following exposure to cadmium can occur even after a latent interval. Once established, the condition is progressive. A TLV of 0.2 mg/M3 for cadmium dusts is proposed to protect against the possibility of these systemic effects, while a lower limit of 0.1 mg/M3 is recommended for the more hazardous cadmium fume."

LFL: Not applicable

VAPOR PRESSURE AT 20 C: Essentially zero

* Friberg, L. et al, "Cadmium in the Environment," 2nd edition, CRC Press.

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USE/EXPOSURE AND CONTROL DOCUMENT
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Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1. Inhalation of dust during the fabrication of cadmium-plated materials (marine, aircraft, and motor vehicle equipment, nuts, bolts, screws, rivets, fasteners, washers, carburetor parts, household appliance parts, machinery parts, pipes, tools).	A	Local exhaust ventilation; personal protective equipment (protective clothing, face shield, or goggles)
2. Inhalation of dust during use of cadmium in the plating industry. Cadmium provides a corrosion-resistant coating for iron and steel products. The cadmium plating may be applied by vacuum deposition, dipping, spraying, or electro-deposition (major method).	A	Process enclosure (when possible); local exhaust ventilation
3. Inhalation of dust during the production and processing of cadmium metal. Cadmium is recovered as a by-product in the processing of zinc. It is never found alone in nature and almost always associated with zinc. Cadmium metal is cast in several shapes to meet customer requirements (electroplating industry - balls, chemical and pigment users - sticks or flakes, alloyers - slabs or ingots, cadmium compound producers - cadmium sponge).	A	Process enclosure (when possible); local exhaust ventilation; personal protective equipment (goggles or face shield, protective clothing)
4. Inhalation of dust during use in the synthesis of cadmium compounds (cadmium sulfide - pigments, cadmium oxide - cadmium - nickel storage battery negative electrode, cadmium stearate - stabilizer in thermosetting plastics, cadmium acetate and salicylate - external antiseptics, cadmium halides - photography and	A	Process enclosure; local exhaust ventilation

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pyrotechnics, cadmium phosphors - TV tubes and fluorescent light tubes). Production of cadmium compounds is either directly or indirectly from cadmium metal.

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|----|---|---|---|
| 5. | Inhalation of dust during the manufacture and fabrication of cadmium alloys (low temperature alloy, silver alloys for soldering and brazing, alloys for electrical contacts in switches and relays, gold alloys for jewelry, alloys for hardening copper) | A | Local exhaust ventilation; personal protective equipment (protective clothing, face shield, or goggles) |
| 6. | Inhalation of dust during recovery of metals collected from flue dusts during smelting of lead and zinc (thallium). The dust may also contain indium, arsenic, selenium, or tellurium. | A | Local exhaust ventilation; personal protective equipment (protective clothing, goggles or face shield, respirator protective device - as necessary) |
| 7. | Inhalation of dust during clean up and maintenance of equipment and places where cadmium plated metal, cadmium alloys or metals have been fabricated (grinding, crushing, polishing, drilling, pulverizing, rubbing, cutting) | A | Local exhaust ventilation; personal protective equipment (protective clothing, goggles or face shield, respiratory protective devices) |
| 8. | Inhalation of dust during the manufacture of nuclear reactor rods (cadmium may be sprayed on graphite or may be made into rods). Cadmium metal has been used in nuclear reactors as a neutron absorber but is being displaced by substitute materials. | A | Process enclosure; local exhaust ventilation |

- A -- Inhalation
- B -- Skin and eye contact resulting in localized irritation
- C -- Ingestion
- D -- Skin contact resulting in absorption and subsequent systemic poisoning