

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** CHROMIUM METAL AND INSOLUBLE SALTS ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for CHROMIUM METAL AND INSOLUBLE SALTS

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 CHROMIUM METAL AND INSOLUBLE SALTS.

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 chromium metal and insoluble salts (as chromium) not in excess of 1 milligram per cubic meter (mg/M3) averaged over an eight-hour work shift (time weighted average), as stated in § 1910.1000, Table Z-1.

(2) "Action level" means one half of the permissible exposure for chromium metal and insoluble salts.

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

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

- (i) Any information, observations, or calculations which may indicate employee exposure to chromium metal or insoluble salts;
- (ii) Any measurements of chromium metal or insoluble salts taken;
- (iii) Any employee complaints of symptoms which may be attributable to exposure to chromium metal or insoluble salts; 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 chromium metal and insoluble salts at or above the action level, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b) (3) of this section reveals employee exposure to chromium metal and insoluble salts 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 chromium metal and insoluble salts 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 chromium metal and insoluble salts 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 chromium metal and insoluble salts 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 chromium metal and insoluble salts below the action level, the employer may terminate measurement for the employee.

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

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

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

Table 1

Concentration	Required Accuracy
Above permissible exposure	$\pm 25\%$
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 chromium metal and insoluble salts above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of chromium metal and insoluble salts 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 chromium metal and insoluble salts.

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

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

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- (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 chromium metal and insoluble salts 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 CHROMIUM METAL AND INSOLUBLE SALTS (AS CHROMIUM)

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION

Particulate Concentration	
5 mg/M3 or less	Any dust and mist respirator.
10 mg/M3 or less	Any dust and mist respirator, except single-use or quarter mask respirator.
	Any fume respirator or high efficiency particulate filter respirator.
	Any supplied-air respirator.
	Any self-contained breathing apparatus.
50 mg/M3 or less	A high efficiency particulate filter respirator with a full facepiece.
	Any supplied-air respirator with a full facepiece, helmet or hood.
	Any self-contained breathing apparatus with a full facepiece.
500 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 500 mg/M3 or entry and escape from	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

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unknown concentrations	A combination respirator which includes a Type C supplied - air respirator with a full facepiece operated in pressure - demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

(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 chromium metal and insoluble salts.

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

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

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

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

(6) Chromium metal shall be stored so as not to come in contact with strong oxidizers.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use impervious clothing, gloves, face shields (eight-inch minimum) and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with solids or liquids containing insoluble salts of chromium. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (a)(6).

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

(3) Employers shall ensure that non-impervious clothing which becomes contaminated with insoluble salts of chromium be removed promptly and not reworn until the insoluble salts of chromium are 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 insoluble salts of chromium may contact the eyes.

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(g) Spills and disposal. In the event that chromium metal or insoluble salts of chromium are spilled the employer shall immediately eliminate potential sources of ignition, provide available ventilation and then clean up the spill.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with insoluble salts of chromium promptly wash or shower with soap or mild detergent and water to remove any insoluble salts of chromium from the skin.

(2) Employers shall ensure that employees do not eat or smoke in areas where solids or liquids containing insoluble salts of chromium are handled, processed or stored.

(3) Employers shall ensure that employees who handle solids or liquids containing insoluble salts of chromium wash their hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.

(i) Training and information. (1) Each employer who has a workplace in which chromium metal or insoluble salts of chromium 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 chromium metal and insoluble salts of chromium above the action level or employees who may have skin or eye contact with solids or liquids containing insoluble salts of chromium, or employees who work where a spill of chromium metal and insoluble salts of chromium may occur, or employees who work where chromium metal presents a fire or explosion hazard, shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for chromium metal and insoluble salts of chromium (Appendix A of this section);

(ii) Advise affected employees as to the signs and symptoms of exposure to chromium metal and insoluble salts of chromium.

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

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

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

(2) The employer shall make available to each employee who is to be exposed to chromium metal or insoluble chromium salts or chromates or airborne concentrations of chromium metal or insoluble chromium salts 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 lungs.

(ii) 14" x 17" chest roentgenogram.

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

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- (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) 14" x 17" chest roentgenogram or a medically acceptable copy.
- (iii) A record of the results of the pulmonary function testing.
- (4) The employer shall make available to each employee, exposed to chromium metal or insoluble chromium salts in excess of the action level at 12 months from the date of the employee's first exposure, and at every 12 months of exposure in excess of the action level thereafter, a medical examination which must include the following:
- (i) A medical history and physical examination with emphasis on the lungs.
- (ii) 14" x 17" chest roentgenogram.
- (iii) Forced vital capacity (FVC and forced expiratory volume-one second (FEV (1 second)) tests.
- (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) 14" x 17" chest roentgenogram or a medically acceptable copy.
- (iii) A record of the results of the pulmonary function testing.
- (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 chromium metal or insoluble chromium salts;
- (ii) A description of the employee's duties as they relate to his exposure to chromium metal or insoluble chromium salts;
- (iii) A description of any personal protective equipment and respirators required to be used;
- (iv) The results of any measurements, which may indicate the affected employee's exposure;
- (v) The affected employee's anticipated exposure; and
- (vi) Upon request of the physician, any available information from previous medical 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 chromium metal or insoluble chromium salts or would directly or indirectly aggravate any detected medical condition;
- (B) Any recommended limitations upon the employee's exposure to chromium metal or insoluble chromium salts, 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 chromium metal or insoluble chromium salts.
- (iii) The employer shall provide the employee with a copy of the physician's written opinion.
- (8) No employee shall be exposed to chromium metal or insoluble chromium salts or chromates or airborne concentrations of chromium metal or
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insoluble chromium salts 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 chromium metal or insoluble chromium salts.

(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.

(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to chromium metal and insoluble salts.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to chromium metal and insoluble salts 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;

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- (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. (1) 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 chromium metal and insoluble salts;
 - (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.
 - (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 chromium metal and insoluble salts which is conducted pursuant to this section.
 - (2) When observation of measurement of employee exposure to chromium metal and insoluble salts 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.

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- (ii) Visually observe all steps related to the measurement of the airborne concentration of chromium metal and insoluble salts 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 CHROMIUM METAL AND INSOLUBLE SALTS OF CHROMIUM

I. SUBSTANCE IDENTIFICATION

- A. Substance: Chromium metal and insoluble salts
- B. Permissible Exposure: 1 milligram of chromium metal and insoluble salts per cubic meter of air (mg/M3) averaged over an eight-hour work shift.
- C. Appearance and Odor: metallic chromium: Shiny steel gray metal with no odor; copper chromite: Greenish blue solid with no odor; basic potassium zinc chromate: Yellow solid with no odor

II. HEALTH HAZARD DATA

- A. Comment: Serious health effects may result if other forms of chromium are present. You should consult the standard for Chromic Acid and Chromates.
- B. Ways in which the chemical affects your body: Chromium metal or insoluble chromium salts of chromium can affect your body if you inhale them. They may also affect your body if you swallow them.
- C. Effects of Overexposure:
 - 1. Exposure: Ferro chrome alloys have been associated with lung changes in workers exposed to these alloys. Chromite dust exposure may cause minor lung changes.
 - 2. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they may be caused by chromium metal or insoluble chromium salts of chromium.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If chromium metal or solids or liquids containing insoluble salts of chromium get into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation

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- is present after washing, get medical attention. Contact lenses should not be worn when working with these chemicals..
- B. Skin Exposure: If solids or liquids containing insoluble salts of chromium get on your skin, wash the contaminated skin using soap or mild detergent and water. If solids or liquids containing insoluble salts of chromium penetrate through your clothing, remove the clothing and wash the skin using 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 chromium metal or insoluble salts of chromium 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 solids or liquids containing insoluble salts of chromium have been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
 - E. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to chromium metal and insoluble salts. 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 solids or liquids containing insoluble salts of chromium. Replace or repair impervious clothing that has developed leaks.
- C. Eye Protection: You must wear splash-proof safety goggles where liquids containing insoluble salts of chromium may contact your eyes. You must wear dust-resistant safety

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goggles where solids containing insoluble salts of chromium may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Chromium metal is combustible and its dust can form explosive mixtures with air.
- B. Chromium metal must be stored in tightly closed containers in a cool, well ventilated area away from strong oxidizers.
- C. Sources of ignition such as smoking and open flames are prohibited wherever chromium metal 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 insoluble salts of chromium and this clothing must not be reworn until the insoluble salts of chromium are removed from the clothing.
- E. If your skin becomes contaminated with insoluble salts of chromium, you must promptly wash or shower with soap or mild detergent and water to remove the insoluble salts of chromium from your skin.
- F. You must not eat or smoke in areas where solids or liquids containing insoluble salts of chromium are handled, processed or stored.
- G. If you handle solids or liquids containing insoluble salts of chromium, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.
- H. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them.
- I. Ask your supervisor where chromium metal and insoluble salts 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 chromium metal and insoluble salts of chromium. In addition, your employer must instruct you in the safe use of chromium metal and insoluble salts of chromium, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to chromium metal and insoluble salts of chromium. 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.

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APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR CHROMIUM METAL AND INSOLUBLE SALTS OF CHROMIUM

The standard for chromium metal and insoluble salts of chromium should not be interpreted for substances listed below for which substances specific information has been provided.)

I. PHYSICAL AND CHEMICAL DATA (metallic chromium)

A. Substance Identification

1. Synonyms: None
2. Formula: Cr
3. Molecular weight: 52

B. Physical Data

1. Boiling point (760 mm Hg): 2640 C (4784 F)
2. Specific gravity (water = 1): 7.2
3. Vapor density (air = 1 at boiling point of metallic chromium): Not applicable
4. Melting point: 1900 C (3452 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: Shiny and odorless metal

II. PHYSICAL AND CHEMICAL DATA (copper chromite)

A. Substance Identification

1. Synonyms: Cuprous chromite
2. Formula: $\text{Cu}_2\text{Cr}_2\text{O}_4$
3. Molecular weight: 295.1

B. Physical Data

1. Boiling point (760 mm Hg): Data not available
2. Specific gravity (water = 1): 5.24
3. Vapor density (air = 1 at boiling point of copper chromite): Not applicable
4. Melting point: Data not available
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: Greenish blue, odorless solid

III. PHYSICAL AND CHEMICAL DATA (basic potassium zinc chromate)

A. Substance Identification

1. Synonyms: Zinc yellow
2. Formula: $\text{K}_2\text{O} \cdot 4\text{ZnO} \cdot 4\text{CrO}_2 \cdot 3\text{H}_2\text{O}$
3. Molecular weight: 873.8

B. Physical Data

1. Boiling point (760 mm Hg): Decomposes at red heat
2. Specific gravity (water = 1): 3.47
3. Vapor density (air = 1 at boiling point of basic potassium zinc chromate): Not applicable
4. Melting point: Loses water slowly above 100 C (212 F)
5. Vapor pressure at 20 C (68 F): Essentially zero

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6. Solubility in water, % by weight at 20 C (68 F): Insoluble
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Yellow, odorless solid

IV. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: Not applicable
2. Minimum ignition temperature (metal): 400 C (752 F) (layer); 580 C (1076 F) (cloud)
3. Minimum explosive dust concentration (metal): 230 grams/M3
4. Extinguishing media: Dry sand, dry dolomite, dry graphite
5. Unusual fire and explosion hazards: Chromium metal is combustible. Its dust can form explosive mixtures with air. All ignition sources must be controlled where chromium metal is used, handled or stored in a manner that could create a potential fire or explosion hazard.
6. 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 chromium metal shall be Class II Group E.

B. Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Chromium metal in contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: None listed.
4. Special precautions: None listed.

V. SPILL AND DISPOSAL PROCEDURES

A. If chromium metal and insoluble salts of chromium are spilled, the following steps should be taken:

1. Remove all ignition sources where metallic chromium has been spilled.
2. Ventilate area of spill.
3. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation, or for disposal in a secured sanitary landfill. Liquids containing chromium and insoluble salts of chromium 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: Chromium metal and insoluble salts may be disposed of in sealed containers in a secured sanitary landfill.

VI. MONITORING AND MEASUREMENT PROCEDURES

A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average 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

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performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or by collection of the particulates using a high efficiency membrane filter with subsequent chemical analyses. The method of measurement must determine the concentration of chromium metal and insoluble salts 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 chromium metal and insoluble salts 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

- A. Chromates may be present with insoluble salts of chromium and may cause a serious health hazard. See the standard for Chromic Acid and Chromates.
- B. Store chromium metal and insoluble salts in tightly closed containers in a cool, well ventilated area.
- C. Employers should advise employees of all areas and operations where exposure to chromium metal and insoluble salts of chromium could occur.

VIII. COMMON OPERATIONS

Common operations in which high exposure to chromium metal and insoluble salts of chromium may occur are: During the metallurgy of chromium, including the preparation and use of chromium alloys; during the production of chromium salts; during their use as contact catalysts for hydrogenation reactions, as inhibiting pigments in metal finishes; during the production of chromium-plated products; and during the refining and processing of chromium.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

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The dusts of chromium metal and its insoluble salts, chiefly the chromites, are usually reported to be relatively nontoxic; but this is debatable, since exposures associated with toxic effects are mixed exposures with hexavalent chromium compounds. Ferrochrome alloys have been associated with pulmonary disease in humans. Four workers engaged in the production of ferrochrome alloys developed a nodular type of pulmonary disease with impairment of pulmonary function; air concentrations of chromium in this study averaged 0.26 mg/M3, although other fumes and dusts were also present. This pulmonary problem may be one of hypersensitivity and reversible. Other reports state that chest roentgenograms have revealed only "exaggerated pulmonic markings" in workers exposed to chromite dust. The lungs of groups of workers exposed to chromite dust have been shown to be the seat of pneumoconiotic changes consisting of slight thickening of interstitial tissue and interalveolar septa, with histologic fibrosis and hyalinization. Chromite ore roast mixed with sheep fat implanted intrapleurally in rats produced squamous cell carcinomata coexisting with sarcomata of the lungs; the same material implanted in the thigh of rats produced fibrosarcomata. A refractory plant using chromite ore to make chromite brick had no excess of lung cancer deaths over a 14-year period, and it was concluded that chromite alone probably is not carcinogenic.

III. SIGNS AND SYMPTOMS

Possible histologic fibrosis of the lungs with x-ray changes.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure. Flush eyes with water and wash skin with soap or mild detergent and water. If swallowed and the person is conscious, induce vomiting. Give artificial resuscitation if indicated.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Chromium metal and its insoluble salts are considered to be, of themselves, of low toxicity. Possible fibrosis of the lung may occur. Since often exposures are mixed, consideration should be given to the possible exposure to hexavalent chromium which is a more toxic form causing damage to mucous membranes, lungs, other organ systems. It is also considered to be a potent carcinogen. It is important that the physician become familiar with plant operating conditions in which exposure to metal and insoluble salts of chromium 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.

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B. PREPLACEMENT

The following medical procedures must be made available to each employee who is exposed to metal and insoluble salts of chromium:

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 respiratory system should be stressed.
2. 14" x 17" chest roentgenogram -- Chromium and its insoluble salts may cause human lung damage. Surveillance of the lungs is indicated.
3. FVC and FEV (1 sec) -- Insoluble chromium salts are 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.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Chromium (as Cr)," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 56.
2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1017-1022.
3. Browning, Ethel: Toxicity of Industrial Metals (2d ed.), Butterworths, London, 1969, pp. 119-131.
4. International Labour Office: Encyclopaedia of Occupational Health and Safety, Vol. I, A-K, McGraw Hill Book Company, New York, 1974, pp. 294-297.
5. Mancuso, T.F. and W.C. Hueper: "Occupational Cancer and Other Health Hazards in a Chromate Plant: A Medical Appraisal - 1. Lung Cancer in Chromate Workers," Industrial Medicine and Surgery, 20:358-363, 1951.
6. Princi, F., et al: "Pulmonary Disease of Ferroalloy Workers," -Journal of Occupational Medicine, 4:301-310, 1962.
7. Hueper, W.C.: "Experimental Studies in Metal Cancerigenesis. X. Cancerigenic Effects of Chromite Ore Roast Deposited in Muscle Tissue and Pleural Cavity of Rats," A.M.A. Archives of Industrial Health: 18:284-291, 1958.

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8. Committee on Medical and Biologic Effects of Environmental Pollutants, Division of Medical Sciences, National Research Council: Chromium, National Academy of Sciences, Washington, D.C., 1974, pp. 42-73, 125-145.

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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: Sax, "Dangerous Properties of Industrial Materials;"
Thienes and Haley, "Clinical Toxicology;" Johnstone and
Miller, "Occupational Diseases and Industrial Medicine"
Ingestion: Patty, "Industrial Hygiene and Toxicology;" International
Labour Office, "Encyclopedia of Occupational Safety and
Health;" Browning, "Toxicity of Industrial Metals"

COMMENTS

- Eye - Classification: 2 and 6
Output statement numbers: 10 and 12 combined
Exceptions: None
Grant states that "chromium metal itself is innocuous" and
that "systemic poisoning as a possible eye disturbance has
been considered, but not established." No specific data
regarding the eye contact effects of insoluble salts of
chromium could be found in the literature.
Because of the large number of compounds being treated
by this standard, and the uncertainty that all are not
hazardous, classifications of 2 and 6 are concluded to be
warranted for the insoluble salts.
- Skin - Classification: 2 and 6
Output statement numbers: 2, 7a, 17g, 17i, 20a
Exceptions: None
According to Sax, chromic trivalent compounds are less toxic
than hexavalent compounds, however, "eczematous dermatitis
due to trivalent chromium compounds has been reported," but
Sax considers the metal to be "essentially non-toxic."
Thienes and Haley state that "trivalent chromium salts
may produce sensitivity dermatitis," while Grant says "contact
dermatitis appears to be well established as a sensitivity
reaction rather than a direct toxic effect."
Johnstone and Miller report "most workers who develop a
sensitivity do so within the first week while with others it
has not occurred until ten years of exposure."
Classifications of 2 and 6 are concluded to be appropriate
to prevent the cited effects. However, since, according to
Grant, "chromium metal itself is innocuous," the standard is
only applied to its insoluble salts.
- Ingestion - Classification: 2 and 6
Output statement numbers: 19, 20a
Exceptions: None
Patty reports trivalent chromium has a low order of toxicity
and has "caused no significant industrial illness."
The International Labour Office reports chromium in the plus
3 state "is not readily absorbed from the digestive system and
combines with proteins in the superficial layers of the skin to
form stable complexes." ILO also states the "only confirmed
long-term effect of exposure to chromium is an increase in lung

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cancer of people employed in the manufacture of dichromates from the ore, chromite -- but since water-soluble, acid soluble and insoluble chromium is found in the lungs in varying amounts, there is no method of determining beyond doubt that lung cancer in a chromates worker is the result of this occupation."

Patty says "although the precise form of Cr responsible for the production of lung cancer among chromate workers is not known with absolute certainty, experimental production of sarcomas by Hueper and Payne relates tumorigenesis to the degree of solubility of the compound: the highest water solubility gave the largest percentage of tumors, the lowest solubility resulted in none."

Patty reports "orally, neither hexavalent nor trivalent Cr was toxic to rats when administered in the drinking water for one year at levels from 0.45 - 25 ppm Cr."

Browning states that chromium taken up by food and liquids from chrome-plated utensils was examined, but although dissolved chromium was found in both, this was in the form of chromic salt and "no toxic effects from this source has been reported."

There is no indication in the literature that insoluble salts of chromium, or the metal itself, can cause toxic effects of a serious nature by ingestion. Nevertheless, because of the number of compounds being addressed by this standard, and the uncertainty that all are not hazardous, classifications of 2 and 6 are concluded to be warranted. Statement 19 has been modified to include both solids or liquids containing insoluble salts of chromium.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, Vol. 5, p. 473 (K-O)

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

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

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

"Gmelin's Handbuch der Anorganischen Chemie," 52B, 865 (Gmelin)

Sources of data items used:

- | | | |
|-----|----|---|
| I. | A. | 1. Synonyms: K-O |
| | | 2. Formula: K-O, Lange |
| | | 3. Molecular weight: Lange |
| | B. | 1. Boiling point: Gmelin |
| | | 2. Specific gravity: Lange, Gmelin |
| | | 3. Vapor density: Not applicable |
| | | 4. Melting point: Gmelin |
| | | 5. Vapor pressure: ADL |
| | | 6. Solubility in water: Gmelin |
| | | 7. Evaporation rate: Not applicable |
| | | 8. Appearance and odor: K-O, Lange |
| II. | A. | 1. Flash point: Not applicable |
| | | 2. Minimum ignition temperature (metal): Not applicable |

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- 3. Minimum explosive dust concentration: Not applicable
- 4. Extinguishing media: ADL
- 5. Special fire fighting procedures: None
- 6. Unusual fire and explosion hazards: Palmer
- B. 1. Conditions contributing to instability: None
- 2. Incompatibilities: NFPA-491M
- 3. Hazardous decomposition products: None
- 4. Special precautions: None
- III. A. Steps if released or spilled: ADL
- C. Waste disposal method: ADL
- V. Miscellaneous precautions: ADL

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

- Considine, D. M., "Chemical and Process Technology Encyclopedia," McGraw Hill, 1974 (Considine)
- Hygienic Information Guide No. 23, "Chromium and Its Compounds," Commonwealth of Pennsylvania, Department of Environmental Resources, Occupational Health, 7/71 (Hyg. Info.)
- Johnstone, S. J. and Johnstone, M. G., "Minerals for the Chemical and Allied Industries," John Wiley and Sons Inc., 1961 (Johnstone)
- Kirk, R. and OTHMER, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 2nd edition, 1972 (K-O)
- "Merck Index of Chemicals and Drugs," Merck and Co., Inc., 8th edition, 1968 (Merck)
- Schwartz, L., Tulipan, L. and Birmingham, D. J., "Occupational Diseases of the Skin," 1957 (Schwartz)

References for Specific Use/Exposure

- 1. K-O
- 2. Considine, K-O
- 3. Considine, Johnstone
- 4. Considine, K-O
- 5. Considine, Johnstone, K-O
- 6. K-O, Merck
- 7. K-O, Merck
- 8. Considine, Merck
- 9. Considine, K-O
- 10. K-O, Merck
- 11. Considine, K-O, Merck

References for Specific Control Methods

Hyg. Info. and Schwartz were the references used in all the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Chromium metal and insoluble salts

D. O. L. STANDARD: 1 mg/M³

Eye Irritation Level: Chromium metal and insoluble salts are not known to be eye irritants.

-IDLH: There is no evidence in the available toxicological information that an acute exposure to a high concentration of chromium metal or its insoluble salts would impede escape or cause any irreversible health effects within one-half hour. For the purposes of this standard, therefore, allowable respiratory protection has been determined on the basis of the protection factor afforded by each device. It is recognized, however, that for

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some substances for which there does not appear to exist a concentration immediately dangerous to life and health, the determination of allowable respiratory protection based on protection factors may result in the selection of a concentration which is not likely to be encountered in the occupational environment. Therefore, for all such particulate substances it has been arbitrarily determined that only those respirators allowed for use above IDLH concentrations are permitted for use in concentrations exceeding 500 times the permissible exposure.

Other Toxicological Information: The permissible exposure limit pertains to metallic chromium and the insoluble salts, except for the hexavalent compounds

According to Patty, "Cr³⁺ salts, including Cr₂O₃, are ascribed a low order of toxicity and have caused no significant industrial illness according to Akatsuka and Fairhall, who also reviewed the industrial toxicology literature of Cr to 1934. On the other hand, chromates and dichromates (oxidation state +6) act as protein precipitants and are irritant in action."

The Committee on Biologic Effects of Atmospheric Pollutants, concerning the effects of chromium compounds on human health, states that "chromium as a metal is biologically inert and does not produce toxic or other harmful effects in man or laboratory animals. Compounds of chromium in the trivalent state (i.e. chromic oxide, chromic acetate, chromic phosphate, all of which are insoluble) have no established toxicity. When taken by mouth, they do not give rise to local or systemic effects and are poorly absorbed. No specific effects are known to result from inhalation. In contact with the skin, they combine with proteins in the superficial layers, but do not cause ulceration. . ."

"The chief health problems associated with chromium are related to hexavalent chromium compounds, which are irritant and corrosive and may be absorbed by ingestion, through the skin, and by inhalation."

The Documentation of TLV's remarks that "the literature on chromium toxicology is devoted primarily to hexavalent chromium. Early studies indicated trivalent (and presumably bivalent) chromium compounds to be essentially nontoxic. . . . Experimental evidence has been reported indicating that trivalent chromium possesses carcinogenic properties. Animals ingesting chromic salts showed one-ninth as much chromium in the tissues as did animals ingesting equal amounts of chromates. . . . The TLV's of 0.5 mg/M³ of soluble chromium and 1 mg/M³ of insoluble chromium (with the exception of hexavalent chromium compounds) are recommended to prevent pulmonary disease or other toxic effects."

Reference: Committee on Biologic Effects of Atmospheric Pollutants, Division of Medical Sciences, National Research Council, "Chromium," Washington - Printing and Publishing Office, National Academy of Sciences, 1974, 155 pp.

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Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1. Inhalation of dust or fume and skin contact with metal during the fabrication of chromium alloys (machining, welding, grinding, polishing). There are thousands of uses for alloys of chromium - from cooking utensils to building construction materials.	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices)
2. Inhalation of dust or fume during the use of chromium, as ferro-chromium alloy, in the preparation of alloy steels (stainless steel, heat-resisting steels, high strength-low alloy steels, alloy tool steels). The chromium is used to enhance corrosion and heat resistance. Stainless steel, the largest single outlet for chromium, is at least 11% chromium.	A	Local exhaust ventilation; general dilution ventilation
3. Inhalation of dust or fume and skin contact with the metal during fabrication of chromium plated products (electrical appliances and parts, automobile fixtures, plumbing fixtures, piston rings, diesel engine cylinders). The chromium plating may be decorative or intended to increase wear resistance.	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices)
4. Inhalation of dust or fume during the use of chromium in the production of non-ferrous alloys	A	Local exhaust ventilation; general dilution ventilation

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(copper, vanadium, zirconium).
There are hundreds of
these chromium bearing
alloys which use the
chromium in order to impart
special qualities to the
alloy.

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|----|---|-----|--|
| 5. | Inhalation of fume or dust during the refining and processing of chromium. The principal chromium ore is ferrous chromite. The ore is heated in an electric furnace with carbon to yield ferrochrome which is used directly in alloys. The metallic chromium can be produced by four different processes (aluminothermic reduction, silicon reduction, electrolysis and carbon reduction process). The metal is ductile and is prepared for distribution by rolling, forging and extrusion. | A | Local exhaust ventilation; general dilution ventilation |
| 6. | Inhalation of dust and skin contact with crystals during the production and processing of insoluble chromium salts. Most of the salts which are insoluble in water are prepared as the hydrate which is soluble in water. For expediency this document does not differentiate between the hydrated and unhydrated insoluble salts since the hydrated salts are practically never used or prepared. | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices, protective clothing) |
| 7. | Inhalation of dust and skin contact with crystals during the use of insoluble chromium salts as chemical intermediates (chromic sulfate, chromic acetylacetonate, chromic carbonate). | A,B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices, protective clothing) |

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They are used in the preparation of catalysts, organic chromium compounds and other chromium salts.

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|-----|---|------|--|
| 8. | Inhalation of dust and skin contact with crystals during use of insoluble chromium salts in the textile industry (chromic sulfate, chromic fluoride). They are used as mordants in dyeing, in treating of silk, in printing and mothproofing of wool. | A, B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, respiratory protective devices) |
| 9. | Inhalation of dust and skin contact with crystals during use of insoluble chromium salts in the leather industry (chromic sulfate is used in the tanning of leather) | A, B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, respiratory protective devices) |
| 10. | Inhalation of dust and skin contact with crystals during use of insoluble chromium salts as a catalyst (chromic acetylacetonate, chromic fluoride, chromic hexacarbonyl, chromous fluoride). They can be used as catalysts for halogenation, alkylation and catalytic cracking of hydrocarbons | A, B | Local exhaust ventilation; general dilution ventilation |
| 11. | Inhalation of dust and skin contact with crystals during use of insoluble chromium salts in miscellaneous applications (photographic fixing baths - chromic sulfate; chromizing - chromic fluoride; fuel and propellant additive - chromic acetylacetonate, chromic hexacarbonyl, chromous fluoride; pigments in ceramics - chromic sulfate, chromic fluoride | A, B | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, respiratory protective devices) |

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