NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND SUPPORTING DOCUMENTATION FOR

*** VANADIUM V2O5 DUST ***

NIOSH/OSHA Draft Technical Standard and Supporting Documentation for VANADIUM V2O5 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 VANADIUM V2O5 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.

(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of vanadium pentoxide dust not in excess of 0.5 milligrams per cubic meter (mg/M3) averaged over any 15-minute period during an eight-hour work shift, as stated in § 1910.1000, Table Z-1.

(2) "Action level" means one half of the permissible exposure for vanadium pentoxide dust.

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

(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 vanadium pentoxide dust;

(ii) Any measurements of vanadium pentoxide dust taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to vanadium pentoxide dust; 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 vanadium pentoxide dust 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 vanadium pentoxide dust 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 vanadium pentoxide dust 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 vanadium pentoxide 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 vanadium pentoxide dust above the permissible exposure. The employee shall also be notified of the corrective action being taken to reduce the exposure to at or below the permissible exposure.

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

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 short term samples which represents the employee's actual exposure averaged over the time periods appropriate to permissible exposure (See Appendix B (IV) of this section).

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

Table 1

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

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

(2) Employee exposures to airborne concentrations of vanadium pentoxide 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 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. 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 vanadium pentoxide dust.

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

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

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

(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of vanadium pentoxide dust 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 VANADIUM PENTOXIDE DUST

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Particulate Concentration	
25 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.
70 mg/M3 or less	A powered air-purifying respirator with a full facepiece and a high efficiency particulate filter. A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet or hood operated in continuous-flow mode.
Greater than 70 mg/M3 or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	A high efficiency particulate filter respirator. Any escape self-contained breathing apparatus.

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

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

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

(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 vanadium pentoxide dust. Face shields shall comply with § 1910.133(a)(2),(a)(4), (a)(5), and (a)(6).

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

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

(4) Employers shall provide and ensure that employees use dust-resistant safety goggles (cup-cover type dust and splash safety goggles), which comply with § 1910.133(a)(2)-(a)(6) where vanadium pentoxide dust may contact the eyes.

(g) Spills and disposal. In the event that vanadium pentoxide dust is spilled the employer shall immediately provide available ventilation and then clean up the spill.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with vanadium pentoxide dust promptly wash or shower to remove any vanadium pentoxide dust from the skin.

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

(3) Employers shall ensure that employees who handle vanadium pentoxide dust 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 vanadium pentoxide 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 vanadium pentoxide dust above the action level or employees who may have skin or eye contact with vanadium pentoxide dust, or employees who work where a spill of vanadium pentoxide dust may occur, shall annually:

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

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

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of exposure to vanadium pentoxide 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 vanadium pentoxide 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) The employer shall make available to each employee who is to be exposed to vanadium pentoxide dust or airborne concentrations of vanadium pentoxide dust 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 and skin.

(ii) 14" x 17" chest roentgenogram.

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

(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 vanadium pentoxide dust 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 and skin.

(ii) 14" x 17" chest roentgenogram (only when indicated by results of pulmonary function testing, FVC and FEV (1 sec)).

(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 vanadium pentoxide dust;

(ii) A description of the employee's duties as they relate to his exposure to vanadium pentoxide 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; 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 vanadium pentoxide dust or would directly or indirectly aggravate any detected medical condition;

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

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

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to exposure to vanadium pentoxide dust.

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

(8) No employee shall be exposed to vanadium pentoxide dust or airborne concentrations of vanadium pentoxide dust 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 vanadium pentoxide dust.

(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 vanadium pentoxide dust.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to vanadium pentoxide dust which are being monitored;

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

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

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

(iii) This record shall be maintained until replaced by a more recent record but in no event for less than one year.

(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of the measurements demonstrating the effectiveness of such ventilation required by paragraph (d)(3) of this section.

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

(iii) These records shall be maintained for at least one year.

(4) Employee training and information. (i) The employer shall keep an accurate record of all employee training and information required by paragraph (i) of this section.

(ii) This record shall include:

(A) Date of training;

(B) Name and social security number of employee trained;

(C) Content or scope of training provided.

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

(5) Medical surveillance. (i) The employer shall keep an accurate record of employee medical surveillance required by paragraph (j) of this section.

(ii) This record shall include:

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

(B) Any employee medical complaints relative to exposure to vanadium pentoxide dust;

(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.

(l) Employee observation of measurement. (1) The employer shall give affected employees or their representatives an opportunity to observe any measurement of employee exposure to vanadium pentoxide dust which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to vanadium pentoxide 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:

(i) Receive an explanation of the measurement procedure.

(ii) Visually observe all steps related to the measurement of the airborne concentration of vanadium pentoxide dust 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 VANADIUM PENTOXIDE DUST

I. SUBSTANCE IDENTIFICATION

A. Substance: Vanadium pentoxide dust

B. Permissible Exposure: 0.5 milligram of vanadium pentoxide dust per cubic meter of air (mg/M3) shall not be exceeded during any fifteen minute period of an eight-hour work shift.

C. Appearance and odor: Yellow-orange powder or dark gray, odorless flakes

II. HEALTH HAZARD DATA

A. Ways in which the chemical affects your body: Vanadium pentoxide dust can affect your body if you inhale it or if it comes in contact with your eyes or skin. It may also affect your body if you swallow it.

B. Effects of Overexposure:

1. Short-term Exposure: Vanadium pentoxide dust may cause irritation of the eyes, nose, throat and respiratory tract. It may also cause bronchitis with wheezing and chest pain. A greenish discoloration of the tongue may occur.
2. Long-term Exposure: After symptoms have occurred following short-term exposure repeated exposure may cause more severe symptoms of the same nature. In addition, repeated exposure may cause chronic bronchitis. Repeated or prolonged exposure may also cause an allergic skin rash.
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 vanadium pentoxide dust.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If vanadium pentoxide dust gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

B. Skin Exposure: If vanadium pentoxide dust gets on your skin, promptly wash the contaminated skin using soap or mild detergent and water. If vanadium pentoxide dust penetrates through your clothing, remove the clothing promptly 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 vanadium pentoxide 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 vanadium pentoxide dust has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the person to vomit by having him touch the back of his throat with his finger or by giving him large amounts (one pint or more) of warm salt water (two tablespoons of salt per pint of water). Do not make an unconscious person vomit.

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 vanadium pentoxide 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: You must wear impervious clothing, gloves, face shield or other appropriate protective clothing to prevent repeated or prolonged skin contact with vanadium pentoxide dust. Replace or repair impervious clothing that has developed leaks.

C. Eye Protection: You must wear dust-resistant safety goggles where vanadium pentoxide dust may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

A. If your work clothing may have become contaminated with vanadium pentoxide dust, you must change into uncontaminated clothing before leaving the work premises.

B. You must promptly remove any non-impervious clothing that becomes contaminated with vanadium pentoxide dust and this clothing must not be reworn until the vanadium pentoxide dust is removed from the clothing.

C. If your skin becomes contaminated with vanadium pentoxide dust, you must promptly wash or shower with soap or mild detergent and water to remove the vanadium pentoxide dust from your skin.

D. You must not eat or smoke in areas where vanadium pentoxide dust is handled, processed or stored.

E. If you handle vanadium pentoxide dust, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.

F. Ask your supervisor where vanadium pentoxide dust is 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 vanadium pentoxide dust. In addition, your employer must instruct you in the safe use of vanadium pentoxide dust, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to vanadium pentoxide 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 of the actions which are being taken to reduce your exposure.

C. Your employer is required to keep records of exposure determinations, exposure measurements, and medical surveillance. Your employer is required to make records of exposure determinations and your exposure measurements available to you or your representative upon your request. Your employer is required to release your medical records to your physician upon your written request.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES FOR VANADIUM PENTOXIDE DUST

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: None
2. Formula: V2O5
3. Molecular weight: 181.9

B. Physical Data

1. Boiling point (760 mm Hg): 1750 C (3182 F) (decomposes)
2. Specific gravity (water = 1): 3.36
3. Vapor density (air = 1 at boiling point of vanadium pentoxide dust): Not applicable
4. Melting point: 690 C (1274 F)
5. Vapor pressure at 20 C (68 F): Essentially zero
6. Solubility in water, % by weight at 20 C (68 F): 0.1
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and Odor: Yellow-orange powder or dark gray flakes with no odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Not combustible

B. Reactivity

1. Conditions contributing to instability: None
2. Incompatibilites: None.
3. Hazardous decomposition products: None.
4. Special precautions: None.

III. SPILL AND DISPOSAL PROCEDURES

A. If vanadium pentoxide dust is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner for reclamation, or for disposal in a secured sanitary landfill.

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

C. Waste disposal methods: Vanadium pentoxide dust may be disposed of in a secured sanitary landfill.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken during periods of maximum expected airborne concentrations of vanadium pentoxide dust. Each measurement should consist of a 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 measurements should be taken on one work shift and the highest of all measurements taken is a good estimate of the employee's highest exposure for that shift. Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or by collection of particulates using a high efficiency membrane filter with subsequent chemical analysis. The method of measurement must determine the concentration of vanadium pentoxide dust 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 above. 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. Samples should be collected as described in 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 vanadium pentoxide 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 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.

V. MISCELLANEOUS PRECAUTIONS

A. Employers should advise employees of all areas and operations where exposure to vanadium pentoxide dust could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to vanadium pentoxide dust is likely to occur are: During the mining and metallurgy of vanadium ores; during the cleaning of ash from oil-fired burners; during the manufacture of alloys of vanadium with iron, titanium, copper and

aluminum; during the manufacture of specialty glasses, ceramics and printing inks; during the cleaning and maintenance of furnaces, boilers, and gas turbines fired by vanadium-containing fuels; and during certain chemical syntheses.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Vanadium pentoxide dust is a respiratory and eye irritant. Sixteen workers exposed to concentrations of dust (and possibly some fume) in excess of 0.5 mg/M3 with a mean particle size in the micron and submicron range developed conjunctivitis, nasopharyngitis, hacking cough, fine rales, and wheezing; in 3 workers exposed to the highest concentrations, the onset of symptoms occurred at the end of the first workday. The bronchospastic element in the more seriously ill persisted for 48 hours after removal from exposure; rales lasted for 3 to 7 days and in several cases cough lasted for up to 14 days. Among those with acute intoxication there was increased severity of symptoms from subsequent exposures of lesser time and intensity. Urinary vanadium excretion was detectable in 12 of the workers for periods of up to 2 weeks; vanadium in the urine may be evidence of absorption and excretion of this element, since vanadium is not ordinarily found in human urine. Workers exposed to a mixture of ammonium metavanadate and vanadium pentoxide at concentrations near 0.25 mg/M3 developed green tongue, metallic taste, throat irritation, and cough. Another report of 36 workers examined 8 years after an acute respiratory reaction from vanadium pentoxide exposure indicated that there was no evidence of either pneumoconiosis or emphysema, although 6 still had bronchitis with rhonchi resembling asthma and bouts of dyspnea. Two volunteers exposed to a concentration of 1 mg/M3 for 8 hours developed a persistent cough which lasted for 8 days; 21 days after the original exposure, reexposure for 5 minutes to a heavy cloud of vanadium pentoxide dust occurred and within 16 hours marked cough developed; the following day, rales and expiratory wheezes were present throughout the entire lung field but pulmonary functions were normal. Subjects exposed to a concentration of 0.2 mg/M3 for 8 hours developed a loose cough the following morning; others exposed for 8 hours to 0.1 mg/M3 developed slight cough with increased mucus which lasted 3 to 4 days. Both eyes and skin are irritated by the dust or by contact with an acid solution of vanadium pentoxide; eczematous lesions have occurred and in 3 cases there was an allergic response to patch tests with sodium vanadate.

III. SIGNS AND SYMPTOMS

Eye irritation; green tongue, metallic taste; throat irritation, cough; fine rales, wheezing, bronchitis, dyspnea; eczema.

IV. SPECIAL TESTS

Vanadium in the urine may be evidence of absorption and excretion of this element, since vanadium is not ordinarily found in human urine.

V. TREATMENT

Remove from exposure. Promptly 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. Consideration should be given to hospitalization and observation for the possible delayed onset of pulmonary edema.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Vanadium pentoxide dust is a respiratory and eye irritant. Increased sensitivity to respiratory effects may result from subsequent exposures of lesser degrees. It is important that the physician become familiar with plant operating conditions in which exposure to vanadium pentoxide 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

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

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. The skin should be examined for evidence of chronic disorders.

2. 14" x 17" chest roentgenogram -- Vanadium pentoxide dust may cause respiratory impairment. Surveillance of the lungs is indicated.

3. FVC and FEV (1 sec) -- Vanadium pentoxide dust is reported of to cause asthmatic-like symptoms. 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 pulmonary function testing.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Vanadium V," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, pp. 275-276.

2. Hygienic Guide Series: "Vanadium Pentoxide," American Industrial Hygiene Association Quarterly, 18:172-173, 1957.

3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1171-1182.

4. Zenz, C., et al: "Acute Vanadium Pentoxide Intoxication," Archives of Environmental Health, 5:542-546, 1962.

5. Zenz, C. and B.A. Berg: "Human Responses to Controlled Vanadium Pentoxide Exposure," Archives of Environmental Health, 14:709-712, 1967.

6. Hudson, T.G.F.: Vanadium, Toxicology and Biological Significance, Elsevier Publishing Company, New York, 1964, pp. 72-77, 100-119, 124-135.

7. Browning, Ethel: Toxicity of Industrial Metals (2d ed.), Butterworths, London, 1969, pp. 340-347. •e73;84

REFERENCES AND SOURCES
VANADIUM PENTOXIDE DUST
1910.93

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

Eye: Sjoberg, S. G., "Health Hazards in the Production and Handling of Vanadium Pentoxide;" "Industrial Hygiene and Occupational Medicine," 3, 631, 1951; Hygienic Guide Series, American Industrial Hygiene Association; Grant, "Toxicology of the Eye;" Sax, "Dangerous Properties of Industrial Materials"

Skin: Sjoberg, S. G., "Health Hazards in the Production and Handling of Vanadium Pentoxide;" "Industrial Hygiene and Occupational Medicine," 3, 631, 1951; Patty, "Industrial Hygiene and Toxicology;" Browning, "Toxicology of Industrial Metals;" Hunter, "The Diseases of Occupations;" Stauden, "Kirk-Othmer Encyclopedia of Chemical Technology"

Ingestion: International Labour Office, "Encyclopedia of Occupational Health and Safety;" Browning, "Toxicology of Industrial Metals;" Stauden, "Kirk-Othmer Encyclopedia of Chemical Technology;" Patty, "Industrial Hygiene and Toxicology;" Fairhall, "Industrial Toxicology;" Elkins, "The Chemistry of Industrial Toxicology"

COMMENTS

Eye - Classification: 6
Output statement numbers: 12
Exceptions: None

It appears the only symptom vanadium dust has on the eye is an irritation of the conjunctiva, ranging from slight, according to Sjoberg, to severe irritation, according to the Hygienic Guide Series.

Grant states that vanadium pentoxide is "the only vanadium compound for which ocular disturbances have been reported. The dust causes a sensation of burning and irritation of the eyes, and signs of conjunctivitis." Local effects have also been observed on the eyes of rabbits.

Sax notes that recent toxicological reports restrict the hazards of vanadium pentoxide to the conjunctivae and respiratory system.

Because of the moderate eye effects of vanadium pentoxide dust, it is concluded that a classification of 6 is appropriate.

Skin - Classification: 6
Output statement numbers: 2, 7a, 17g, 17i, 20a
Exceptions: None

Sjoberg reports skin diseases from vanadium pentoxide dust which are characterized by papular eruptions on the face, the hands and the backs of the feet.

A more detailed report from Patty says that "Sjoberg found 9 cases of skin diseases among 36 exposed individuals. Eruptions of the face showed highest prevalence (7 cases), in which papules or dry seborrhealike patches occurred in chin and cheeks and around the edges of the face mask.

Four cases showed eruptions on the hands, usually between the fingers; some eruptions occurred on the wrists, legs and dorsum of the feet." He cites another source which indicates "V2O5 in . . . 0.8% solutions . . . representing approximately saturated solutions, do not irritate the skin.

Browning also states that vanadium pentoxide dust is a skin irritant.

Hunter considers that contact must be prevented to the extent that "men handling vanadium pentoxide in chemical works must be protected by means of a polyvinyl chloride air-fed pressure suit."

Vanadium pentoxide has a boiling point of 1750 C and a melting point of 690 C. Its vapor pressure is essentially zero at 20 C. It appears as a yellow-orange powder or dark gray flakes. Solubility in water is given as being in the range of 0.05 - 0.1% by various sources.

The various sources give a somewhat incomplete and inconsistent "picture" in regards to the local effects of the substance. However, if the report is accepted that an essentially saturated aqueous solution does not irritate the skin, then it must be concluded that the solid causes skin lesions only where there is a rubbing action between clothing and the skin or between different patches of skin. This conclusion is supported by Sjoberg's report that effects occurred around the edges of the face mask, between the fingers, etc. To prevent such effects, it is concluded sufficient to assign the dust a classification of 6. Statement 5b is not considered to be warranted for vanadium pentoxide dust.

Ingestion - Classification: 6

Output statement numbers: 19, 20a

Exceptions: None

According to the ILO, "experience has shown that only vanadium oxides, and in particular, the pentoxide and its derivative (ammonium meta vanadate) cause harmful effects in man." The major toxic effect, however, seems to be respiratory, rather than by ingestion.

In industry, Browning says that the toxic effects of vanadium occur mainly through inhalation, though from a lesser extent "from ingestion of the pentoxide, sulphate or mixed vanadium dust."

Stauden notes that "much of the vanadium taken by mouth is excreted and there appears to be no cumulative effect, provided the daily tolerance is not exceeded."

Fairhall, however, states emphatically that "there is no question but that vanadium compound are toxic, even such substances as the crude ore showing striking toxic effects on exposure to the dust." Most reports, however, associate exposure to the dust with respiratory diseases indicating that systemic intoxication is the result of dust inhalation rather than direct ingestion.

The ILO also indicates that the tongue "may present

a greenish discoloration and also the cigarette ends of vanadium workers may show a greenish color, resulting from chemical interactions." The ILO points out that this color "is probably evidence of exposure, rather than of intoxication."

Elkins states that "only Wyeis found some evidence of systemic intoxication. Pielsticker states that chronic vanadium poisoning has not been established, and Massmann and Opitz do not consider vanadium compounds a serious industrial hazard."

Patty reports "dietary V2O5 . . . is toxic at 100 ppm vanadium to rats fed the casein (suboptimal, systhetic) diet, whereas it required 1000 ppm vanadium in the optimal diet (Purin chow) to produce definite signs of toxicity. Only at 2000 ppm vanadium, however, did deaths occur from dietary V2O5. V2O5 was ingested for a lifetime, 2.5 years, by rats and dogs at levels of 10 and 100 ppm vanadium with no significant change in any of the criteria measured, except for reduced hair cystine values."

A classifications of 6 is concluded to be appropriate.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

Foote Mineral Co., Material Safety Data Sheet (Foote)
Kerr - McGree Chemical Corp., Technical Data Sheet Bulletin 1810 and Material Safety Data Sheet (KMG)
Kirk - Othmer, "Encyclopedia of Chemical Technology," 2nd edition, Vol. 21, p. 157 - 180 (K-O)
"Lange's Handbook of Chemistry," 11th edition (Lange)
Stauffer Chemical Co., "Vanadium - Sulfuric Acid Catalyst" (Stauffer)

Sources of data items used:

I. A.
1. Synonyms: ADL
2. Formula: KMG
3. Molecular weight: KMG

B.
1. Boiling point: KMG
2. Specific gravity: Foote, KMG
3. Vapor density: Not applicable
4. Melting point: KMG
5. Vapor pressure: ADL
6. Solubility in water: K-O
7. Evaporation rate: Not applicable
8. Appearance and odor: Foote

II. A.
1. Flash point: Not applicable
2. Autoignition temperature: Not applicable
3. Flammable limits: Not applicable
4. Extinguishing media: ADL
5. Special fire fighting procedures: Stauffer
6. Unusual fire and explosion hazards: KMG

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

III. A. Steps if released or spilled: Foote, KMG
C. Waste disposal method: ADL
V. Miscellaneous precautions: KMG, Foote
VI. Common operations: KMG, K-O

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

Browning, E., "Toxicity of Industrial Metals," Butterworth and Co., Ltd., 2nd edition, 1969 (Browning Metals)
Considine, D. M., "Chemical and Process Technology Encyclopedia," McGraw Hill, 1974 (Considine)
International Labour Office, "Encyclopedia of Occupational Health and Safety," 1972 (ILO)
Johnstone, S. J. and Johnstone, M. G., "Minerals for the Chemical and Allied Industries," John Wiley and Sons, Inc., 1961 (Johnstone)
Kirk, R. and Othemr, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 2nd edition, 1972 (K-O)
"Mineral Facts and Problems," U. S. Department of the Interior, Staff, Bureau of Mines Bulletin 650, 1970 (Mineral Facts)
Patty, F. A., "Industrial Hygiene and Toxicology," Vol. II, Interscience Publishers, 1962 (Patty)
"Vanadium Pentoxide," Hazard Process Index, Hazard Entry No. 198, NIOSH HSM-99-73-62 (HPI)
"Vanadium Sulfuric Acid Catalyst," Production Safety Information, Stauffer Chemical Company (Stauffer)
Williams, N., "Vanadium Poisoning from Cleaning Oil-Fired Boilers," British Journal of Industrial Medicine, 9, p. 50 - 55, 1952 (Williams)
Wyers, H., "Some Toxic Effects of Vanadium Pentoxide," British Journal of Industrial Medicine, 3, p. 177 - 182, 1946 (Wyers)

References for Specific Use/Exposure

1. Browning Metals, Williams
2. Considine, Mineral Facts, Patty
3. Considine, HPI, Johnstone, Wyers
4. Considine, HPI, ILO, K-O
5. HPI, Johnstone
6. HPI, K-O
7. K-O
8. K-O
9. Considine, K-O
10. Johnstone, Mineral Facts, Patty

References for Specific Control Methods

1. ILO, Stauffer, Williams

ILO was the reference used in numbers 2 - 10 of the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Vanadium pentoxide dust

D. O. L. STANDARD: 0.5 mg/M3 shall not be exceeded

Eye Irritation Level: According to Grant, vanadium pentoxide dust "causes a sensation of burning and irritation of the eyes, and signs of conjunctivitis . . ." The eye irritation is accompanied by "irritation nose and throat. The respiratory irritation occurs at lower concentration than does the ocular irritation. The local effects on the eye have also been observed in rabbits." The Documentation of TLV's sta

that "Gulko referred to eye and bronchial irritation from exposure at 0.5 to 2.2 mg/M3."

IDLH: 70 mg/M3

Basis for IDLH Value: This IDLH is based upon the report in the Documentation of TLV's that "vanadium pentoxide dust at concentrations of 70 mg/M3 is fatal to animals within a few hours." The Hygienic Guides state that "rabbits succumb from edema of lungs with air concentrations of 200 mg/M3 (V2O5) after one seven-hour exposure."

Other Toxicological Information: The AIHA Hygienic Guides state that vanadium pentoxide is "moderately hazardous for both acute and chronic exposures. Effects are chiefly severe irritation of the eyes, throat, and respiratory tract resulting in conjunctivitis, nasal catarrh, irritation of throat (atrophic pharyngitis), bronchopneumonia and mild chronic bronchitis. Eczematous lesions of the skin and discoloration of the tongue may also occur. Prognosis is favorable. Chief complications are slight to moderate chronic changes in mucous membranes of the respiratory tract (pharynx), pneumonitis, and allergy. Questionable fibrosis and emphysema has been reported after exposure of several years. . . (The) atmospheric concentration immediately hazardous to life (is) unknown for man. Rabbits succumb from edema of lungs with air concentrations of 200 mg/M3 (V2O5) after one seven-hour exposure." According to Patty, the actual concentration was 205 mg/M3 V2O5 dust.

The Documentation of TLV's states that "vanadium is unquestionably poisonous to all animals in any but very small doses, no matter how it is administered, according to Hudson. The pentavalent compounds, such as V2O5 and vanadates, are more toxic than other forms . . . Vanadium pentoxide dust at concentrations of 70 mg/M3 is fatal to animals within a few hours. (The NIOSH Toxic Substances List gives a rat LCL0 of 70 mg/M3 for a 2-hour exposure).

"When inhaled, the chief effects of vanadium pentoxide are on the respiratory passages. Tracheitis, bronchitis, emphysema, pulmonary edema, or bronchial pneumonia may be observed, but no specific chromic lung lesions have been described . . .

"Threshold limits of 0.5 mg/M3 air for vanadium pentoxide dust, and 0.1 mg/M3 for the pentoxide as a fume, were suggested by Roshcin on the basis of limited animal studies made in reference to animal exposures. These values were subsequently incorporated in the USSR list of permissible concentrations. Extensive studies by Stokinger and co-workers with animals, using vanadium pentoxide dust at the recommended limit at respirable particle sizes, substantiated the recommendation of Roschin for V2O5 dust with regard to lack of systemic or localized effect in the lung.

"Zenz and Berg, in studying the effects of exposure to V2O5 dust in five human volunteers, found severe upper respiratory tract irritation in the form of persistent productive cough at an average concentration of 0.2 mg/M3 during a single eight-hour exposure. No systemic complaints were evident. Exposure of two previously unexposed volunteers at a level of 0.1 mg/M3 was still productive of a delayed cough and increased mucus. The authors concluded that the recommended TLV of 0.5 mg/M3 should be revised. Hudson also considered the 0.5 mg/M3 level too high for V2O5 dust."

USE/EXPOSURE AND CONTROL DOCUMENT
VANADIUM PENTOXIDE DUST

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of dust and skin contact with dust during cleaning and maintenance of furnaces, boilers and gas turbines fired by fuels (crude oil) containing vanadium. During the burning of the fuel the vanadium oxidizes to V205 and is deposited on the inside of the boilers or furnaces and on the outside of the heat exchanger tubes of gas turbines.	A,B	Local exhaust ventilation; personal protective equipment (goggles, gloves, long-sleeved clothing, respirator protective device)
2.	Inhalation of dust during mining and processing of vanadium ores containing V205 (milling, grinding, crushing)	A	Local exhaust ventilation; process enclosure - if possible, personal protective equipment (goggles, respiratory protective devices)
3.	Inhalation of dust and skin contact with dust during manufacture and processing of V205 (extraction from ore, extraction from soot deposits in furnaces and oil burning liners, extraction from slag in production of ferrovanadium, chemically - by calcining ammonium metavandate). The V205 is marked in three grades: fused technical oxide, air dried technical and air dried C.P.	A,B	Local exhaust ventilation; process enclosure - if possible, personal protective equipment (goggles, respiratory protective devices)
4.	Inhalation of dust during use as a catalyst (manufacture of catalyst component, use of catalyst, cleaning and recharging of spent catalyst, sieving of dust from pellets). These catalysts are used in	A	Local exhaust ventilation; process enclosure - if possible, personal protective equipment (goggles, respiratory protective devices)

	the preparation of organic and inorganic compounds - sulfur trioxide, phthalic anhydride, maleic acid, anthraquinone, sulfuric acid, acetaldehyde, oxalic acid. V2O5 catalysts are used mainly in oxidation processes.		
5.	Inhalation of dust during use in chemical synthesis (basic material in the preparation of vanadium compounds - vanadyl sulfate, vanadyl chloride, sodium metavandate)	A	Local exhaust ventilation; process enclosure - if possible, personal protective equipment (goggles, respiratory protective devices)
6.	Inhalation of dust during use in the manufacture of ultraviolet filter glass (filters out ultraviolet rays to prevent ultraviolet radiation eye injury and to prevent fading of fabrics - used especially in store windows)	A	Local exhaust ventilation; process enclosure - if possible, personal protective equipment (goggles, respiratory protective devices)
7.	Inhalation of dust during use in the manufacture of afterburners for automobiles (device to oxidize the hydrocarbons in exhaust gases - the V2O5 catalyzes the oxidation process)	A	Local exhaust ventilation; process enclosure - if possible, personal protective equipment (goggles, respiratory protective devices)
8.	Inhalation of dust during use in the textile (catalyzes oxidation of aniline to give black dyes of great intensity) and printing industries (catalyzes formation of resinous black pigments from tar oils)	A	Local exhaust ventilation
9.	Inhalation of dust during use in the ceramics industry (small amounts are used in ceramic pigments - combined with other substances such as zirconium, lead, zinc, silica, tin, etc. to produce dif-	A	Local exhaust ventilation; process enclosure

ferent colors)

10.	Inhalation of dust during use as a component of special steels (electric furnace steels, welding rods, permanent magnets)	A	Local exhaust ventilation; process enclosure

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

------ JES2 JOB STATISTICS ------

1,318 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

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