NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND

SUPPORTING DOCUMENTATION FOR

*** SILICA, CRYSTALLINE ***

NIOSH/OSHA Draft Technical Standard and Supporting Documentation for SILICA, CRYSTALLINE

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 SILICA, CRYSTALLINE.

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) (i) "Permissible exposure" means exposure of employees to airborne concentrations of crystalline silica not in excess of 10 milligrams per cubic meter (mg/M3) of respirable dust divided by two (2) plus the percent crystalline silica averaged over an eight-hour work shift (time weighted averaged).

(ii) "Permissible exposure" means exposure to airborne total dust concentrations of crystalline silica not in excess of 30 mg/M3 divided by the percent crystalline silica plus two (2), averaged over an eight-hour work shift; or

(iii) "Permissible exposure" means exposure of employees to respirable forms of crystalline silica not in excess of 250 million particles per cubic foot (mppcf), divided by the percent crystalline silica plus five (5). (250 mppcf/% SiO2 + 5) as stated in $ 1910.1000, Table Z-3.

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

(3) Crystalline silica means quartz, cristobalite and tridymite mineral calcined diatomaceous earth and other minerals or mineral mixtures containing silicon dioxide in a crystalline form.

(4) Respirable dust means that fraction of the total dust having aerodynamic properties as defined by the ACGIH respirable dust curve as contained in the footnote of Table Z-3 in 1910.1000.

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

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

(i) Any information, observations, or calculations which may indicate employee exposure to crystalline silica;

(ii) Any measurements of crystalline silica taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to crystalline silica; and

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

(3) If the employer determines that any employee may be exposed to crystalline silica above the permissible exposure, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b) (3) of this section reveals employee exposure to crystalline silica above the action level, the employer shall:

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

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

(5) If an employee exposure measurement reveals that an employee is exposed to crystalline silica above the action level, but not above the

permissible exposure, the exposure of that employee shall be measured at least every three months.

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

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to crystalline silica 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	± 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 crystalline silica above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of crystalline silica shall be controlled to at or below the permissible exposure by engineering and work practice controls.

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and

shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. When local exhaust is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity or static pressure, shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of crystalline silica.

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

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

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

(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of crystalline silica 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 CRYSTALLINE SILICA (QUARTZ)

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Particulate Concentration	
5 x* or less	Any dust respirator.
10 x* or less	Any dust 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 x* 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 x* or less	A powered air-purifying respirator with a high efficiency

	particulate filter.
or less	A Type C supplied-air respirator operated in pressure - operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 500 x* 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.

* $x = \frac{30\ mg/M3}{\%\ SiO2 + 2}$ (total dust) or $\frac{10\ mg/M3}{\%\ SiO2 + 2}$ (respirable)

(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 crystalline silica.

(f) Personal protective equipment. (Reserved).

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

(h) Sanitation. (Reserved).

(i) Training and information. (1) Each employer who has a workplace in which crystalline silica 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 crystalline silica above the action level without regard to the use of respirators, or employees who work where a spill or release of crystalline silica may occur, shall annually:

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

(ii) Advise affected employees as to the signs and symptoms of exposure to crystalline silica.

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

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

(2) Preplacement medical examination. The employer shall make available to each employee who is exposed, or will be exposed to airborne concentrations of crystalline silica above the action level, without regard to the use of respirators, a preplacement medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the lungs and heart;

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

(iii) 14" x 17" chest roentgenogram.

(3) Periodic medical examination. The employer shall make available to each employee exposed to airborne concentrations of crystalline silica above the action level, without regard to the use of respirators, twelve months from the date of the employee's first exposure, and every twelve months thereafter, a periodic medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the lungs and heart;

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

(iii) A 14" x 17" chest roentgenogram.

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

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

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

(5) Interim medical examination. The employer shall provide an interim medical examination for the employee if the employee informs the employer of any of the signs or symptoms of exposure to crystalline silica which are listed in Appendix A which the employee suspects are caused by exposure to crystalline silica.

(6) Informing the physician. The employer shall provide to the physician performing any medical examination required by this section the following information:

(i) A copy of this regulation with Appendixes A, B, and C for crystalline silica;

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

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurements which may indicate the affected employee's exposure;

(v) The affected employee's anticipated exposure level; and

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

(7) Where a medical examination is required by paragraphs (j)(2), (j)(3), or (j)(5) of this section, following such examination the employer shall obtain from the examining physician a written opinion which conforms with paragraph (j)(8) of this section.

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

(A) Whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to crystalline silica;

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

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

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to the employee's employment.

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

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

(i) A recording of the results of the pulmonary function tests;

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

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

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

(11) No medical procedure which would be performed pursuant to paragraphs (j)(2) or (j)(3) of this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(12) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of such refusal and obtain a signed statement from the employee indicating that the employee understands the risk involved by refusal to be examined.

(13) The employer shall provide emergency medical treatment for any employee injured through exposure to crystalline silica.

(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 crystalline silica.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to crystalline silica which are being monitored;

(C) Sampling and analytical method used and evidence of their accuracy;

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

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

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

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

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

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

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

(ii) This record shall include:

(A) Date of training;

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

(C) Content or scope of training provided.

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

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

(ii) This record shall include:

(A) The name and social security number of the employee;

(B) Results of tests required by paragraph (j)(2) and (j)(3) of this section and results of any tests conducted pursuant to paragraphs (j)(4) of this section;

(C) Any employee medical complaints relative to exposure to crystalline silica;

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

(E) Physician's written opinion; and

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

(iii) This record shall be maintained for the duration of and for five years after termination of the employment of the affected employee.

(6) Access to records. (i) All records required to be maintained by this section shall be made available upon request to authorized

representatives of the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health.

(ii) Each employee or former employee shall have access to the exposure determination and exposure measurement records required to be maintained by this section which indicate his own exposure to crystalline silica.

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

(2) When observation of measurement of employee exposure to crystalline silica 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 crystalline silica that are being performed at the place of exposure; and

(iii) Record the results obtained.

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

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR CRYSTALLINE SILICA

I. SUBSTANCE IDENTIFICATION

A. Substance: Crystalline silica (Quartz, cristobalite and tridymit diatomaceous earth and other minerals or mineral mixtures contain in a crystalline form.)

B. Permissible Exposure:

1. Exposure to airborne total dust concentrations not in excess per cubic meter (mg/M3) divided by the percent crystalline s over an eight-hour work shift as stated in 1910.1000 Table Z

2. Exposure to airborne respirable dust concentrations not in e

per cubic meter (mg/M3) divided by the percent crystalline s over an eight-hour work shift. Respirable dust is that frac dust having the aerodynamic properties as defined in the foo 1910.1000.

3. Exposure to airborne respirable dust concentrations not in e particles per cubic foot (mppcf) divided by the percent crys

C. Appearance and Odor: Colorless, odorless solid (Crystalline sili of many mineral dusts.)

II. HEALTH HAZARD DATA

A. Ways in which the chemical affects your body: Crystalline silica can affect your body if you inhale it.

B. Effects of Overexposure:

1. Exposure to crystalline silica dust may cause scarring of the lungs with cough and shortness of breath. This is called "Silicosis."

2. Reporting Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to crystalline silica.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If crystalline silica dust gets into your eyes wash your eyes immediately with large amounts of water, lifting the upper and lower lids occasionally. If irritation is present after washing get medical attention.

B. Breathing: If you or any other person breathes in large amounts of crystalline silica dust move the exposed person to fresh air at once.

C. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the emergency rescue equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. Respirators: Respirators are not the best way to control exposure to crystalline silica. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where there use is required. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Protective Clothing: None required.

C. Eye Protection: None required.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

A. Ask your supervisor where crystalline silica is used or 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 crystalline silica. In addition, your employer must instruct you in the safe use of crystalline silica, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to crystalline silica. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.

C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of five years following uour termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.

D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

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

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES FOR CRYSTALLINE SILICA

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Quartz; coesite; cristobalite; tridymite
2. Formula: SiO_2
3. Formula weight: 60.1

B. Physical Data

1. Boiling point (760 mm Hg): 2230 C (4046 F)

2. Specific gravity (water = 1): 2.2 - 3.0
3. Vapor density (air = 1 at boiling point of crystalline silica): Not applicable
4. Melting point: 1600 C (2912 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: Colorless odorless solid (Crystalline silica may be a component of many mineral dusts.)

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Not combustible

B. Reactivity

1. Conditions contributing to instability: None
2. Incompatibilites: Contact with powerful oxidizing agents such as fluorine, chlorine trifluoride, manganese trioxide, oxygen difluoride, etc. may cause fire.
3. Hazardous decomposition products: None.
4. Special precautions: Crystalline silica is attacked by hydrogen fluoride (or hydrofluoric acid).

III. SPILL AND DISPOSAL PROCEDURES

A. If crystalline silica is spilled or released in hazardous concentrations, the following steps should be taken:

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

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

C. Waste disposal methods: Crystalline silica may be disposed of in a sanitary landfill.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as portable-direct reading instruments or by collection of particulates using a efficiency membrane filter with subsequent gravemetric analysis. The method of measurement must determine the concentration of crystalline silica 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 crystalline silica 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 S" (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 their exposure to cyrstalline silica could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to crystalline silica is likely to occur are: During the mining, crushing, grinding and cutting of any rock that contains crystalline silica such as granite or sand; during foundry operations; during sandblasting; during the manufacture of piezo-electric devices; during its use in metallurgy and in the manufacture of fiberglass and ceramics.

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

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Crystalline silica or quartz dust causes silicosis, a form of disabling, progressive, and sometimes fatal pulmonary fibrosis characterized by the presence of typical nodulation in the lungs. The earliest lesions are seen in the region of the respiratory bronchioles. Lymphatics become obliterated by infiltration with dust-laden macrophages and granulation tissue. Morphologically, the typical lesion of silicosis is a firm

nodule composed of concentrically arranged bundles of collagen. These nodules usually measure between 1 to 10 mm in diameter and appear around blood vessels and beneath the pleura, as well as in mediastinal lymph nodes. There may be conglomeration of nodules as the disease progresses, leading to massive fibrosis. Histologically, the silicotic nodule consists of a relatively acellular, avascular core of hyalinized reticulin fibers arranged concentrically and blending with collagen fibers toward the periphery, which has well-defined borders. The particles of silica responsible for the reaction are birefringent and can be visualized under polarized light if they exceed 1 micron in diameter. Silica in the lungs can be identified by x-ray diffraction studies and incinerating a portion of the lung, with subsequent analysis of the ash. The silica content of the normal lung should not exceed 0.2 percent dry weight. The clinical signs and symptoms of silicosis tend to be progressive with continued exposure to quantities of dust containing free silica, with advancing age, and with continued smoking habits. Symptoms may also be exacerbated by pulmonary infections and cardiac decompensation. Symptoms include cough, dyspnea, wheezing and repeated nonspecific chest illnesses. Impairment of pulmonary function may be progressive. In individual cases there may be little or no decrement when simple discrete nodular silicosis is present, but when nodulations become larger or when conglomeration occurs, recognizable cardiopulmonary impairment tends to occur. Progression of symptoms usually continues after dust exposure ceases. While there may be a factor of individual susceptibility to a given exposure to silica dust, the risk of onset and the rate of progression of the pulmonary lesion is clearly related to the character of the exposure (dust concentration and duration). The disease tends to occur after an exposure measured in years rather than months. Occasionally, exposures to very high concentrations occur in short periods of time in occupations such as sandblasters and tunnel workers; in these cases of acute or rapidly-developing silicosis there may be severe respiratory symptoms resulting in death. It is generally accepted that silicosis predisposes to active tuberculosis, and that the combined disease tends to be more rapidly progressive than uncomplicated silicosis. A group of 972 granite shed workers were studied to relate exposure levels to incidence of silicosis. The workers were grouped according to average exposure levels: 37-60, 27-44, 20, and 3-9 mppcf. Those with the highest dust exposure showed development of early silicosis in 40 percent of the workers after 2 years and 100 percent after 4 years of exposure. The development of silicosis in the remaining workers appeared to be proportional to the dust exposure. At the second highest exposure level (27-44 mppcf), early stages of silicosis appeared after 4 years of exposure and more advanced stages developed by the seventh year. In the group exposed at an average of 20 mppcf there was little indication of severe effects upon the health of the workers. In the lowest exposure group where the average dust concentration was 6 mppcf (range 3 to 9 mppcf), there was no indication of any untoward effects of dust exposure on workers.

III. SIGNS AND SYMPTOMS

Cough, dyspnea, wheezing; impairment of pulmonary function which may be progressive.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Remove from exposure.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Crystalline silica or quartz causes a disabling pneumoconiosis. A history of exposure to free silica is necessary before pulmonary function and chest roentgenogram can be used in making a diagnosis of silicosis. A histologic examination of lung tissue is the only single method that can unequivocally demonstrate the unique pulmonary effects of exposure to hazardous amounts of free silica. It is important that the physician become familiar with plant operating conditions in which exposure to silica 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 crystalline silica:

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 and cardiovascular system should be stressed.

2. 14" x 17" chest roentgenogram -- Crystalline silica or quartz causes human lung damage. Surveillance of the lungs is indicated.

3. FVC and FEV (1 sec) -- Crystalline silica or quartz is reported to cause decreased pulmonary function. Periodic surveillance is indicated.

C. PERIODIC EXAMINATIONS

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

VII. REFERENCES

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for SILICA, CRYSTALLINE

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2. Hygienic Guide Series: "Silica (Free Silica, Silicon Dioxide)," American Industrial Hygiene Quarterly, 18:276-278, 1957.

3. National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: Criteria of Recommended Standard....Occupational Exposure to Crystalline Silica, HEW Publication No. (NIOSH) 75-120, U.S. Government Printing Office, Washington, D.C., 1974.

4. Zenz, C.: Occupational Medicine - Principles and Applications, Year Book Medical Publishers, Chicago, 1975, pp. 117, 129-134.

REFERENCES AND SOURCES
CRYSTALLINE SILICA (QUARTZ)
1910.1000

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

Eye: Grant, "Toxicology of the Eye"

Skin: None

Ingestion: Gleason, "Clinical Toxicology of Commercial Products;" Deichmann and Gerarde, "Toxicology of Drugs and Chemicals"

COMMENTS

Eye - Classification: 0

Output statement numbers: None

Exceptions: None

Grant reports that "particles of silica predominantly in the range of 2 to 3 microns introduced into the corneal stroma of rabbit eyes cause very little reaction. The same particles introduced in the anterior chamber . . . in the course of 3 - 5 weeks cause an inflammation reaction with formation of fibrotic nodules in the iridocorneal angle. Finely divided silica injected into the vitreous of rabbit eyes has caused necrosis of the retina and atrophy of the choroid."

It is evident that silica particles must penetrate the eye to cause significant injury. Consequently, it is concluded that prevention of direct eye contact with this substance is not appropriate for this standard.

Skin - Classification: 0

Output statement numbers: None

Exceptions: None

As would be expected, there are no indications in the literature that skin exposure to silica presents any hazard. This substance is, therefore, assigned a classification of zero.

Silica is insoluble in water, is not combustible, and has a vapor pressure which is essentially zero. Its melting point is 2912 degrees F.

Ingestion - Classification: 0

Output statement numbers: None

Exceptions: None

Gleason reports that silica is "chemically and biologically inert when ingested in any of its many physical forms, such as crystalline quartz . . ." Deichmann and Gerarde state "the effects of ingestion of silica are purely mechanical."

Since the substance is inert, it is assigned a classification of zero.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

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

Kirk-Othmer, "Encyclopedia of Chemical Technology," Vol. 18, p. 46; Vol. 7, p. 459 (K-O)

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

Sources of data items used:

I. A. 1. Synonyms: Lange

2. Formula: Lange
3. Formula weight: Lange

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

II. A. 1. Flash point: Not combustible

B. 1. Conditions contributing to instability: ADL
2. Incompatibilities: NFPA-491M
3. Hazardous decomposition products: None
4. Special precautions: K-O

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:

Hamilton, A. and Hardy, H. L., "Industrial Toxicology," Publishing Science Group, Inc., 3rd edition, 1974 (H and H)

Hawley, G. G, "The Condensed Chemical Dictionary," Van Nostrand Reinhold Co., 8th edition, 1971 (Hawley)

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., 2nd edition, 1961 (Johnstone)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 2nd edition, Vol. VII, 1965; Vol. XVIII, 1969; Vol. VI, 1965 (K-O)

"Mineral Facts and Problems," U. S. Dept. of the Interior, Bureau of Mines, Bulletin 650, 1970 edition (Mineral Facts)

Patty, F. A., "Industrial Hygiene and Toxicology," Vol. II, Interscience Publishers, 1962 (Patty)

"Silica, Free Silica, Silicon Dioxide," Hygienic Guide Series, American Industrial Hygiene Assoc., Sept. 1957 (Hygienic Guides)

Smith, A. R. and Stern, A. C., "The Silicosis Hazard in Graining Lithographic Plates and Its Control," Monthly Review, 30 - 1, Jan. 1950 (Smith)

References for Specific Use/Exposure

1. H and H, Johnstone
2. ILO, Johnstone
3. Patty
4. Mineral Facts
5. H and H, Johnstone
6. H and H, Johnstone, K-O (Vol. 6)
7. H and H, Johnstone
8. Johnstone, Mineral Facts, Patty
9. Mineral Facts
10. Johnstone, Mineral Facts, Patty

11. H and H., Hawley, K-O (Vol. 6), Mineral Facts, Smith
12. Johnstone, K-O (Vol. 18)
13. K-O (Vol. 7)

References for Specific Control Methods

1. H and H, Hygienic Guides, Patty
2. ILO, Patty
3. Hygienic Guide, Patty
4. H and H, Hygienic Guides, Patty
5. Hygienic Guide, Patty

H and H, Hygienic Guides, and Patty were the references used in 6 - 8.

9. Patty
10. H and H, Hygienic Guides, Patty
11. Hygienic Guide, Patty
12. Johnstone
13. H and H, Hygienic Guides, Patty

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Crystalline silica (quartz)

D. O. L. STANDARD: 30 mg/M3 / -------- (total) or 10 mg/M3 / -------- (respirable)
% SiO2 + 2 % Si)2 + 2

Eye Irritation Level: Grant states that crystalline silica "has been observed to cause fibrotic nodules in the eye analogous to pulmonary silicosis. Particles of silica predominantly in the range of 2u to 3u introduced into the corneal stroma of rabbit eyes cause very little reaction. The same particles introduced into the anterior chamber sink to the bottom of the chamber and in the course of three to five weeks cause an inflammatory reaction with formation of fibrotic nodules in the iridocorneal angle. The reaction is quite different and more severe than that induced by brickdust, glass, or magnesium silicate . . .

"An apparently unique report of involvement of the cornea in foundry workers who developed pulmonary silicosis has described gradual decrease in visual acuity due to corneal opacities in the pupillary area and has reported spectroscopic analytical evidence of an abnormally high silicon content in the cornea."

For the purposes of this standard, quarter- and half-facepiece respirators are permitted.

IDLH: There is no evidence in the available toxicological information which indicates that an acute exposure to a high concentration of crystalline silica would impede escape or cause any irreversible health effects within one-half hour. For the purposes of this standard, therefore, respirators have been selected on the basis of the protection factor afforded by each device. It is recognized, however, that for 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 exceedi 500 times the permissible exposure.

Other Toxicological Information: According to the AIHA Hygienic Guides,

the severity of the health hazard of crystalline silica is "nil, for acute; high, for chronic exposures. Inhalation of extreme concentrations of particles of one micron or less may lead to a diffuse, fulminating lung fibrosis in a few months. Development of the usual chronic type of silicosis takes many months or years. Effects of repeated inhalations of silica dust are cumulative and progressive. The different crystalline forms produce varying responses, in animals, with tridymite and cristobalite more severe than quartz. Disease is characterized by an initial generalized linear or perivascular increase in pulmonary density, progressing to small nodules diffusely scattered throughout the lung fields. As exposure continues, these nodules attain sufficient size to interfere with normal pulmonary function. Dyspnea and emphysema are characteristic of the more advanced stages. Silicosis seldom, if ever, produces death. However, common complications are tuberculosis, chronic bronchitis, and other bacterial infections."

The Documentation of TLV's states that "the margin of safety of the quartz TLV's is not known. In the documented examples of virtual silicosis elimination, concentrations have averaged well below the TLV. It is suggested that quartz concentrations be maintained as far below the TLV as current practices will permit."

USE/EXPOSURE AND CONTROL DOCUMENT
CRYSTALLINE SILICA

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of dust during use in metallurgy (foundry molds - iron and steel casting, flux in smelting basic ores)	A	Local exhaust ventilation; general dilution ventilation; wet process; personal protective equipment (respiratory protective devices)
2.	Inhalation of dust and skin contact with fiber during use in the manufacture of fiberglass (for sound, heat, cold or electrical insulation; chemical filtration; fireproofing and reinforcing fabrics)	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, respiratory protective devices)
3.	Inhalation of dust during the refining of sand for the production of quartz (rotary kiln drying, screening, elevating, storing, carloading)	A	Process enclosure when possib local exhaust ventilation; water sprays, personal protec tive equipment (respiratory protective devices)
4.	Inhalation of dust during manufacture and processing of synthetic quartz (quartz crystals are grown in an autoclave at elevated temperature and pressure). Synthetic quartz can replace natural for almost all its uses.	A	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices)
5.	Inhalation of dust during use in the ceramics industry (white and enamel ware; ordinary glass; chemical apparatus - tubes, crucibles, dishes)	A	Local exhaust ventilation; general dilution ventilation; personal protective equipment (respiratory protective devices)
6.	Inhalation of dust during use as an abrasive (scouring and polishing soaps and powders, flint sandpaper, metal polishes, sandblast work)	A	Local exhaust ventilation; general dilution ventilation; wet process; personal protective equipment (respiratory protective devices)

7.	Inhalation of dust during use in the manufacture of refractories and building products (silica bricks)	A	Local exhaust ventilation; general dilution ventilation; wet process; personal protective equipment (respiratory protective devices)
8.	Inhalation of dust during use of quartz in the manufacture of electrical instruments (cutting, grinding, polishing quartz). Because of its piezoelectric properties, this is the chief industrial use for high grade crystal quartz (electronic grade) - frequency control oscillators for radio and TV transmission, depth sounding devices, range finders, filter circuits, etc.	A	Local exhaust ventilation; general dilution ventilation; wet process; personal protective equipment (respiratory protective devices)
9.	Inhalation of dust during the grading and classification of electronic and optical grade quartz (sorting according to size range, separation of faced and unfaced crystals, inspection and testing). All of these operations must be done by hand. High grade quality quartz is mined and imported from Brazil and Madagascar.	A	Local exhaust ventilation; general dilution ventilation
10.	Inhalation of dust during the manufacture of optical equipment (prisms, wedges, lenses) - cutting, grinding, polishing. High quality quartz is necessary for this usage. Used in scientific equipment that requires optics fabricated of quartz.	A	Local exhaust ventilation; general dilution ventilation; wet process; personal protective equipment (respiratory protective devices)
11.	Inhalation of dust during miscellaneous uses of quartz (paint extenders,	A	Local exhaust ventilation; general dilution ventilation; personal protective equipment

	lining for acid towers in chemical industry, in dental porcelain composition, ablative material in rocket engines and space-craft, semiprecious gem stones, graining lithographic plates)		(respiratory protective devic
12.	Inhalation of dust during the manufacture of fused quartz or quartz glass (formed by the direct melting of quartz crystals). Quartz is crystalline; fused glass is vitreous. Among the many uses for quartz is the manufac-ture of certain types of glass and some glass fibers.	A	Process enclosure
13.	Inhalation of dust during exposures which occur as a result of its being a component of granite or similar minerals (granite quarrying, monu-ment cutting, foundry operations). These are all trades where there is a heavy exposure to dusts containing varying amounts of quartz. For other exposures to quartz, please see the amorphous silica document.	A	Local exhaust ventilation; general dilution ventilation; wet process, personal pro-tective equipment (respirator protective devices)

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

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

1,257 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

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