Designation: E2625 – 09

Standard Practice for Controlling Occupational Exposure to Respirable Crystalline Silica for Construction and Demolition Activities[1]

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INTRODUCTION

Silicon dioxide (silica, SiO_2) is encountered in nature and industry in a wide variety of forms. These range from essentially anhydrous types with or without a very high degree of crystallinity, to highly hydroxylated or hydrated types which are amorphous by X-ray diffraction examination. Crystalline silica[2] exists in a number of forms or polymorphs. The three major forms, quartz, cristobalite, and tridymite, pertain to this practice. Quartz (or alpha quartz) is the more common form encountered as airborne particulates. Two of the polymorphs, cristobalite and tridymite, are formed at elevated temperatures and are much less common in nature, but might be encountered in several occupations where silicas are fired (calcined) at high temperatures[3]. These silica materials have a broad range of physical and chemical properties.

1. Scope

1.1 This practice describes several actions to reduce the risk of harmful occupational exposures in environments containing respirable crystalline silica. This practice is intended for the unique conditions during construction and demolition activities.

1.2 Health requirements relating to occupational exposure to respirable crystalline silica not covered in this practice fall under the jurisdiction of Practice E1132.

1.3 Nothing in this practice shall be interpreted as requiring any action that violates any statute or requirement of any federal, state, or other regulatory agency.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[4]

D4532 Test Method for Respirable Dust in Workplace Atmospheres Using Cyclone Samplers

E1132 Practice for Health Requirements Relating to Occupational Exposure to Respirable Crystalline Silica

2.2 *ANSI Standards:*[5]

Z88.2 1992 American National Standard Practice for Respiratory Protection

ANSI/AIHA Z9.2 2001 Fundamentals Governing the Design and Operation of Local Exhaust Systems

2.3 *Code of Federal Regulations:*[6]

29 CFR 1910.134 Respiratory Protection

29 CFR 1910.1000 Air Contaminants

29 CFR 1910.1200 Hazard Communication

42 CFR 84 Title 42, Part 84 Approval of Respiratory Protective Devices, Tests for Permissibility, Fees

30 CFR 56, Title 30, Subpart D Air Quality, Radiation, and Physical Agents (MSHA)

[1] This practice is under the jurisdiction of ASTM Committee E34 on Occupational Health and Safety and is the direct responsibility of Subcommittee E34.80 on Industrial Heath.

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[2] Smith, Deane K., Opal, cristobalite, and tridymite: Noncrystallinity versus crystallinity, nomenclature of the silica minerals and bibliography, *Powder Diffraction*, Vol 13, 1998, pp 1–18.

[3] Miles, W.J., Crystalline silica analysis of Wyoming bentonite by X-ray diffraction after phosphoric acid digestion, *Analytical Chemistry Acta*, Vol 286, 1994, pp 97–105.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[6] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

2.4 *NIOSH Publications:*[7]

Manual of Analytical Methods, 4th Ed., DHHS (NIOSH), Publication No. 94-113 August 1994.

Method 7500 for Silica, Crystalline, Respirable (XRD)

Method 7601 for Silica, Crystalline Visible Absorption Spectrophotometry

Method 7602 for Silica, Crystalline (IR)

2000 Guidelines for the Use of ILO International Classification of Radiographs of Pneumoconioses

2.5 *Other References:*

American Thoracic Society, Standardization of Spirometry—1994 Update

3. Significance and Use

3.1 These practices and criteria were developed for occupational exposures during construction and demolition activities. They are intended to (*a*) protect against clinically significant disease from exposure to respirable crystalline silica, (*b*) be measurable by techniques that are valid, reproducible, and readily available, and (*c*) be attainable with existing technology and protective practices.

4. General Requirements

4.1 *Occupational Exposure Limit:*

4.1.1 *Permissible Exposure Limit (PEL)*—U.S. Occupational Health and Safety Administration (OSHA) General Industry (see 29 CFR 1910.1000)—Workers shall not be exposed to respirable dust containing 1 % or more quartz exceeding 10/(% quartz + 2) mg/m^3 as an 8-h time weighted average in any 8-h work shift of a 40-h work week or, for total dust (respirable plus non-respirable), 30/(% quartz + 2) mg/m^3 . The PEL for respirable cristobalite and tridymite is one-half the value for quartz.

$$PEL\,(mg/m^3)\,(respirable\ fraction) = 10 \div [\%\ quartz + (\%\ cristobalite \times 2) + (\%\ tridymite \times 2) + 2]$$

$$PEL\,(mg/m^3)\,(total\ dust) = 30 \div [\%\ quartz + (\%\ cristobalite \times 2) + (\%\ tridymite \times 2) + 2]$$

4.1.2 Federal OSHA PEL is approximately equivalent to a quartz level of 100µg/m^3.

4.1.3 Employer shall determine the appropriate PEL for their operation, but in no case shall the PEL be less stringent than the applicable government limit.

4.2 *Exposure Assessment and Monitoring:*

4.2.1 Risk can be assessed qualitatively based on material safety data sheets (MSDS), historical data, likelihood of dust generation, proximity of airborne dust to workers, nature of the construction process (for example, wet work—low risk; dry work—higher risk), and location of workers (for example, closed equipment cab). Note that the absence of visible dust is not a guarantee of lack of risk.

4.2.2 Where qualitative risk assessment indicates that a potential risk is present, initial sampling of tasks or representative workers' exposures shall be made to characterize the exposure and its variability, to determine compliance with standards given in 4.1, and to establish a baseline exposure level in all areas where workers are or have the potential to be exposed to silica. Initial task sampling would be not required for short duration or transient tasks, tasks where sampling results would not be timely, representative concentrations are already known or proven task protection is in place. Conduct exposure sampling when needed to prevent a significant and deleterious change in the contaminant generation process or the exposure controls so that overexposures do not go undetected. This is particularly true for areas or operations where conditions can change dramatically within a short span of time.

4.2.3 Recordkeeping required under this practice shall be maintained and made available for review by employees.

4.2.4 For workers with regular exposure to high silica concentrations who are placed inside of supplied air respirators or ventilated enclosures, such as in sandblasting, conduct sampling inside of the control device to determine employee exposure. The sampling line shall not interfere with the fit of the respirator. It is possible that consultation with the respirator manufacturer will be necessary to achieve the above requirement.

4.2.5 In areas where overexposures are persistent, a written exposure control plan shall be established to implement engineering, work practice, and administrative controls to reduce silica exposures to below the PEL, or other elected limit, whichever is lower, to the extent feasible. Conduct a root cause analysis for all exposures in excess of the PEL that cannot be accounted for. Root cause analysis involves investigating cause(s) for the excessive exposure, providing remedies, and conducting follow-up sampling to document that exposures are below the PEL.

4.2.6 The employer shall re-assess exposures when there has been a change in the process, equipment, work practices or control methods that have the potential to result in new or additional exposures to crystalline silica or when the employer has any reason to believe that new or additional exposures have occurred.

4.2.7 Measurement of worker occupational exposures shall be within the worker's breathing zone and shall meet the criteria of this section. Such measurements need to be representative of the worker's customary activity and be representative of work shift exposure. Use area sampling to characterize exposures and identify effective controls when appropriate to the circumstances.

4.2.8 Respirable dust samples are to be collected in accordance with accepted methods. Refer to D4532.

4.2.9 Sample data records shall include employee identification, a log of the date and time of sample collection, sampling time duration, volumetric flow rate of sampling, documentation of pump calibration, and description of the sampling location, analytical methods, and other pertinent information.

4.2.10 Analyze samples for silica content analysis by an AIHA-accredited laboratory.

4.3 *Exposure Monitoring:*

4.3.1 The employer shall provide employees with an explanation of the sampling procedure.

[7] CDC/NIOSH, 4676 Columbia Pkwy, Cincinnati, OH 45226-1998.

4.3.2 Whenever exposure monitoring activities require entry into an area where the use of respirators, protective clothing, or equipment is required, the employer shall provide and ensure the use of such personal protective equipment and shall require compliance with all other applicable safety and health procedures.

4.3.3 Affected employees shall be provided with copies of their sampling results when returned by the laboratory and explanations of the data.

4.4 *Methods of Compliance:*

4.4.1 *Task-based Control Strategies*—Where exposure levels are known from empirical data, a task based control strategy shall be applied that matches tasks with controls. The following lists examples of this approach.

4.4.1.1 *Abrasive Blasting*—OSHA has already established standards for abrasive blasting work requiring ventilation (29 C.F.R. 1926.57) and respiratory protection (29 C.F.R. 1926.103). In the case of abrasive blasting operations, it is recommended that the employer provide a Type CE, pressure demand or positive-pressure, abrasive blasting respirator (APF of 1000 or 2000).

4.4.1.2 Other engineering controls with the potential to limit exposure are:

(1) Using alternative materials

(2) Wet suppression systems

(3) Exhaust ventilation

4.4.1.3 *Cutting Clay and Concrete Masonry Units*—The controls found in Tables 1-5 apply to employees cutting masonry units during a full work shift and does not apply to occasional cutting limited to 90 minutes total time

4.4.2 *Exposure-based Control Strategies*—Where exposure levels are measured and known to exceed the PEL, an exposure based control strategy shall be applied that uses the appropriate controls to lower exposure.

4.4.2.1 *Engineering Controls:*

(1) Use of properly designed engineering controls is the most desirable approach for controlling dust from crystalline silica-containing materials.

(2) Adequate ventilation or other dust suppression methods shall be provided to minimize respirable crystalline silica concentrations to below the PEL, where feasible.

(3) Enclosed workstations, such as control booths and equipment cabs, designed for protection against respirable crystalline silica dust, shall be provided with filtered air to reduce exposures.

(4) Engineering design of tools and equipment shall include, where feasible, provisions to minimize exposure of workers to respirable crystalline silica dust to the PEL or below. If ventilation systems are used, they shall be designed and maintained to prevent the accumulation and re-circulation of respirable crystalline silica dust in the working environment (see ANSI Z9.2). If wet suppression systems are used, spray nozzles and associated piping shall be maintained to ensure that adequate wetting agent is applied where needed to control respirable crystalline silica dust.

(5) All engineering controls shall be properly maintained and periodically evaluated and brought up to specifications, when needed.

4.4.3 *Work Practices and Administrative Controls:*

4.4.3.1 Ensure that workers do not work in areas of visible dust generated from materials known to contain a significant percentage of respirable crystalline silica without use of respiratory protection, unless proven task protection is in use or air sampling shows exposures less than the PEL.

4.4.3.2 Workers shall not use compressed air to blow respirable crystalline silica-containing materials from surfaces or clothing, unless the method has been approved by an appropriate Regulatory agency.

4.4.3.3 Employers shall instruct workers about specific work practices that minimize exposure to respirable crystalline silica.

4.4.3.4 Workers shall utilize good housekeeping practices to minimize the generation and accumulation of dust.

4.4.3.5 Workers shall utilize available means to reduce exposure to dust, including the use of respirators, rest areas, ventilation systems, high efficiency particulate air (HEPA) vacuum cleaners or water spray, wet floor sweepers, and rotation of personnel to minimize individual exposure.

4.5 *Respiratory Protection:*

4.5.1 Respirators shall be required in work situations in which engineering and work practice controls are not sufficient to reduce exposures of employees to or below the applicable

TABLE 1 Cutting Masonry Units

Operation/Task	Control Measures	Respiratory Protection
Cutting masonry units— (Using stationary or portable saws)	*Wet Method*: Continuously apply stream or spray at the cutting point.	Not Required
	OR *Dry Method*: Enclose saw within a ventilated enclosure operated with a minimum face velocity of 250 feet-per-minute. Saw blade must be contained entirely within the booth and exhaust must be directed away from other workers or fed to a dust collector with a HEPA filtration system.	100 series filtering face piece (disposable dust mask) OR ½ face respirator with 100 series filters
* Additional control measures for consideration: Ventilation (natural and mechanical), dust collection methods, architectural design, use special-shaped products, job rotation and demarcation of specific cutting areas.		

TABLE 2 Mixing Concrete, Grout, and Mortar

Operation/Task	Control Measures	Respiratory Protection
Mixing Concrete, Grout or Mortar	Natural ventilation and demarcation of mixing areas	Not Required

TABLE 3 Tuck Pointing

NOTE 1—The following control measures have the potential to be useful in reducing exposure levels, but are not necessarily adequate to reliably reduce exposures below the PEL.

Operation/Task	Control Measures	Respiratory Protection
Tuck Pointing	The following control measures may be useful in reducing exposure levels but may not be adequate to reliably reduce exposures below the PEL. Ventilation Natural Mechanical Dust collection/vacuum Shroud Gauge/Guide for Equipment Wet methods	These types of respiratory protection will be necessary to provide adequate protection in the absence of control methods that demonstrate compliance with the PEL: Full face respirator with 100 series filter OR Supplied air respirator

TABLE 4 Concrete Cutting

Operation/Task	Control Measures	Respiratory Protection
Outdoor Slab Sawing	Use water-fed system that delivers water continuously at the cut point with natural ventilation OR Early entry sawing OR Dry cutting with integrated vacuum system	Not Required
Indoor Slab Sawing	Use water-fed system that delivers water continuously at the cut point with natural ventilation.	100 series filtering face piece respirator
	OR Mechanical ventilation (fans)	100 series filtering face piece respirator
	OR Early entry sawing OR Dry cutting with integrated vacuum system	100 series filtering face piece respirator
Outdoor Wire Sawing w/ remote Outdoor Wire Sawing w/o remote	Use water-fed system that delivers water continuously on wire, operated via remote control with natural ventilation.	Not Required
Outdoor Wall Sawing	Use water-fed system that delivers water continuously on blade with natural ventilation.	Not Required
Indoor Wall Sawing	Use water-fed system that delivers water continuously on blade, operated via remote control with natural ventilation.	100 series filtering face piece respirator
Outdoor Hand Sawing	Use water-fed system that delivers water continuously on blade with natural ventilation.	Not Required
	OR Use vacuum system at point of operation with natural ventilation.	Not Required
Indoor Hand Sawing	Use water-fed system that delivers water continuously on blade with natural ventilation.	100 series filtering face piece respirator

TABLE 5 Core Drilling

Operation/Task	Control Measures	Respiratory Protection
Core Drilling	Use water-fed system that delivers water continuously at the cut point with natural ventilation	Not Required
	OR *Dry Method*: Use vacuum system at point of operation with natural ventilation.	None OR 100 series filtering face piece respirators
Hand Held tools with core drilling bits	Use water-fed system that delivers water continuously at the cut point with natural ventilation.	None OR 100 series filtering face piece respirators
	OR Use vacuum system at point of operation with natural ventilation.	None OR 100 series filtering face piece respirators

PEL or company adopted level. Where the use of personal respiratory protection is required under this practice, the employer shall establish and enforce a program.

4.5.2 The employer shall institute a respiratory protection program that includes: individual medical clearance for respirator usage, worker training in the use and limitations of respirators, routine air monitoring, and the inspection, cleaning, maintenance, selection, and proper storage of respirators. This training shall be done at first employment and annually as refresher training. Any respiratory protection must, at a minimum, meet the requirements of 29 CFR 1910.134 and ANSI Z88.2. Respirators shall be used according to the manufacturer's instructions. See Section 4.4.1 for recommended respiratory protection.

4.5.2.1 Each respirator wearer will receive medical clearance prior to the issuance of a respirator and subsequent fit testing. Detailed guidance is provided at 29 CFR 1910.134. Medical clearance is the process to determine an individual's psychological and medical functional-ability to wear a respirator.

4.5.2.2 Employers shall perform respirator fit tests in accordance with ANSI Z88.2 at the time of initial fitting and at least annually, thereafter, for each worker wearing tight-fitting respirators. The tests shall be used to select respirators that provide the required protection.

4.6 *Respiratory Medical Surveillance:*

4.6.1 The employer shall institute a respiratory medical surveillance program for all workers who work in areas, for 120 days per year or more, where the TWA concentration of respirable crystalline silica dust exceeds the PEL (see 4.1) or a lower company adopted OEL, or where such concentrations are anticipated.

4.6.2 All medical examinations and medical procedures as required under 4.6 are to be performed by or under the direction of a licensed physician, and are provided without cost to the worker.

4.6.3 The employer shall make available the required medical surveillance to the workers and at a reasonable time and place.

4.6.4 Persons who administer the pulmonary function testing shall demonstrate proficiency in spirometry using the American Thoracic Society "Standardization of Spirometry—1994 Update."

4.6.5 Medical examinations shall be made prior to placement of new workers (as defined in 4.6.1) and no less than once every three years thereafter. These examinations shall include as a minimum:

4.6.5.1 Medical and occupational history to elicit information on respiratory symptoms, smoking history, and prior exposures to dust and agents affecting the respiratory system.

4.6.5.2 A posterior-anterior (PA) chest roentgenogram on a film no less than 14 by 17 in. and no more than 16 by 17 in. at full inspiration. The roentgenogram shall be classified according to the 2000 Guidelines for the Use of ILO International Classification of Radiographs of Pneumoconioses by currently NIOSH certified "B" readers. NIOSH "B" readers are physicians that have demonstrated proficiency in the classification of roentgenograms according to the ILO system by successfully completing a practical examination.

4.6.5.3 A tuberculosis intradermal skin test using purified protein derivative for workers with roentgenographic evidence of silicosis who have not been tested.

4.6.5.4 Spirometry is an OPTIONAL component of this practice. There is currently no evidence that routine medical surveillance with spirometry is useful for early detection of silica-induced lung disease. Experience has shown that most abnormalities on screening spirometry are not due to work-related disorders. Smoking, non-occupational pulmonary disease, and other variables are more common causes of alterations in pulmonary function. Provided spirometry is conducted, ensure that pulmonary function measurements are obtained and include a determination of forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1), and forced expiratory volume in 1 s as a percentage of total forced vital capacity (FEV1/FVC%). Compare spirometry results with the 95th –percentile lower limit of normal (LLN) values (See Hankinson et al, Am J. Respiratory Critical Care Med. 1999Jan; 159(1): 179-87). Technicians performing spirometry test shall have attended a NIOSH certified spirometry training course (DHHS (NIOSH) Pub No. 2004-154c).

4.6.6 The employer shall provide the following information to the health care provider:

4.6.6.1 A copy of this practice with appendix,

4.6.6.2 A description of the affected worker's duties as they relate to the worker's exposure,

4.6.6.3 The worker's representative exposure level or anticipated exposure level to respirable crystalline silica,

4.6.6.4 A description of any personal protective and respiratory protective equipment used or to be used by the worker, and

4.6.6.5 Information from previous medical examinations of the affected worker that is not otherwise available to the health care provider.

4.6.7 The medical provider shall provide the following information to the employee:

4.6.7.1 A copy of the results of the medical examination, to include results of x-rays, spirometry and other laboratory testing.

4.6.7.2 Any abnormalities, whether occupational or non-occupational, with recommendations, if any, for medical follow-up.

4.6.8 The employer shall provide the employee with a copy of the physician's written opinion pomptly from its receipt. Situations of serious incidental disease or findings shall be reported to the employee as soon as feasible.

4.7 *Medical Protection:*

4.7.1 Workers with profusion of opacities equal to or greater than 1/1 shall be evaluated at a frequency as determined by a physician qualified in pulmonary disease. Workers will not be assigned to any jobs that are inconsistent with the work restrictions recommended by the treating physician.

4.7.2 Workers with profusion of opacities equal to or greater than 1/1 will be counseled by a physician or other person qualified in occupational safety and health, at least annually, about silicosis prevention, safe work practices, respiratory protection, personal habits, smoking cessation, and other items and areas that could contribute to the betterment of their respiratory health.

4.7.3 When silicosis is diagnosed, consider it a sentinel event. It is important to re-examine all aspects of exposure history, exposure monitoring, engineering control, administrative control, and personal protection and to improve them, as necessary, to protect similarly exposed workers. The employer and employee shall make every effort to collect and report exposure and medical histories for any silicosis diagnosis.

4.8 *Worker Training and Education:*

4.8.1 *Training*—The employer shall provide training for each worker exposed or potentially exposed to high levels of respirable crystalline silica.

4.8.2 *Frequency*—Training shall be provided as follows:

4.8.2.1 Prior to the initial job assignment for new workers exposed to respirable crystalline silica dusts,

4.8.2.2 Whenever a worker is assigned to a new or unfamiliar task or operation involving respirable crystalline silica dust exposure, and

4.8.2.3 Whenever a worker demonstrates unsafe job performance, which has the potential to result in increased respirable crystalline silica dust exposures.

4.8.3 *Content*—At a minimum, training shall consist of the following elements:

4.8.3.1 The specific nature of operations which could result in exposures to respirable crystalline silica dust above the PEL,

4.8.3.2 An explanation of engineering, work practice, hygiene, administrative and personal protection equipment (PPE) controls used in each of the above operations to minimize respirable crystalline silica dust exposures, and

4.8.3.3 If applicable, the purpose and description of the exposure monitoring and medical surveillance programs and the medical protection program, including information concerning the following:

(1) The adverse health effects associated with excessive exposures to respirable crystalline silica dusts including silicosis, tuberculosis, and the possible association with lung cancer.

(2) The relationship between smoking and exposure to respirable crystalline silica dusts in producing silicosis.

4.8.3.4 The purpose, proper selection, fitting, use, cleaning, disinfection, inspection, repairs, storage and limitations of respirators if they are used to supplement engineering, administrative, and work practice controls to reduce respirable crystalline silica dust exposures.

4.8.4 *Competency*—Prior to assignment to new or unfamiliar respirable crystalline silica dust-exposing tasks and operations, the employer shall observe workers' proficiency in the use of all applicable exposure control measures for that operation such as PPE, engineering, administrative, work practice, and hygiene controls.

4.8.5 *Training Methods*—The employer shall present all training required by 4.8 in a language and manner that the worker is able to understand.

4.8.6 *Documentation of Training*—The employer shall document that training has been completed.

4.8.7 *Access to Information and Training Materials*—The employer shall upon request, by any worker, permit review of this standard practice and its appendix and to materials relating to the employer's silica training, medical, respiratory protection, and exposure control plan programs.

4.9 *Warning Signs and Labels:* In areas where respirable crystalline silica concentrations in the atmosphere are anticipated to exceed the PEL, appropriate warning signs shall be provided. In some cases, it will be potentially appropriate to post a warning sign near the area where silica is released or on equipment that is associated with the exposure. In other cases, it will be potentially appropriate to post a warning at the entrance to a job site.

4.10 *Record Keeping:* The employer shall establish and maintain an accurate record of all medical and exposure monitoring required by this practice. These records shall include, as a minimum, the following:

4.10.1 Name, identification number, and job classification of each worker monitored for dust exposure. The exposure monitoring result, work location, and monitoring date for each worker monitored.. For sampling, reference:

4.10.1.1 The type of respiratory protection worn by each worker monitored, if any, and fit testing records.

4.10.1.2 Where relevant, environmental variables with the potential to have affected the measurement of worker exposure for each worker measurement.

4.10.2 Medical evaluation results and records of all sampling schedules, including sampling methods, analytical methods, breathing zone, and work area respirable crystalline silica dust concentrations shall be kept as required by law.

4.10.2.1 Medical records to include medical histories, radiographic films and any pulmonary function results shall be maintained according to standards of confidentiality.

4.10.3 Each worker shall have access to records of that worker's occupational exposure and medical examination records and be able to make copies for their own use in accordance with regulatory provisions.

4.10.4 Employees will have access to medical and sampling results promptly. Maintain an acknowledgment record, signed by the employee, attesting to being so informed of his or her access rights along with medical records.

4.11 *Employer evaluation of this Standard Practice:*

4.11.1 Periodic review and evaluation of workplace respirable silica exposure and silica-related health and disease records shall be performed to determine the effectiveness of control measures.

5. Physical and Chemical Properties

5.1 The physical and chemical properties of the crystalline silica (quartz) dusts and its polymorphs, cristobalite and tridymite, that are the subject of this practice vary over ranges characteristic of purity and particle size distribution.

5.1.1 Crystalline silica or quartz (CAS No 14808-60-7):

Specific gravity (20 C)	2.65
Melting point	1610 C
Boiling point	2230 C
Appearance	White to dark gray
X-Ray characteristics	Principal d-spacings and relative intensities
	3.34 4.26 1.82

5.1.2 Cristobalite (CAS No. 14464-46-1):

Specific gravity (20 C)	2.33
Melting point	1713 C
Boiling point	2230 C
Appearance	White to yellowish
X-Ray characteristics	Principal d-spacings and relative intensities 4.05 2.48 2.84 3.13

5.1.3 Tridymite (CAS No. 15468-32-3):

Specific gravity (20 C)	2.26
Melting point	1703 C
Boiling point	2230 C
Appearance	White
X-Ray characteristics	Principal d-spacings and relative intensities 4.10 4.32 3.81 2.97

6. Laboratory Analysis

6.1 *General Requirements:*

6.1.1 The concentration of respirable crystalline silica dust in the air sampled with a gravimetric personal sampler shall be determined by scientifically sound methods.

NOTE 1—Commonly used NIOSH methods include sections on applicability, interferences, accuracy, and evaluation. Generally, Method 7500 (XRD) is to be preferred, but recently there is increased use of Method 7602 (IR), particularly for coal mine dust samples. An advantage of Method 7500 is its ability to distinguish among quartz and cristobalite, and tridymite. Method 7601 does not distinguish among these three. Method 7602 (IR) can distinguish between quartz and cristobalite, but only at some loss of sensitivity. However, tridymite can be determined only in the absence of the other two polymorphs. Interferences should be considered when selecting an analytical method, especially when silicates are involved. To assist the laboratory in identifying interferences, information should be provided along with the sample concerning the potential presence of aluminum phosphate, feldspars, graphite, iron carbide, lead sulfate, micas, montmorillonite, potash, sillimanite, silver chloride, talc, and zircon.

7. Keywords

7.1 crystalline silica dust; cristobalite; dust; occupational exposure; permissible exposure limits; quartz dust; respirators; respiratory protection; tridymite

APPENDIX

(Nonmandatory Information)

X1.

X1.1 Compliance Hierarchy

X1.1.1 Construction employers are required to implement engineering controls and work practices to reduce and maintain employee exposures to or below the PEL.

X1.1.2 When feasible engineering controls and work practices are not sufficient to reduce employee exposure to or below the PEL, the employer must supplement them with the use of respiratory protection in accordance with the requirements of OSHA's Respiratory Protection Standard, 29 CFR 1926.103.

X1.2 Engineering Controls

X1.2.1 The use of properly designed engineering controls is generally thought to be the most reliable approach for controlling dust from crystalline silica-containing materials. The contractor should review the project to determine which, if any, engineering controls are technologically feasible for each project. The following are some of the engineering controls that can be used to control dust generation from work with masonry and concrete materials:

(1) Work with architects, engineers and manufacturers to reduce the amount of cutting

(2) Natural ventilation

(3) Local exhaust systems

(4) Shrouds, HEPA filters, fans, ventilation systems and other specialty equipment that can be used to suppress dust (such as cabs, enclosures or isolation systems)

(5) Dust suppression systems

(6) Dust collection systems

(7) Wet systems or methods

X1.3 Work Practices or Administrative Controls

X1.3.1 The following are some of the work practices that can be used to control dust generation from work with masonry and concrete materials:

(1) A comprehensive hazard communication program, incorporating a silica-based training program with appropriate emphasis on silica hazards, silica-specific control measures, and compliance with instructions accompanying manufacturers' materials and equipment

(2) Positioning the worker upwind of the work

(3) Job rotation and creative scheduling

(4) The employee must follow good personal hygiene and housekeeping practices, which include:

(a) Not smoking tobacco products; use of tobacco products has been shown to increase the risk of illness from exposure to airborne crystalline silica.

(b) Avoiding, to the extent practical, activities that would contribute significantly to an employee's exposure to airborne respirable crystalline silica.

(c) Prohibiting the use of compressed air to clean up respirable crystalline silica dust.

X1.4 Personal Protective Equipment (PPE)—General

X1.4.1 If the contractor/employer determines that engineering controls and administrative controls will not adequately protect the workers, personal protective equipment (PPE) must

be used. The need for PPE should be evaluated for each work classification relative to an assessment of the site hazards.

X1.5 Implementation and Employee Compliance

X1.5.1 To have an effective exposure control program for crystalline silica, employers must:

X1.5.1.1 establish work rules designed to ensure compliance with the applicable requirements;

X1.5.1.2 adequately communicate those work rules to its employees; and

X1.5.1.3 take effective actions to enforce the rules when violations are discovered.

X1.6 Determining Exposure

X1.6.1 A silica exposure assessment should include the following elements:

(1) A list of tasks the employees will perform, which may result in employee exposure to respirable crystalline silica

(2) A list of engineering and administrative controls and necessary respiratory protection equipment used by the employer to reduce exposures for each task identified

(3) A determination that the measures used by the employer are adequate

X1.6.2 Given the dynamic nature of a construction site, it is generally recognized that obtaining timely and representative site-specific exposure monitoring for the tasks being performed is often impractical if not infeasible. Generally, the results of exposure monitoring would not be available until after operations involving the monitored exposure have been completed. Therefore, the employer would not be in a position to make use of the monitoring results to determine appropriate control measures for that task. In other cases, the workplace conditions in construction worksites vary to such a great extent that it would be difficult to accurately characterize employee exposure from one day to the next. For example, an employee may work: outdoors on a dry, windy day on day one; outdoors on a calm, humid day on day two; and in an enclosed environment on day three. Personal monitoring for crystalline exposure on a given day is not likely to accurately reflect these changing conditions.

X1.6.3 Despite these challenges, the employer needs to have an objective basis for concluding that the control measures it is using are adequate to limit workplace exposures to respirable crystalline silica from exceeding the PEL though a combination of historical data (obtained by the employer through its prior work, or obtained from NIOSH, OSHA, the state consultation service, another government agency or industry association), objective data (from a manufacturer or a published scientific study), or site-specific employee exposure monitoring.

NOTE X1.1—If certain tasks are of very limited duration, such as a few cuts of brick or block or using a hammer to drill anchor holes, exposure assessments should not be necessary. However, appropriate engineering and administrative controls are recommended, where appropriate, to protect workers and ensure compliance with the PEL.

X1.6.4 When exposure monitoring is performed, the employer should ensure that all samples are:

(1) collected in accordance with the procedures specified in sampling methods for respirable crystalline silica published by OSHA and/or NIOSH; and

(2) analyzed by a certified/ compliant laboratory (see DEFINITIONS Section) in accordance with the protocol for respirable crystalline silica published by OSHA and/or NIOSH.