STATE OF HAWAII

DEPARTMENT OF LABOR AND INDUSTRIAL RELATIONS

OCCUPATIONAL SAFETY AND HEALTH

Date: April 14, 2008
Revised: September 8, 2008

To: All Branch Managers, OSHCOs, & EHSs

From: Darwin L.D. Ching, Director
Department of Labor and Industrial Relations

Subject: National Emphasis Program – Crystalline Silica

The attached is a guideline for inspection policies and procedures for implementing a National Emphasis Program (NEP) to identify and reduce or eliminate health hazards associated with occupational exposure to crystalline silica.

The federal directive for Crystalline Silica has been amended to reflect the way that HIOSH will be enforcing the NEP.

This GOSH applies to both general industry and construction workplaces.

Please remove from you Part I GOSH CPL 03-00-007, National Emphasis – Crystalline Silica, April 14, 2008 and replace it with the attached GOSH and annotate the index accordingly.

This GOSH is effective upon receipt.

Source: OSHA Instruction CPL 03-02-007, January 24, 2008

DIRECTIVE NUMBER: CPL 03-00-007

EFFECTIVE DATE: April 14, 2008

SUBJECT: Adoption by Hawaii of National Emphasis Program – Crystalline Silica

ABSTRACT

Purpose: This instruction describes policies and procedures for implementing a National Emphasis Program to identify and reduce or eliminate the health hazards associated with occupational exposure to crystalline silica.

Scope: This instruction applies to the Hawai'i state program only – the Hawai'i Occupational Safety and Health Division (HIOSH)

References:

- OSHA Instruction CPL 02-00-103 (CPL 2.103), September 26, 1994, Field Inspection Reference Manual (FIRM).
- OSHA Instruction CPL 02-00-140, June 26, 2006, Complaint Policies and Procedures.
- OSHA Instruction CPL 02-00-025 (CPL 2.25I), January 4, 1995, Scheduling System for Programmed Inspections.
- OSHA Instruction CPL 02-00-051(CPL 2-0.51J), May 28, 1998, Enforcement Exemption and Limitations under the *Appropriations Act*.
- OSHA Instruction CPL 02-00-120 (CPL 2-0.120), September 25, 1998, Inspection Procedures for the Respiratory Protection Standard.
- OSHA Instruction CPL 02-02-038 (CPL 2-2.38D), March 20, 1998, Inspection Procedures for the Hazard Communication Standard.

Action Offices: Hawai'i Enforcement and Consultation Offices

Originating Agency: Occupational Safety and Health Administration (OSHA), OSHA Instruction CPL 03-00-007, January 24, 2008

By and Under the Authority of
Darwin L.D. Ching
Director
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Executive Summary

In 1996, the Occupational Safety and Health Administration (OSHA) issued a memorandum establishing a Special Emphasis Program (SEP) for Silicosis, which provided guidance for targeting inspections of worksites with employees at risk of developing silicosis. This instruction establishes a National Emphasis Program (NEP) that expands and builds upon the 1996 SEP.

This instruction addresses targeting of worksites with elevated exposure to crystalline silica, as well as silica-related inspection procedures and compliance assistance.

Table of Contents

I. Purpose.

This instruction describes policies and procedures for implementing a National Emphasis Program (NEP) to identify and reduce or eliminate the health hazards associated with occupational exposure to crystalline silica.

II. Scope.

This instruction applies to the Hawai'i State program only – the Hawai'i Occupational Safety and Health Division (HIOSH)

III. References.

A. OSHA Instruction CPL 02-00-103 (CPL 2.103), September 26, 1994, Field Inspection Reference Manual (FIRM).
B. OSHA Notice CPL 07-03 (CPL 02), May 14, 2007, Site-Specific Targeting 2007(SST-07).
C. OSHA Instruction CPL 02-00-140, June 26, 2006, Complaint Policies and Procedures.
D. OSHA Instruction CPL 02-00-025 (CPL 2.25I), January 4, 1995, Scheduling System for Programmed Inspections.
E. OSHA Instruction CPL 02-00-051 (CPL 2-0.51J), May 28, 1998, Enforcement Exemptions and Limitations under the Appropriations Act.
F. OSHA Instruction TED 01-00-015 (TED 1-0.15A), January 20, 1999, Occupational Safety and Health Administration Technical Manual.
G. Memorandum for Regional Administrators from R. Davis Layne, Deputy Assistant Secretary, July 12, 1999, Subject: Strategic Plan IMIS Coding.
H. OSHA Instruction CPL 02-00-120 (CPL 2-0.120), September 25, 1998, Inspection Procedures for the Respiratory Protection Standard.
I. OSHA Instruction CPL 02-02-038 (CPL 2-2.38D), March 20, 1998, Inspection Procedures for the Hazard Communication Standard.
J. OSHA Instruction CPL 02-00-135, Recordkeeping Policies and Procedures Manual (RKM), December 30, 2004.

IV. Program Change.

This instruction describes a program change under which Hawai'i has adopted the OSHA National Emphasis Program (NEP) to reduce or eliminate employee exposure to crystalline silica through inspection targeting, outreach and compliance assistance.

V. Application.

This instruction applies to general industry and construction workplaces where crystalline silica is present.

VI. Background.

The term "silica" refers broadly to the mineral compound silicon dioxide (SiO2).
Silica can be crystalline or amorphous. Crystalline silica is significantly more hazardous to employees than amorphous silica. In addition to causing the disabling and irreversible lung disease silicosis, crystalline silica has been classified as a Group I carcinogen - Carcinogenic to Humans by the International Agency for Research on Cancer (IARC) [IARC, 1997]. The term "silica" as it is used in this directive refers specifically to crystalline silica.

Crystalline silica is an important industrial material, and occupational exposure occurs in a variety of workplace settings, including mining, manufacturing, construction, maritime, and agriculture. Processes associated historically with high rates of silicosis include sandblasting, sand-casting foundry operations, mining, tunneling, cement cutting and demolition, masonry work, and granite cutting. Appendix A provides further information on silica, including sources, industrial uses, and adverse health effects. Appendix B provides a list of North American Industrial Classification System (NAICS) and Standard Industrial Classification (SIC) codes for industries in which silica exposure occurs frequently, based on a review of OSHA inspection data for the period 1996 to 2007.

Reducing and ultimately eliminating the workplace incidence of silicosis has been a primary goal of OSHA since its inception. In 1972, OSHA issued guidelines for conducting inspections in workplaces with significant crystalline silica exposure. In the early 1980s, OSHA placed a special emphasis on the prevention of silicosis in foundry personnel, and in 1996 OSHA implemented a Special Emphasis Program (SEP) to reduce the workplace incidence of silicosis.

The 1994 Government Performance and Results Act (GPRA) mandates that federal agencies improve performance and devise a system for measuring results. To comply with the provisions of GPRA, OSHA developed a Strategic Plan for improving the safety and health of all employees. In 1998 and again in 2003, under the Strategic Plan, OSHA identified crystalline silica as one of the focused hazards.

While the State of Hawaii has not previously participated in OSHA's silica special emphasis efforts, the increase in the use of materials containing crystalline silica has recently become of great concern to Hawaii. As a result, the state believes it is appropriate to adopt the OSHA NEP for silica.

VII. National Emphasis Program Goals.

The purpose of this NEP is to significantly reduce/eliminate employee overexposures to crystalline silica and, therefore, control the health hazards associated with such exposures. This goal will be accomplished by a combined effort of inspection targeting, outreach to employers, and compliance assistance.

Inspections should be targeted to work sites that likely create high silica exposures. The silica-related inspections should be conducted at a range of facilities reasonably representing the distribution of general industry and construction work sites in that region.
To ensure abatement and measure the effectiveness of this NEP, follow-up site visits often will be necessary as outlined in Section XI.(D.) below.

VIII. Program Procedures.

A. NEP Development

Inspections conducted under this NEP will focus on industries where employees are potentially exposed to levels of crystalline silica in excess of the permissible exposure limit (PEL). Appendix B, which was developed from OSHA inspection data, lists industries with potential silica exposure and provides an overview of the types of industries in which silica exposures frequently occur.

1. Industry Selection

The Occupational Health (OH) Branch will identify the industry sectors that are to be targeted for inspection and shall then prepare a master list of NAICS codes from those listed in Appendix B. The rationale for selecting each industry shall be documented, and may include information such as, but not limited to:

a. Potential for overexposures, based on previous inspection history of OSHA or other states.

b. Limited or no local inspection history of an industry listed in Appendix B.

c. The OH Branch Manager may establish knowledge of a pattern of silicosis or overexposures to silica by reviewing objective illness or exposure data from any and all sources including, state workers' compensation records or public health data from sources such as the National Institute for Occupational Safety and Health (NIOSH).

d. Industries that are not included in Appendix B, but are known by the OH Branch Manager, based on local knowledge (i.e. a documented history of referrals from local agencies or healthcare providers, or previous inspection histories, etc.), to have demonstrated a pattern of silica overexposures or cases of silicosis.

2. Site Selection

a. Targeting Sources

The source for the master list of establishments to be inspected is employment data from the Department's Research and Statistics Office.

b. Master List Generation

After identifying the relevant industries, the OH Branch Manager shall request a list of establishments within the targeted industries from the DLIR Research and Statistics Office. Establishments with fewer than 10 employees shall also be included in this NEP. Establishments will be placed on the list in alphabetical order by NAICS industry code.

c. **Deletions**

Based on their familiarity with local industries, the OH Branch Manager shall delete from the master list any firms known to be out of business.

The OH Branch Manager shall also delete any establishment that has had an inspection where employee exposures to silica have been evaluated within the previous three (3) years, provided either that no serious violations related to silica exposures were cited or that serious violations were cited but a follow-up inspection documented effective abatement of the cited conditions.

d. **Cycle Generation**

Each establishment on the corrected list will be assigned a sequential number, starting at the top of the list with number one.

A random number table will then be applied to create the first inspection cycle of five or more establishments. Subsequent cycles will be created in the same way until the expiration of the NEP or until all establishments on the list have been assigned to a cycle. Cycles may be created all at once or as needed, and need not be of the same size.

Whenever HIOSH becomes aware of a previously unknown establishment in one of the identified NAICSs, that establishment shall be added to the master list for inclusion in the next inspection cycle.

3. **Inspection Scheduling:**

Within a specified cycle, inspections may be scheduled in any order to make efficient use of resources. An inspection cycle must be completed before another cycle is started except that establishments may be carried over with the HIOSH Field Operations Manual (FOM).

For construction, inspections shall be scheduled from a list of construction work sites rather than construction employers, pursuant to the HIOSH FOM. If during the course of any construction inspection an Occupational Safety and Health Compliance Officer (OSHCO) encounters material that may contain crystalline silica, an appropriate referral shall be made to the Occupational Health Branch. Where available, the label wording indicating crystalline silica and the material safety data sheet (MSDS) should accompany the referral.

4. **Complaints and Referrals:**

Detailed guidance regarding complaints and referrals is provided in OSHA Instruction CPL 02-00-140, June 26, 2006, Complaint Policies and Procedures.

5. **Voluntary Compliance Programs**

Employers participating in voluntary compliance programs may be exempt from programmed inspections. The EHS should follow the procedures outlined in the FOM, for additional guidance if an on-site consultation visit is in progress, or if the establishment is a participant in OSHA's Voluntary Protection Programs (VPP) or the Safety and Health Achievement Recognition Program (SHARP).

6. **Expanding Scope of Inspection:**

The Environmental Health Specialist (EHS) may expand the scope of the NEP inspection beyond the silica-related activities if other hazards or violations are observed, following the guidelines set forth in the FOM.

B. Inspection Procedures

This section outlines procedures for conducting inspections and preparing citations for silica-related violations. For further guidance, the EHS should consult the OSHA directives, appendices, and other references provided below.
Appendix H contains a checklist that summarizes the information to be documented during a silica-related inspection. The checklist may be used by the EHS to ensure proper coverage of the essential elements of a silica-related inspection.

1. **Employee Exposure Monitoring:**

a. Conduct monitoring to determine employee exposure to respirable dust containing crystalline silica, in accordance with the OSHA Technical Manual (OTM), Section II, Chapter 1 and OSHA method ID-142. Appendix C contains guidelines on collecting air samples and Appendix D summarizes procedures for performing leak tests on cyclones.

b. Obtain bulk samples of settled dust from silica operations, in accordance with the OTM, Section II, Chapters 1 and 4.

c. Review any existing employer's silica exposure monitoring records. ***Citation Guidance:*** When the PEL for respirable dust containing silica is exceeded (regardless of the use of PPE), the EHS should cite §12-202-4.02(a)(1).

2. **Engineering and Work Practice Controls:**

a. Document and evaluate any engineering and work practice controls in place intended to reduce exposure to respirable crystalline silica, such as:

1) Location of employee(s) with respect to dust generation source.

2) Isolation (e.g., control room, enclosures, or barriers).

3) Local exhaust ventilation (LEV) systems.

4) Wet methods for cutting, chipping, drilling, sawing, grinding, etc.

5) Use of HEPA-equipped vacuums or wet sweeping for cleaning.

6) Employers should be advised not to use compressed air for cleaning silica contaminated surfaces.

7) Substitution with non-crystalline silica material.

8) Use of tools with dust collecting systems.

Controls for abrasive blasting are addressed further in Section XI(B)(7), below.

b. Guidelines for investigations of ventilation systems are contained in the OTM, Section III, Chapter 3.

Citation Guidance: If an employer fails to implement feasible engineering or work practice controls for reducing respirable crystalline silica exposures to levels less than the PEL, the EHS should cite §12-202-12. Guidance on what constitutes feasible administrative, work practice, and engineering controls is provided in the HIOSH FOM.

Subsequent citations may not be appropriate when all of the following conditions have been met:

1) The employer has fully implemented the feasible means of abatement recommended in the previous citation;

2) The employer has fully implemented a respiratory protection program;

3) Applicable engineering controls used to address the hazard have not significantly advanced since the previous citation.

3. <u>Respiratory Protection:</u>

a. Detailed inspection and citation guidance related to respiratory protection is contained in OSHA Instruction 02-00-120 (CPL 2-0.120) – Inspection Procedures for the Respiratory Protection Standard.

b. Minimum Respiratory Protection: When respirators are a permissible means to address overexposure, the minimum respiratory protection for employees exposed to crystalline silica during operations, other than abrasive blasting, is the N95 NIOSH approved respirator for exposures that do not exceed the assigned protection factor.

c. Medical Evaluations for Respirator Use: Medical evaluations must be given to all employees required to wear a respirator, however, medical evaluations are not required for employees who voluntarily use filtering face-piece respirators (dust masks). Employees who refuse to be medically evaluated cannot be assigned to work in areas where they are required to wear a respirator.

4. **Hazard Communication:**

a. Detailed inspection and citation guidance related to hazard communication is contained in OSHA Instruction CPL 02-02-038 (CPL 2-2.38D)–Inspection Procedures for the Hazard Communication Standard.

b. Labeling of Carcinogens: Information regarding evidence of carcinogenicity must be included on container labels and Material Safety Data Sheets (MSDSs) for crystalline silica, and for products containing crystalline silica. Carcinogen warnings are required on containers of materials containing more than 0.1 percent crystalline silica by weight or volume, as determined by analysis of a bulk sample of the original product. The EHS should collect bulk samples to determine silica content if MSDSs appear inadequate or incomplete.

c. Bricks/Tiles/Cement boards: Bricks, tiles and cement boards containing silica fall under the requirements of the Hazard Communication standard (HCS) due to the hazards associated with silica. Under normal conditions of use, bricks, tiles and cement boards are cut, sawed, or drilled, generating airborne levels of crystalline silica that could result in elevated exposures and are therefore not considered to be exempt under the HCS as articles.

Note: Bricks do not need to be individually labeled. Bricks that are palletized and bound by metal bands are considered to be containers and are to be tagged with an appropriate label.

d. Crushed Stone: Vehicles hauling shipments of crushed stone shall include hazard warnings concerning the carcinogenicity of crystalline silica on their shipping papers or bills of lading. EHSs should initially determine whether the Mine Safety and Health Administration (MSHA) or OSHA has jurisdiction over the specific crushed stone operation.

5. **Housekeeping and Hygiene Practices:**

a. Determine whether the employer's housekeeping and hygiene practices may contribute to overexposure. For example:

1) Exposed surfaces should be as free as practicable of silica containing dust (bulk samples of the dust may need to be collected).

2) Contaminated surfaces should not be blown clean with compressed air or other forced air (such as leaf blowers).

3) Wet sweeping should be used to clean areas if possible.

4) If vacuuming is used for cleaning, the exhaust air should be properly filtered to prevent release of airborne silica back into the workroom.

5) There should be separate break areas for consuming food, beverages, etc. that are kept free of silica.

6) Clothes contaminated with silica should not be blown or shaken to remove dust.

b. Document poor housekeeping and hygiene practices.

Citation Guidance: If employees are overexposed to crystalline silica, and poor housekeeping practices are noted, the EHS should cite, as applicable, 1910.141 (see §12-67.2, HAR) or 1926.51(f) or 1926.51(g) (see §12-117.1, HAR).

6. <u>Employee Exposure and Medical Records:</u>

a. Interview employees to determine whether they understand their right to review their medical and exposure records, as well as their rights regarding the confidentiality of such records.

b. Review the employer's recordkeeping program to ensure that the required information is being collected and reported.

c. Evaluate the employer's method for ensuring the confidentiality of employee medical records.

d. When it is necessary to review employee medical records, ensure that they are obtained and remain confidential in accordance with §12-55 and 1910.1020 (see §12-202.3-1, HAR).

Citation Guidance: If violations are found, EHSs should cite the applicable section of 1910.1020 (see §12-202.3-1, HAR). These rules do not require creation of any records, only preservation and access requirements.

Recent revisions to recordkeeping policies and procedures are described in CPL 02-00-135, Recordkeeping Policies and Procedures Manual (RKM).

7. <u>Abrasive Blasting:</u>

In addition to the program elements described above, the following procedures apply specifically to abrasive blasting operations:

a. Conduct monitoring to determine employee exposure to metals, such as: lead, arsenic, manganese, chromium, cadmium, copper, and magnesium. (Abrasive blasters may be exposed to metals either from the surface being blasted or from non-silica abrasive media.)

b. The air sampling device (cyclone) must be placed within the breathing zone, outside of any protective equipment including the abrasive blasting hood.

c. Conduct exposure monitoring of potentially exposed employees not engaged in abrasive blasting but still working in the area.

d. Conduct noise exposure monitoring as appropriate.

e. Determine whether the ventilation systems for abrasive blasting rooms and containment structures prevent escape of dust and provide prompt clearance of dust-laden air.

f. Determine whether each blast cleaning nozzle is properly equipped with an operating valve that must be held open manually.

g. For supplied-air respirators, evaluate breathing air quality and use. For oil-lubricated compressors, ensure that the compressor is equipped with a high-temperature or carbon monoxide alarm, or both, to ensure that carbon monoxide levels remain below the PEL.

[Note: Using an abrasive blasting hood while wearing a filtering face piece respirator violates the NIOSH approval for both respirators.]

h. When compressors are used to supply air, ensure that in-line absorbent beds are used and maintained.

i. Review electrical grounding.

j. Review pressure controls.

k. Determine whether the abrasive blasters have adequate PPE, such as canvas or leather gloves and aprons, to protect against injury from material impact.

l. Where an alternative abrasive material is being used such as glass beads, steel grit and shot, sawdust and shells, ensure that an appropriate evaluation of the hazards associated with the material has been conducted.

Citation Guidance: If overexposures to metals or noise are found, the EHS should cite the applicable standard.

If the ventilation system for a blast cleaning enclosure is found to be inadequately designed or ineffective at controlling dust, the EHS should cite the applicable section of 1910.94(a) (see §12-69.1, HAR).

If blast cleaning nozzles are not properly equipped with operating valves that must be held open manually, the EHS should cite 1910.244(b) (see §12-79.1, HAR) or 1926.302(b)(10) (see §12-127.1, HAR).

Violations related to respiratory protection for abrasive blasting operations may be cited under 1910.94(a)(5) (see §12-69.1, HAR). Guidance is also contained in OSHA Directive CPL 02-00-120 (CPL 2-0.120), Inspection Procedures for the Respiratory Protection Standard. Violations related to personal protective equipment should be cited under 1910.94(a)(5) (see §12-69.1, HAR), 1910.132 (see §12-64.1, HAR), 1926.95 (see §12-114.2, HAR), or 1926.100-103 (see §12-114.2, HAR).

C. Outreach

The OSHA Office of Training and Education, in conjunction with the Directorate of Enforcement Programs and the Office of Communications, has developed crystalline silica-related information and training materials. This information is available to the States. Hawai'i will provide outreach and training where appropriate.

1. Suggested Outreach:

Products and activities include the following:

a. Letters and News Releases announcing implementation of the Silica National Emphasis Program.

b. Seminars on silica-related topics, tailored for specific audiences, such as employers, employee groups, local trade unions, apprentice programs (e.g., masons, bricklayers, railroad employees), and equipment manufacturers. Local occupational medical staff can be invited to participate.

c. Partnerships and Alliances, such as teaming employers within the same industry (e.g., foundries) to share successes and technical information concerning effective means of controlling and reducing or eliminating employee exposure to crystalline silica.

d. Partnership and Alliance with groups representing non-English speaking employees such as Hispanic Contractors of America.

Include silica-related information on OSHA's new Spanish language website.

2. Targeted Audiences for Outreach:

a. Local employers engaged in silica-related work (refer to Appendix B for examples).

- **b.** Local employer associations, such as Associated General Contractors. Associated Builders and Contractors, Inc. and Shipbuilders Council of America.
- **c.** Local trade unions and apprenticeship programs (e.g., masons, bricklayers, railroad employees) and other employee groups.
- **d.** Independent contractors and the self-employed.
- **e.** Local hospitals, occupational health clinics, and other health organizations (e.g., state lung associations).
- **f.** Local professional associations (e.g., local safety councils).
- **g.** Temporary employment agencies providing employees to targeted employers (e.g., construction day laborers).
- **h.** Local building permitting authorities.
- **i.** Local newspapers, TV stations, trade magazines (can help inform the public and less accessible employers).
- **j.** Local government, such as health departments and department of transportation.
- **k.** Local suppliers of materials or services.

D. Follow-up and Monitoring

1. Where citations are issued for overexposure to crystalline silica, follow-up site visits must be conducted to determine whether the company is eliminating silica exposures or reducing exposures below the PEL. Where exposures cannot feasibly be reduced below the PEL, engineering and administrative controls must be used to reduce exposures to the extent feasible and employees protected with the use of PPE.

2. For those employers where follow-ups cannot be done, (i.e., construction sites or temporary abrasive blasting operations) the OH Branch Manager should request that the employer provide written updates documenting the progress of their abatement efforts per §12-51, HAR.

E. NEP Evaluation

Two years from implementation, this NEP will be evaluated by the Administration and Technical Support Branch. To determine its effectiveness, this NEP will be evaluated using data collected from case files and follow-up site visit reports. Other methods may be used to determine the effectiveness of the NEP.

F. <u>IMIS Coding Instructions</u>

For each form that has a Strategic Plan field, "SILICA" will be entered in that field for all inspections.

For inspections which are conducted under this NEP, for each form that has an NEP field, enter "SILICA" in the appropriate field (see below).

Additionally, for situations where crystalline silica is used as the abrasive media when abrasive blasting, Optional Information "ABRASIVE" will be entered on all forms (see below).

OSHA Form	NEP Field		Optional Information				Strategic Plan	
	Item	Value	Item	Type	ID	Value	Item	Value
1	25d	SILICA	42	N	02	ABRASIVE	25f	SILICA
7	50	SILICA	46	N	02	ABRASIVE	52	SILICA
36	36	SILICA	35	N	02	ABRASIVE	38	SILICA
55	15	SILICA	19	N	02	ABRASIVE	17	SILICA
90	30	SILICA	29	N	02	ABRASIVE	32	SILICA

Consultation: Recording silica related visits will be done whenever a visit is made in response to this NEP. For each form that has an NEP field, enter "SILICA" for situations where crystalline silica is used. For situations where crystalline silica is used as the abrasive media when abrasive blasting, Optional Information "ABRASIVE" will be entered on all forms (see below).

	NEP Field		Optional Information			
Form	Item	Value	Item	Type	ID	Value
Request Form-20	25	SILICA	18	N	02	ABRASIVE
Visit Form-30	28	SILICA	22	N	02	ABRASIVE

List of Appendices

Appendix A: Background Information on Silica

This appendix provides an overview of the following silica-related topics: the forms and sources of silica; common industrial uses of silica and workplaces with silica exposure; history of silicosis; and health effects associated with exposure. The reference list at the end of this appendix, as well as the expanded bibliography in Appendix J, provide many sources that may prove useful to those interested in a more in-depth treatment of these topics.

Introduction

"Silica," is a term which refers broadly to the mineral compound silicon dioxide (SiO2). Silica can be crystalline or amorphous. Crystalline silica is significantly more hazardous to employees than amorphous silica. In addition to causing the disabling and irreversible lung disease known as silicosis, crystalline silica has been classified as a human carcinogen by the International Agency for Research on Cancer (IARC) [IARC, 1997]. As it is typically used in this document, "silica" refers specifically to crystalline silica.

Crystalline silica is characterized by a large scale, repeating pattern of silicon and oxygen atoms, as distinguished from the more random arrangement found in amorphous silica. Abundant in the earth's crust, crystalline silica is a basic component of most classes of rock. Naturally-occurring forms of amorphous silica include diatomaceous earth (the skeletal remains of marine organisms) and vitreous silica or volcanic glass [Markowitz and Rosner, 1995; Davis, 1996].

Forms and Sources of Crystalline Silica

Crystalline silica occurs in three primary mineralogical forms, or polymorphs–quartz, cristobalite, and tridymite. Silica is also called "free silica," to distinguish it from the silicates, which are minerals containing silicon dioxide bound to one or more cations [Beckett et al., 1997].

Quartz is by far the most common form of naturally-occurring silica [Davis, 1996; IARC, 1997]. Cristobalite and tridymite, which are molecularly identical to quartz, are distinguishable by their unique crystalline structures. They are less stable than quartz, thus accounting for the dominance of the quartz form. Quartz itself exists as either of two sub-polymorphs, alpha-quartz (also known as low quartz), and beta-quartz (high quartz). Alpha-quartz is the thermodynamically stable form of crystalline silica and accounts for the overwhelming portion of naturally-occurring crystalline silica [IARC, 1997].

Quartz is a major component of soils and is readily found in both sedimentary and igneous rocks, although the quartz content varies greatly from one rock type to another. For instance, granite contains on average about 30 percent quartz, and shales contain about 20 percent quartz. Natural stone, such as beach sand or sandstone, may be nearly pure quartz [IARC, 1997; Davis, 1996].

Cristobalite and tridymite are natural constituents of some volcanic rock, and man-made forms result from direct conversion of quartz or amorphous silica that has been subjected to high temperature or pressure. Diatomaceous earth, composed of amorphous silica, crystallizes during heating (calcining), yielding a calcined product that contains as much as 75 percent cristobalite.

Cristobalite is also found in the superficial layers of refractory brick that has been repeatedly subjected to contact with molten metal [Markowitz and Rosner, 1995; Ganter, 1986; Cheng et al., 1992; Bergen et al., 1994].

Major Industrial Sources of Crystalline Silica Exposure

Crystalline silica is an important industrial material and occupational exposure occurs across a broad range of industries, including mining, manufacturing, construction, maritime, and agriculture (see Appendix B for a listing of industries and Standard Industrial Classifications with potential for significant occupational exposure). Processes associated historically with high rates of silicosis include sandblasting, sand-casting foundry operations, mining, tunneling, and granite cutting.

Crystalline silica, in the form of finely ground quartz sand as an abrasive blasting agent, is used to remove surface coatings prior to repainting or treating, a process that typically generates extremely high levels of airborne respirable crystalline silica. A 1992 report published by the National Institute for Occupational Safety and Health (NIOSH) estimates that there are more than one million U.S. employees who are at risk for developing silicosis, and of these employees, more than 100,000 are employed as sandblasters. Abrasive blasting is performed in a wide variety of different industries; the construction industry employs the largest number of employees as abrasive blasters, concentrated in the special trades [NIOSH 92-102; CDC, 1997].

In addition to abrasive blasting, construction employees perform numerous other activities that may result in significant silica exposure, including tunnel and road construction, excavation and earth moving, masonry and concrete work, and demolition [IARC, 1997]. Foundry employees, primarily in iron and steel foundries, may be exposed to crystalline silica throughout the metalcasting process, including the production of sand-based molds and cores, shakeout and knockout, and finishing and grinding operations.

Crystalline silica, primarily as quartz, is a major component of the sand, clay, and stone raw materials used to manufacture a variety of products, including concrete, brick, tile, porcelain, pottery, glass, and abrasives. The powdered form of quartz, also called silica flour, is used in the manufacture of fine china and porcelain. Finely ground crystalline silica is also used as a functional filler in the manufacture of paints, plastics, and other materials. The rock crystal form of quartz is of great value to the electronics industry.

Agricultural employees perform activities, including plowing and harvesting, that may generate elevated silica levels. However, OSHA does not regulate crystalline silica exposure on farms with fewer than ten employees and exposure data for this population is lacking [Linch et al., 1998]. On the other hand, OSHA does regulate crystalline silica exposure in the agricultural services sector, and crystalline silica exposures have been documented in the sorting, grading, and washing areas of food processing operations for crops such as potatoes and beans. Cristobalite, as calcined diatomaceous earth, is used as a filler in materials such as paints and as a filtering media in food and beverage processing. Maintenance and trades personnel who repair and replace refractory brick linings of rotary kilns and cupola furnaces may be exposed to significant levels of quartz, as well as cristobalite and tridymite. These kilns and furnaces are found in glass, ceramics, and paper manufacturing facilities as well as foundries [Markowitz and Rosner, 1995].

The industries described above, (see Appendix B) represent the major industrial sources of crystalline silica exposure. However, there are numerous other operations in which silica may be used or otherwise encountered, and it is important to be aware of the risk of silicosis in industries not previously recognized to be at risk.

History of Silicosis

Silicosis is one of the world's oldest known occupational diseases; reports of employees with the disease date back to ancient Greece. By 1800, there were numerous common names for the lung disease now known as silicosis. The names frequently referred to the affected laborers' trade, such as grinders' asthma, grinders' rot, masons' disease, miners' asthma, miners' phthisis, potters' rot, sewer disease, and stonemasons' disease. Despite its different names through the centuries, silicosis is a single disease with a single cause–exposure to respirable crystalline silica dust.

During the 1920s, the health risks of the "dusty" trades, in particular the granite industry, emerged as a significant public health concern, and by 1930 silicosis was considered the most serious occupational disease in the United States. During the 1930s and 1940s, the granite industry was the focus of a major effort to alleviate dusty conditions and create a safer working environment [Rosner and Markowitz, 1994]. However, as the more extreme silica hazards were brought under control, attention shifted away from silica to other occupational health hazards. Nonetheless, as the studies described below indicate, in recent decades silicosis has continued to pose a significant health threat to employees in a variety of occupations, including but not limited to construction, foundries, and sandblasting. It is important to be aware of the possible risk of silicosis in workplaces not previously recognized to be at risk.

- Silicosis was listed as the underlying cause of death in 6,322 fatalities in the United States from 1968 through 1990, according to a study reviewing multiple-cause-of-death data from the National Center for Health Statistics. The total number of U.S. deaths with mention of silicosis for that period was 13,744. The study found that 69 percent of the deaths due to silicosis were concentrated in 12 states: California, Colorado, Florida, Illinois, Michigan, New Jersey, New York, Ohio, Pennsylvania, Virginia, West Virginia, and Wisconsin. The construction industry accounted for more than 10 percent of the total silicosis-related deaths, and iron and steel foundries accounted for another 5.4 percent [Bang et al., 1995].
- Death certificates for approximately 868 men and 46 women listed silicosis as the underlying cause of death in non-mining occupations, according to a study that reviewed death certificates for the period 1985 to 1992. The researchers focused on death certificates that provided an entry for indicating the potential for substantial silica exposure, reviewing a total of 411,404 death certificates for men and 30,563 for women [Walsh, 1999].
- A ten-year study (1985 to 1995) of Michigan employees found that nearly 80 percent of the 577 confirmed cases of silicosis occurred in industries in the Standard Industrial Classification (SIC) 3300, Primary Metals, which encompasses iron and steel foundries

  [Rosenman et al., 1997]. In another study, foundry employees whose lungs exhibited radiographic changes consistent with silicosis were concentrated in four primary job assignments: core making, mold making, core knockout, and cleaning/finishing. The study was conducted at a Midwestern gray iron foundry that has produced automotive engine blocks since 1949; the researchers analyzed medical records and silica exposure data for 1,072 current and retired employees with at least five years of employment as of June 1991. Radiographic readings consistent with silicosis were also correlated with the number of years at the foundry, smoking habits, and silica exposure levels [Rosenman et al., 1996].

- In the mid-1990s, there were two cases of accelerated silicosis in relatively young sandblasters following short periods of extremely high crystalline silica exposures. In 1995, a 36-year-old man who had sandblasted oil field tanks in Western Texas for 36 months died from respiratory failure, eleven years after his initial exposure to crystalline silica. A second sandblaster at the same facility, a 30-year-old man who had worked as a sandblaster from 1986 to 1990, died in 1996, ten years after his initial exposure [CDC, 1998]. Both of these sandblasters died from progressive massive fibrosis, an advanced stage of silicosis.

Adverse Health Effects of Crystalline Silica Exposure

Pulmonary silicosis has historically been the disease most well-known as being caused by the inhalation of respirable crystalline silica particles. Additionally, there is evidence that exposure to crystalline silica-containing dusts causes or is associated with the following conditions: lung cancer, tuberculosis, chronic obstructive pulmonary disease (including emphysema and bronchitis), autoimmune diseases or immunologic disorders, chronic renal disease, and subclinical renal changes [NIOSH, 2002].

Silicosis

Silicosis is a fibrotic disease of the lungs caused by the inhalation of crystalline silica dust. It is a type of pneumoconiosis, which is a general term for chronic lung disease that occurs when certain particles are inhaled and deposited deep in the lung.

There are two main types of silicosis, *chronic silicosis* (also called "classical" or "nodular" silicosis) and *acute silicosis*, medically referred to as silico-proteinosis or alveolar lipoproteinosis-like silicosis. Chronic silicosis, by far the most common form of the occupational disease, typically appears 20 to 40 years after initial exposure and tends to progress even after exposure ceases. *Accelerated silicosis* is a variant of chronic silicosis but develops after more intense exposure to crystalline silica; it is characterized by earlier onset (within 5 to 15 years of initial exposure) and more rapid progression of disease than chronic silicosis [Weill et al., 1994].

Acute silicosis results from an overwhelming exposure to silica and the symptoms become manifest in as little time as a few weeks after exposure. Acute silicosis appears to be distinct from the other forms of silicosis, possibly involving an immune mechanism not associated with either accelerated or chronic silicosis. This disease, though rare, is invariably fatal. Outbreaks of acute silicosis have occurred among sandblasters and silica flour mill employees [Peters, 1986].

The development of silicosis is dependent on the size of the crystalline silica dust particle, the dust concentration, and the duration of exposure. Crystalline silica particles smaller than 10 micrometers (□m) in diameter, so-called *respirable* particles, are particularly hazardous, because they easily pass through the tracheobronchial tree and are deposited in the deepest recesses of the lungs, the alveolar structures. Particles larger than 10 □m in diameter are trapped in the nose or the mucous lining of the airway and are removed by the mucociliary escalator.

Chronic silicosis has an early manifestation of a dry or non-productive cough when there is continued exposure to the inhaled irritant. The cough then becomes prolonged and distressing, with sputum production as the disease advances. Initially, breathlessness occurs while exercising, but progresses to shortness of breath during normal activity [Porth, 1994]. Wheezing typically only occurs when conditions such as chronic obstructive bronchitis or asthma are also present. Advanced states of silicosis include pneumothorax and respiratory failure. Respiratory symptoms increase with the progression of silicosis [Wang, 1999].

A rapid increase in the rate of synthesis and deposition of lung collagen has also been seen with the inhalation of crystalline silica particles. The collagen formed is unique to silica-induced lung disease and is biochemically different from normal lung collagen [Olishifski and Plog, 1988].

Silicosis in all its forms is incurable and causes significant impairment or death. Therefore, eliminating or controlling occupational exposure to respirable crystalline silica is critical to prevention of the disease.

Lung Cancer

The International Agency for Research on Cancer [IARC, 1997] classifies crystalline silica inhaled in the form of quartz or cristobalite from occupational source as "carcinogenic to humans (Group 1)." However, in making the overall evaluation, the IARC Working Group noted "that carcinogenicity in humans was not detected in all industrial circumstances studied." The Working Group also stated: "Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs."

The IARC analysis included studies of U.S. gold miners, Danish stone industry employees, U.S. granite shed and quarry employees, U.S. crushed stone industry employees, U.S. diatomaceous earth employees, Chinese refractory brick makers, Italian refractory brick makers, U.K. pottery makers, Chinese pottery makers and cohorts of registered silicotics from North Carolina and Finland. Most of these studies found a statistically significant association between occupational exposure to crystalline silica and lung cancer.

Tuberculosis

Epidemiologic studies have firmly established the association between TB and silicosis. Some studies have indicated that employees who do not have silicosis but who have had long exposures to silica dust may also be at increased risk of developing TB [NIOSH, 2002]. Individuals with chronic silicosis are more susceptible to developing active tuberculosis than the general population. However, it is not clear whether low-level exposure to silica, in cases where silicosis has not developed, also predisposes employees to tuberculosis [Davis, 1996].

Chronic Obstructive Pulmonary Disorder

Epidemiologic studies have shown that occupational exposure to respirable crystalline silica is associated with chronic obstructive pulmonary disease, including bronchitis and emphysema. The findings from some of these studies suggest that emphysema and bronchitis may occur less frequently or not all in nonsmokers. Epidemiologic studies have also found significant increases in mortality from nonmalignant respiratory disease, a category that includes silicosis, emphysema, and bronchitis, as well as some other related pulmonary diseases [NIOSH, 2002].

Immunologic Disorders and Autoimmune Diseases

Several epidemiologic studies have found statistically significant increases in mortality from or cases of immunologic disorders and autoimmune diseases in employees exposed to silica. These disorders and diseases include scleroderma (a rare multisystem disorder characterized by inflammatory, vascular, and fibrotic changes usually involving the skin, blood vessels, joints, and skeletal muscle), rheumatoid arthritis, systemic lupus erythematosus (lupus), and sarcoidosis (a rare multisystem granulomatous disease characterized by alterations in the immune system) [NIOSH, 2002].

Renal Disease

Epidemiological studies report statistically significant associations between occupational exposure to silica dust and several renal diseases or effects, including end-stage renal disease morbidity (including that caused by glomerular nephritis, chronic renal disease mortality, and Wegener's granulomatosis (systemic vasculitis often accompanied by glomerulonephritis) [NIOSH, 2002].

Stomach and Other Cancers

There is some evidence from studies of various occupational groups exposed to crystalline silica of statistically significant excesses of mortality from stomach or gastric cancer. However, most of these studies did not adjust for confounding factors and possible exposure-response relationships were not assessed. Similar issues with confounding and lack of exposure-response assessment exist for the infrequent reports of statistically significant numbers of excess deaths or cases in silica-exposed employees of other nonlung cancers such as nasopharygeal or pharyngeal, salivary gland, liver, bone, pancreatic, skin, esophageal, digestive system, intestinal or peritoneal, lymphopoietic or hematopoietic, brain, and bladder [NIOSH, 2002].

Summary

As these health findings indicate, crystalline silica exposure is associated with a number of diseases, in addition to silicosis. Silica exposure continues to pose substantial risks to employees, centuries after it was first identified as an occupational hazard. The only way to prevent disease is to eliminate exposure to crystalline silica or reduce crystalline silica exposure to safe levels.

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Appendix B: Industries with Potential Overexposure to Crystalline Silica

This appendix contains a list of industries in which employees may be exposed to elevated levels of crystalline silica. The list is based on a review of inspection data from OSHA's Integrated Management Information System (IMIS) for crystalline silica (quartz), for the period January 1996 through March 2007. This table is intended to show the range of industries in which crystalline silica exposure may occur, but should not be considered to be an exhaustive listing. Employee exposure to crystalline silica may occur in industries not listed here. Likewise, crystalline silica exposure does not occur in all establishments encompassed within these North American Industry Classification System (NAICS) or Standard Industrial Classification (SIC) codes.

Industries with Crystalline Silica Exposures, 1996-2007		
1987 SIC Code[1]	1987 SIC Industry Title	2002 NAICS Code[2]
1521	General Contractors – Single Family Houses	236115, 236118
1522	General Contractors – Residential Buildings Other than Single-Family	236115, 236118
1541	General Contractors – Industrial Buildings and Warehouses	23610, 236220
1611	Highway and Street Construction, Except Elevated Highways	237310
1622	Bridge, Tunnel, and Elevated Highway Construction	237310, 237990
1623	Water, Sewer, Pipeline, and Communications and Power Line Construction	237110, 237120, 237130
1629	Heavy Construction, n.e.c.	236210, 237110, 237120, 237310, 237990
1721	Painting and paper Hanging*	237310, 238320
1741	Masonry, Stone Setting, and Other Stone Work	238140
1742	Plastering, Drywall, Acoustical, and Insulation Work	238310
1761	Roofing, Siding, and Sheet Metal Work	238160, 238170, 238390
1771	Concrete Work	238110, 238140, 238990
1794	Excavation Work	238910
1795	Wrecking and Demolition Work	238910
1799	Special Trade Contractors, n.e.c.	236220, 237990, 238150, 238190, 238290
3251	Brick and Structural Clay Tile	327121, 327331
3253	Ceramic Wall and Floor Tile	327122
3255	Clay Refractories	327124
3261	Vitreous China Plumbing Fixtures and China and Earthenware Fittings and Bathroom Accessories	327111
3262	Vitreous China Table and Kitchen Articles	327112
3264	Porcelain Electrical Supplies	327113
3269	Pottery Products, n.e.c.	327112
3271	Concrete Block and Brick	327331
3272	Concrete Products, Except Block and Bricks	327332, 327390, 32799
3273	Ready-Mixed Concrete	327320
3281	Cut Stone and Stone Products	327991
3291	Abrasive Products	327910, 332999
3299	Nonmetallic Mineral Products, n.e.c.	327112, 327420, 327999
3312	Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills	324199, 331111, 331221
3321	Gray and Ductile Iron Foundries	331511
3322	Malleable Iron Foundries	331511
3325	Steel Foundries, n.e.c.	331513

Continued on next page.

Industries with Crystalline Silica Exposures, 1996-2007		
1987 SIC Code[1]	1987 SIC Industry Title	2002 NAICS Code[2]
3334	Primary Production of Aluminum	331312
3365	Aluminum Foundries	331524
3366	Copper Foundries	331525
3369	Nonferrous Foundries, Except Aluminum and Copper	331528
3431	Enameled Iron and Metal Sanitary Ware	332998
3441	Fabricated and Structural Metal*	332312
3443	Fabricated Plate Work (Boiler Shops)*	332313, 332410, 332420
3444	Sheet Metal Work*	332321, 332322, 332439, 333415
3471	Electroplating, Polishing, Anodizing, and Coloring*	332813
3479	Coating, Engraving, and Allied Services, n.e.c.*	332812, 339911, 339912, 339914
3531	Construction Machinery and Equipment*	333120, 333923, 336510
3599	Industrial and Commercial Machinery and Equipment*	332710, 332813, 332999, 333319, 333999, 334519, 336399
3715	Truck Trailers*	336212
5032	Brick, Stone, and Related Construction Materials[3]	423320, 425110, 425120, 444190
7532	Top, Body, and Upholstery Repair Shops and Paint Shops*	811121

*Crystalline silica exposure primarily from abrasive blasting operations

[1] *Standard Industrial Classification Manual*, 1987. Executive Office of the President, Office of Management and Budget.

[2] *North American Industry Classification System,* United States, 2002. Executive Office of the president, Office of Management and Budget.

[3] This industry may be subject to OSHA Instruction CPL 02-00-051 – Enforcement Exemptions and Limitations under the Appropriations Act (or a subsequent version).

Source: Federal OSHA Inspection Data for Silica (Code 9010–Quartz) compiled in the OSHA Integrated Management Information System (IMIS), from 01/01/1996 through 03/31/2007.

Appendix C – Guidelines for Air Sampling

This appendix summarizes the procedures for collecting air samples of respirable crystalline silica, contained in OSHA sampling and analytical method ID-142. Although OSHA ID-142 applies to the collection of quartz and cristobalite, tridymite can also be collected and analyzed using this method if the appropriate reference material and diffraction pattern are used.

Environmental Health Specialists (EHSs) should consult the method directly for detailed information. Additionally, information on respirable dust samplers and crystalline silica sampling is contained in the OSHA Technical Manual, Section II: Chapter I.

Sampling Equipment

1. A 5-μm pore size, 37-mm diameter polyvinyl chloride (PVC) filter, preceded by a 10-mm nylon Dorr-Oliver cyclone, is used with a personal sampling pump for the collection of airborne respirable crystalline silica. Note: SKC metal cyclones shall not be used for sampling respirable dust (OSHA Instruction TED 01-00-015 {TED1-0.15A}). The metal cyclones do not "cut" the appropriate particle size as required by the OSHA standard.

   [Hawai'i's standard does not require that the cyclone meet the fraction size-selector requirements of footnote e in Table Z-3, of §1910.1000, so the Higgins-Dewell (HD) or equivalent cyclone may be used if the NIOSH 7500 analytical method is used in lieu of the OSHA ID-142.]

2. EHSs or OSH-Advisors (Health) may obtain pre-weighed PVC filters by contacting OSHA's Salt Lake Technical Center (SLTC) or Cincinnati Technical Center (CTC). The pre-weighed filter is needed by method ID-142 in order to make a preliminary determination of whether the sample might approach or exceed the permissible exposure limit (PEL) based on an assumption of 100% crystalline silica. Based on this preliminary gravimetric analysis, only samples which may approach or exceed the PEL would be submitted for XRD analysis for quartz, cristobalite and/or tridymite.

Sampling Instructions

1. Calibrate the personal sampling pump to a flow rate of 1.7 liters per minute (L/min), with a representative sampler assembly (cyclone, filter, etc.) in-line. The pump shall be calibrated before and after each use. Refer to the OSHA Technical Manual (OTM), Section II: Chapter 1, for detailed information on pump calibration when sampling with cyclones. The recommended and maximum sampling time is 480 minutes (resulting in a sample air volume of 816 liters at 1.7 L/min.), and the minimum sample time is 240 minutes (408 liters collected at 1.7 L/min.).

2. Before and after each use, clean the cyclone gently, taking care not to scratch it. A leak test must be conducted on a cyclone at least once a month with regular usage. Refer to the OSHA OTM Section 1: Chapter 1. Also, Appendix D summarizes the Cyclone Leak Test Procedure.

3. The cyclone shall be positioned outside of the employee's personal protective equipment but within the breathing zone. Do not allow the cyclone to be inverted during or after sampling. Maintain the cyclone in an upright position until the filter is removed from the cyclone.

4. Check the pump and sampling assembly periodically, to verify pump performance and monitor particulate loading on the sample filter. Filters should be replaced when employees move to another task or activity, or if observation during sampling suggests possible filter overload (greater than 3 mg.). [Note: The EHS should not enter an area while the abrasive blasting operation is active.]

5. When submitting the sample to the laboratory, indicate whether the requested analysis is for quartz, cristobalite, or both. Operations in which the material has been heated to high temperatures generally should be analyzed for both. When other airborne compounds are known or suspected to be present, such information, including the suspected identities, should be provided to the laboratory. Where possible, a copy of the MSDS should be submitted to aid in identifying interferences. Potential analytical interferences are listed in Appendix A of OSHA ID-142. A partial listing follows:

    - Aluminum phosphate
    - Feldspars (microcline, orthoclase, plagioclase)
    - Graphite
    - Iron carbide
    - Lead sulfate
    - Micas (biotite, muscovite)
    - Montmorillonite
    - Potash
    - Sillimanite
    - Silver chloride
    - Talc
    - Zircon (Zirconium silicate).

6. Identify and submit an appropriate blank filter from each lot of filters used.

7. Obtain bulk samples in accordance with standard procedures described in the OTM, Section II: Chapter 1. The bulk sample should be representative of the airborne silica content of the work environment, e.g., from settled dust. A bulk sample of the raw material should be collected to evaluate compliance with the Hazard Communication standard. The type of bulk sample shall be stated on the OSHA-91 form and cross-referenced to the appropriate air samples.

Determining Compliance with the PEL for Respirable Crystalline Silica

Hawai'i's permissible exposure limit, time-weighted-average (PEL-TWA) for silica (Table-202-1, Limits for air Contaminants) is as follows:

Substance	CAS No.	mg/m^3
Silica, crystalline cristobalite (as quartz), respirable dust	14464-46-1	0.05
Silica, crystalline quartz (as quartz), respirable dust	14808-60-7	0.1
Silica, crystalline Tripoli (as quartz), respirable dust	1317-95-9	0.1
Silica, crystalline tridymite (as quartz), respirable dust	15468-32-3	0.05
Silica, fused, respirable dust	60676-86-0	0.1

1. The Salt Lake Technical Center (SLTC) or the Cincinnati Technical Center (CTC), using Method Number ID-142, will report:

   a. % analyte
   b. Mg respirable dust containing analyte, and
   c. Mg respirable dust containing analyte/m^3

2. To determine whether there is an overexposure, compare the PEL with the sample respirable dust results. The severity ratio is determined by the following formula:

$$\text{Severity ratio} = \frac{\text{Respirable dust in sample } (mg/m^3)}{\text{PEL } (mg/m^3)}$$

3. Calculate the Lower Confidence Limit (LCL) by subtracting the Sampling and Analytical Error (SAE) from the severity

$$LCL = Severity - SAE$$

If the LCL is greater than 1, there is a greater than 95% confidence that the sampled employee's exposure exceeded the PEL, and the employee was, therefore, overexposed to respirable dust containing crystalline silica as quartz.

Other factors may have to be considered before arriving at a final exposure value. For example, the Time Weighted Average (TWA) calculation may require combining two or more sample results and adjusting to an 8-hour workday. Consult the OTM, Section II: Chapter 1 for procedures to determine the PEL when the employee is exposed to different types of respirable crystalline silica (i.e., quartz, cristobalite, and tridymite) during the course of a single work shift.

References

Occupational Safety and Health Administration (OSHA), OSHA ID-142, Quartz and Cristobalite in Workplace Atmospheres (XRD), December 1996.

Occupational Safety and Health Administration (OSHA), OSHA Technical Manual TED 01-00-015 (TED 1-0.15A), Section II: Sampling, Measurement Methods and Instruments, Chapter I: Personal Sampling for Air Contaminants, Appendix II:1-5. Sampling for Special Analyses, Samples Analyzed by X-Ray Diffraction, Air Samples, January 20, 1999.

Appendix D: Cyclone Leak Test Procedure

This section summarizes procedures for leak testing of the Dorr-Oliver cyclone samplers used for collecting respirable dust. Further details on this procedure are contained in the Cyclone Leak Test Procedure (CLTP) available through the OSHA Cincinnati Technical Center (OSHA, 1997). Environmental Health Specialists (EHSs) should review the entire leak test procedure before conducting the leak test as summarized below. See the CLTP for more specific procedures regarding leak tests.

Nylon Part Inspection

- Disassemble the cyclone assembly, clean it, and inspect it for cracks and worn fit between parts. Take care not to scratch the inside surface of the cyclone chamber.
- Replace any worn or cracked units or parts.

O-Ring, Tubing, and Filter Leak Test

- Connect the entire cyclone assembly (minus the cyclone body) to the pressure gauge and aspirator, maintaining the normal spacing between the plastic filter adaptor (coupler) and the vortex finder.
- Seal the cyclone vortex finder opening by placing an airtight cap or your fingertip over the hole.
- Hold the cyclone assembly together with one hand.
- With your other hand, squeeze and gently release the aspirator bulb until the pressure gauge reads between 4" H2O and 10" H2O, then fold the tubing halfway between the "Tee" fitting and the aspirator. If the pressure reading is beyond full scale, release the vacuum and try again.
- Observe the pressure gauge reading for 30 seconds. If the pressure drops less than 25 percent, the leakage is acceptable and the unit passes the leak test. If the pressure drops more than 25 percent, corrective action is necessary. Sources of leaks include worn or damaged O-rings, cracked or ill-fitting tubing, and leaky pre-weighed filter cassettes.

Note: Leaks between the filter input and the air sampling pump are more disruptive than leaks at the plastic filter adaptor O-rings.

Final Pump-Fault Leak Test

- Connect the cyclone assembly to the pump in the normal sampling configuration with the air sampling pump running at 1.7 L/min.
- Close the inlet to the cyclone with tape or a finger. If the pump bears down and goes into a fault mode, the assembly passes this final, but crude, pump-fault leak test.

Reference

Occupational Safety and Health Administration (OSHA), Cyclone Leak Test Procedure, OSHA Cincinnati Technical Center. September 15, 1997.

Appendix E: Conversion Factor for Silica PELs in Construction and Maritime

Not applicable to Hawaii

Appendix F: Employee Questionnaire

This questionnaire, when completed, may be considered a medical record and must be used in accordance with 1913.10 - *Rules Concerning OSHA Access to Employee Medical Records*. The questionnaire is intended to provide Environmental Health Specialists (EHSs) with a form they may fill out when interviewing employees to evaluate the employer's medical monitoring program. EHSs should consult with the Occupational Health Branch Manager regarding any findings of potential silicosis.

Date: __________ Company Name: ____________________ Location: ______________

A. Personal Information

Employee's Name: ____________________ Gender: ☐ Male ☐ Female
Current Job Title: ____________________ Age: __________

B. Job-Related Information

Number of hours worked in silica-related tasks per week:
- ☐ 10-20
- ☐ 20-30
- ☐ 30-40
- ☐ More than 40 (________ hours)

List previous jobs and duration of each job:
a. ____________________ (___yrs.)
b. ____________________ (___yrs.)
c. ____________________ (___yrs.)
d. ____________________ (___yrs.)

Time at current job:
- ☐ Six months or less
- ☐ 1-2 yrs
- ☐ 3-5 yrs
- ☐ More than 5 yrs. (________yrs.)

C. Brief Medical History

Are you being treated by a physician for breathing problems? ☐ Yes ☐ No
Have you ever had a chest X-ray? ☐ Yes ☐ No
If yes, when was your last chest X-ray? ______________________________
Why was the chest X-ray taken? ______________________________
Did the doctor tell you everything was normal? ☐ Yes ☐ No
If no, what was noted? ______________________________
What treatment are you receiving for this problem? ______________________
Have you discussed your medical history with your employer? ☐ Yes ☐ No
Are you a cigarette smoker? ☐ Yes ☐ No

Appendix G: Non-Mandatory Medical Monitoring Recommendations for Employees Exposed to Crystalline Silica

A. Recommendations for Baseline Medical Examination

Note: These are recommendations only and are not required by any current OSHA regulation.

It is recommended that a pre-placement baseline medical examination be provided to employees who are potentially exposed to crystalline silica at one-half the permissible exposure limit (PEL) or more. The baseline examination should contain the following elements:

- A medical examination emphasizing the respiratory system, as well as an occupational and medical history; and
- A chest roentgenogram (X-ray), posteroanterior 14" x 17" or 14" x 14", classified according to the 1980 ILO International Classification of Radiographs of Pneumoconiosis (ILO, 1981), and read by a board-certified radiologist or certified class "B" reader (who is qualified to distinguish silicosis from sarcoidosis, asbestosis, coal miner's pneumoconiosis, and other pneumoconioses).

B. Recommended Frequency of Examinations

- It is recommended that a medical examination emphasizing the respiratory system and a chest X-ray be repeated every three years if the employee has less than 15 years of crystalline silica exposure, every two years if the employee has 15 to 20 years of exposure, and annually if the employee has 20 or more years of exposure.
- It is recommended that a chest X-ray be obtained at termination of employment.

Appendix H: EHS Checklist for Conducting Silica-Related Inspections

This non-mandatory checklist is intended as a quick reference tool for Compliance Safety and Health Officers (EHSs) conducting silica-related inspections. The EHS may wish to review the checklist before completing the inspection to make sure that none of the essential elements have been overlooked. The checklist addresses all of the topics discussed in Section VIII(B), Inspection Procedures, of this directive.

____ Employee Exposure Monitoring

- ☐ Sample for Respirable Dust/Silica
- ☐ Leak Test Filters/Cyclones
- ☐ Bulk Samples of Settled Dust
- ☐ Employer's Monitoring Records
- ☐ Other ____________

____ Engineering and Work Practice Controls

- ☐ Location of Employees
- ☐ Ventilation
- ☐ Wet Methods
- ☐ Other _______________

____ Respiratory Protection

- ☐ Written Program
- ☐ Cartridge Selection and Change-out Schedule
- ☐ Medical and Fit Test Records
- ☐ Breathing Air Quality and Use
- ☐ Other ______________

____ Hazard Communication

- ☐ Written Program
- ☐ MSDSs
- ☐ Training
- ☐ Bulk Sample of Products
- ☐ Other __________

____ Symptoms of Silicosis in Workplace

- ☐ Survey/Interview Employees
- ☐ Employees Obtaining Medical Evaluations
- ☐ Other ___________

____ Medical Surveillance

- ☐ Employer Aware of Silicosis Risk
- ☐ Employer identifying Possible Cases
- ☐ Employer Referring Cases to Physician
- ☐ Other _____________

____ Housekeeping and Hygiene Practices

- ☐ Facility Cleanliness
- ☐ Clean-up Methods (Compressed Air, Dry Sweeping?)
- ☐ Change Rooms/PPE Storage
- ☐ Separate Break Areas
- ☐ Other ______________

____ Employee Exposure and Medical Records

- ☐ Employer Monitoring and Medical Records
- ☐ Employee Access and Confidentiality
- ☐ Other _______________

____ Abrasive Blasting (on-site or off-site)

- ☐ Sample for Silica and Metals (including Bystanders)
- ☐ Sample for Noise
- ☐ Ventilation and Dust Containment
- ☐ PPE and Respirators
- ☐ Carbon Monoxide Alarm on Respirator
- ☐ Manual Control of Blast Nozzle Operating Valve
- ☐ Electrical Grounding
- ☐ Pressure Range (90-120 psi)
- ☐ Heat Stress
- ☐ Other____________

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