

Safety topic

Silica

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Overview and applicability

The federal Occupational Safety and Health Administration (OSHA) recently issued new rules to protect workers from occupational exposure to respirable crystalline silica. The original permissible exposure limit (PEL) used by OSHA to protect workers was set in 1971. Studies have shown that the previous PEL was not protective enough to prevent significant risk of developing silicosis, lung cancer, chronic obstructive pulmonary disease, and kidney disease. In addition, new uses for silica, such as stone or artificial countertop fabrication and hydraulic fracturing, have emerged providing new exposure scenarios to address.

Oregon OSHA combined the 2016 federal construction and general industry (including maritime) silica rules into one set of rules applicable to these industries. The rules not only reduce the exposure limit, they take a comprehensive approach to protecting workers by creating an action level and requiring exposure assessments, engineering and other controls, a written exposure control plan, respiratory protection, medical surveillance, regulated/restricted access areas, education and training, and recordkeeping.

SAIF developed this guide to provide employers with knowledge of the health effects and protective measures for controlling exposures to respirable crystalline silica. A step-by-step approach is provided for businesses to use in order to determine applicability of the rules to their organizations and implement efforts to protect worker safety and health.

Oregon OSHA silica rules (437-002-1053 through 437-002-1065) are outlined in this guide.

Resources at the end of the guide include a respirable crystalline silica exposure decision-making process map, appendices that describe requirements based on exposure levels, and an example written silica exposure control plan.

Exemptions from the new respirable crystalline silica rules include:

1. Agricultural operations.
2. Exposures resulting from *processing sorptive clays* (such as kitty litter). This exclusion is based on the fact that this type of silica is typically occluded (blocked with ions) or coated and does not pose the same level of health risks as crystalline silica.
3. Operations where *objective data* demonstrate employee exposures will remain below the 25 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) as an eight-hour time-weighted average (TWA) under any foreseeable conditions.

Step-by-step approach

Follow the steps listed below to ensure you are protecting workers' health and safety and complying with the new requirements.

1. Review your worksite materials and products to determine whether you have the type of regulated (crystalline) silica at your facility or construction site.
2. Review your work activities and conditions of use to determine whether or not exposures to crystalline silica may occur.
3. Review the Oregon OSHA rules on silica (437-002-1053 through 437002-1065).
4. If you have silica at your workplace, clearly identify the staff responsible for developing, implementing, and monitoring the respirable crystalline silica program. If there is an airborne exposure to respirable crystalline silica, monitor the airborne levels by having initial and periodic air sampling conducted. Implement program elements based on air sampling results.
5. Follow the Silica Rule Flowchart Guide to complete your program. (See Appendix 1.)

General information

Silica, or silicon dioxide, is a specific type of silicate and is found as a naturally occurring component of sand, rock, soil, clays, granite, certain minerals, and some living organisms. There are different forms of silica: crystalline and noncrystalline forms (amorphous type). The three types of crystalline silica of concern to human health are quartz (most common), cristobalite, and tridymite.

Silica has been known since ancient times and today is used in many different industrial activities and commercial products. Some industries such as mining, construction, and granite quarrying involve disturbing silica-containing materials. Many industries, including dental labs, pottery and ceramics, glass making, abrasive blasting, and cement production, utilize sand and other silica-containing products.

Health hazards and routes of exposure

Certain factors can affect the potential toxicity of silica. The crystalline form has sharp edges that can damage living tissue. Also, the age of the crystalline particle, the presence of impurities, or coating on the particle surface may either reduce or increase the health hazard. Since workplace settings and types

of silica vary, the exposure risk to workers of a given level of respirable crystalline silica may not be equivalent in different work environments.

Health hazards

Several types of adverse lung health effects have been associated with respirable crystalline silica exposures. Some of these diseases are listed below.

Silicosis

Respirable crystalline silica structures, as opposed to non-crystalline (amorphous) structures, present a unique health hazard. The crystalline silica particles cause lung tissue to react and form fibrotic nodules and scarring around the trapped particles. The formation of these nodules can develop into a disease condition referred to as silicosis, a slowly progressive, irreversible, and potentially fatal disease. Even with cessation of exposure, disease progression can continue once established. There are three types of silicosis; acute, chronic, and accelerated.

Initially, workers with silicosis may have no symptoms. As the disease progresses, however, symptoms begin to emerge. Difficulty breathing, coughing, weight loss, weakness, fever, and night sweats may begin to occur. Significant loss of lung capacity and gas exchange function, and increased airflow obstruction occur in the later stages of silicosis. Respiratory failure may occur with advanced and severe cases. On average, those with silicosis have a life span approximately 11 years shorter than those without the disease (NIOSH, 2008c; NORMS database).

Infectious tuberculosis (TB)

An increased risk for lung infections, including tuberculosis (TB), exists with silicosis due to the reduced immune capacity of the lungs.

Other non-malignant respiratory diseases

Chronic obstructive pulmonary diseases (COPD), such as emphysema and chronic bronchitis, have been observed in silica-exposed workers.

Cancer

The International Agency for Research on Cancer (IARC) has classified respirable crystalline silica as a Group 1 human carcinogen. This means there is sufficient scientific evidence that it causes cancer in humans. The most studied type of cancer associated with inhalation of respirable crystalline silica is lung cancer. However, increases in risk of other cancers such as larynx, nasopharynx, stomach, and esophageal cancer have been suggested in scientific studies.

Kidney and immune system diseases

Several types of kidney disease have been associated with silica exposure. Autoimmune diseases, such as scleroderma, rheumatoid arthritis, and systemic lupus erythematosus, have also been linked to silica exposures.

Any of these conditions make it difficult or even impossible to work and result in significant and permanent functional limitations, reduced quality of life, and sometimes death.

Exposure route

Inhalation is the route of exposure for respirable crystalline silica. In general, silica particles vary in size. Larger particles get entrapped in the nose, throat, larynx, trachea, and bronchi from which they can be expectorated (coughed up) or swallowed into the digestive tract. Respirable-sized particles penetrate deeper into the lungs. Crystalline silica containing substances can become respirable sized particles when workers grind, cut, drill, or crush materials that contain crystalline silica.

Exposures to respirable crystalline silica can also occur when mixing or handling raw materials in other industrial activities if small particles become airborne and are inhaled. For example, cutting open bags that have silica-containing product and pouring out the contents can generate airborne silica dust.

Factors affecting health risk

Research has shown that smoking doubles the negative effects of silica dust exposure. A strong correlation has been reported for increased risk of lung cancer among silica-exposed workers who smoke and have silicosis.

Factors affecting occupational exposure risk

The use of controls in the workplace to prevent exposures to respirable crystalline silica is required when air concentrations are above the permissible exposure limit. However, if these controls are not used or are used improperly, exposure risk increases. Personal protective equipment is often used in conjunction with engineering and other controls to protect workers. When respiratory protection is worn, a proper fit is a significant factor in reducing exposure risk.

Workplace assessment

Material and product review

Many construction sites typically contain well-known sources of silica such as sand, stone, soil, and concrete. Geological surveys can provide some information on soil, rock, and minerals at a construction site.

Products containing silica are used in the construction and general (including maritime) industries. Glass makers, mineral wool manufactures, abrasive blasting operations, and dental laboratories are just a few of the many industries that use silica-containing materials.

Some products that contain silica may not be so commonly known or easily identified. A safety data sheet (SDS) should provide information helpful in determining silica content of manufactured products. The hazard identification

section and/or composition (ingredient) section should include this information. The exposure controls/personal protection section, and/or the toxicological information section should also indicate whether or not silica is in the product and explain potential health effects (such as silicosis or lung cancer). SDSs should have descriptive words that indicate silica content such as the following:

- Crystalline silica
- SiO₂
- Silica dust
- Silica
- Quartz
- Sand

Conditions of use and work activity review

A review of work activities associated with silica-containing products and materials should be conducted. Any activities that may generate airborne dust should be carefully assessed. Some processes use silica bound in a matrix (occluded) or amorphous (non-crystalline) silica. These materials are not the same as crystalline silica particles and are considered not as hazardous. Process knowledge along with product knowledge is essential for assessing the workplace and work tasks for potential risk of crystalline silica exposures.

The respirable crystalline silica standard

Exposure limits

The development and application of an action level (AL) provides a trigger for implementing specific controls and efforts to reduce worker exposures. The AL is 25 micrograms of respirable silica quartz per cubic meter of air (25 µg/m³) averaged over an eight-hour period. The new action level aligns with the American Conference of Governmental Industrial Hygienists (ACGIH[®]) threshold limit value (TLV[®]) which was established in 2009.

The permissible exposure limit is 50 µg/m³ averaged over an eight-hour period. Employers must ensure that no employee is exposed above the established permissible exposure limit (PEL).

Exposure assessment

Employers are required to determine employee exposures to respirable crystalline silica unless one of the specific exposure control methods detailed in Table 1 are used. There are two options provided for assessing employee exposures: the performance option and the scheduled monitoring option.

Performance option

An assessment of employee exposure may consist of objective data and/or air monitoring data that accurately characterizes employee exposures to respirable crystalline silica. An employer must demonstrate through objective data that any material containing silica or any specific process, operation, or activity

involving silica-containing materials cannot release respirable crystalline silica dust in concentrations at or above $25 \mu\text{g}/\text{m}^3$ as an eight-hour TWA under any expected conditions of use.

Objective data means “information, such as air monitoring data from industrywide surveys or calculations based on composition of a substance, demonstrating employee exposure to respirable crystalline silica associated with a particular product or material or a specific process, task, or activity.” The data must reflect work conditions closely resembling or with a higher exposure than the tasks, controls, processes, materials, and/or environmental conditions in the current work activities.

Objective data can consist of monitoring data obtained prior to the effective date of the rule. It can also consist of size-specific real-time monitoring, material information, such as safety data sheets or geoengineering sample analysis, or any other form of alternative information where the definition is satisfied. However, objective data cannot include exposures below the action level due to engineering or other controls in place.

Scheduled monitoring option (a.k.a. periodic monitoring option)

Initial monitoring must first be performed to determine eight-hour TWA exposures for each employee. One or more breathing zone samples must be obtained that represent employees on each shift, job classification, and work area. If there are a number of employees who share the same tasks, shifts, and/or job classification, a representative number of samples can be taken to determine similar exposure groups. If representative sampling is done instead of sampling all employees, the employer shall sample the employee(s) expected to have the highest respirable crystalline silica exposures.

The employer requirements based on initial monitoring results are listed below:

1. If initial monitoring results are below AL ($<25 \mu\text{g}/\text{m}^3$), monitoring may be discontinued for those employees.
2. If initial monitoring results are at or above AL and below PEL ($\geq 25 \mu\text{g}/\text{m}^3$ and $< 50 \mu\text{g}/\text{m}^3$), then monitoring must be repeated within six months of the most recent monitoring event.
3. If initial monitoring results are above the PEL ($>50 \mu\text{g}/\text{m}^3$), then monitoring must be repeated within three months of most recent monitoring.
4. If monitoring results, other than initial sampling results, are below the AL ($<25 \mu\text{g}/\text{m}^3$), then repeat monitoring within six months of most recent monitoring event until two consecutive measurements taken seven or more days apart are below the AL. If this occurs, then monitoring can be discontinued for those employees.

Methods of sample collection and analysis

Employers must ensure that all samples taken to determine employee exposure are *collected* using approved sampling methods (for respirable-sized particles) and *evaluated* by an accredited laboratory that analyzes air samples for respirable crystalline silica according to approved analytical methods.

A link to Oregon OSHA's approved methods of sample analysis is included in the resource section of this guide.

Air sampling results should be reported in total respirable crystalline silica (RCS) which contains analyzed concentrations for quartz, cristobalite, and tridymite forms of silica. The RCS concentration is compared to the exposure limits.

Reassessment of exposures

If changes in the workplace may result in new or additional exposures at or above the action level, a new exposure assessment must be conducted to accurately represent the changed conditions and exposures.

Employee notification of exposure assessment results

Employers must notify all affected employees of the results either by providing individual results in writing or by posting the results in an appropriate, accessible location for all affected employees.

The time requirements for reporting exposure results are listed below:

- Construction employees must receive the results of exposure monitoring within five working days of employer receipt of results.
- All other employees must receive the results of exposure monitoring within 15 working days of employer receipt of results.

Observation of exposure monitoring

Affected employees or their designated representatives must be provided an opportunity to observe any monitoring of employee exposure to respirable crystalline silica.

If entry into a regulated or restricted access area is required to observe monitoring, personal protective equipment and clothing must be provided at no cost to the observer. The employer is required to ensure the observer used the equipment and clothing.

Specified exposure control methods (including Table 1)

Certain tools and equipment used in construction-type work activities can be retrofitted with dust controls. Specific work practices can provide additional dust controls. Wet methods, exhaust ventilation, and enclosures are some examples of specific exposure controls methods to reduce exposure when handling crystalline silica-containing materials.

Indoor and enclosed area tasks

Tasks performed indoors or in enclosed areas must include a means of exhaust to minimize dust accumulation.

Wet methods

Workers can wet surfaces or use equipment with water delivery systems designed to deliver water at the cutting or grinding surface. The water flow rate must be sufficient to minimize the release of visible dust. An example of a wet method is a wet saw used for cutting tile or concrete.

Ventilation

Local exhaust ventilation systems capture dust at the source. This type of dust control method is very efficient when designed for the tool or equipment. High-efficiency particulate air (HEPA) filtration must be used to ensure redistribution of dust does not occur. An example of a ventilation control is a rotary hammer drill equipped with a vacuum and HEPA filter for dust control.

Enclosures

Enclosures provide a barrier to separate the worker from the dust source. Seals must be airtight to provide appropriate dust control. Enclosed cabs or booths on vehicles and large equipment must be under positive pressure and temperature controlled, have airtight seals and gaskets, and have properly functioning doors and closing mechanisms. In addition, the enclosure must have an air intake filter with a minimum efficiency rating value (MERV) rating of 16 or better and be maintained as free from settled dust as practicable. A rock drilling rig with an enclosed cab is an example of a dust control method for a construction activity.

Some specific exposure control methods have been deemed acceptable by Oregon OSHA. These methods are included in Table 1.

Air sampling is not required when construction employees engage in tasks using the specific exposure controls outlined in Table 1.

In addition, air sampling is not required when non-construction employees, such as building maintenance personnel, engage in tasks using the methods in Table 1 as long as:

- The task is indistinguishable from a construction task listed; and
- The task will not be performed regularly in the same environment; and
- The specific controls and respiratory protection are fully implemented according to the table.

NOTE: All other elements of the silica rules apply when using Table 1, (construction or non-construction employees) except for air sampling. This includes training, medical surveillance, control measures, and recordkeeping.

If an employee performs more than one task in Table 1 during their shift, the total duration of tasks must be used to determine the appropriate respiratory protection. For instance, tasks which total less than four hours may use the respiratory protection specified for less than four hours. If the total duration of tasks is greater than four hours, then the respiratory protection must be the level specified in the "> hours/shift" column.

Table 1: Specified exposure control methods

All equipment must be operated and maintained according to manufacturer's recommendations to minimize dust emissions.

Adapted from Oregon OSHA OAR 437-002-1057

Task	Equipment	Control method	Required respiratory protection and minimum assigned protection factor (APF)	
			≤ 4 hours/shift	> 4 hours/shift
Cutting	Stationary masonry saws	Saw equipped with continuous water-feed system	None	None
	Handheld power saws (any blade diameter)	Saw equipped with continuous water-feed system: Used outdoors Used indoors or in enclosed area	None APF 10	APF 10 APF 10
	Handheld power saws for cutting fiber-cement board (blade diameter 8 inches or less)	Outdoor tasks ONLY: Saw equipped with commercially available dust collection system. Dust collector must provide air flow recommended by manufacturer and have a filter with 99% or greater efficiency.	None	None
	Walk-behind saws	Saw equipped with continuous water-feed system: Used outdoors Used indoors or enclosed area	None APF 10	None APF 10
	Drivable saws	Outdoor tasks ONLY: Saw equipped with continuous water-feed system	None	None
	Rig-mounted core saws or drills	Tool equipped with integrated water-delivery system to cutting surface.	None	None

Table 1: Specified exposure control methods (continued)

All equipment must be operated and maintained according to manufacturer's recommendations to minimize dust emissions.
Adapted from Oregon OSHA OAR 437-002-1057

Task	Equipment	Control method	Required respiratory protection and minimum assigned protection factor (APF)	
			≤ 4 hours/shift	> 4 hours/shift
Drilling	Handheld and stand-mounted drills (including impact and rotary hammer drills)	Drill equipped with commercially available shroud or cowling with dust collection system. Dust collector must provide air flow recommended by manufacturer and have a filter with 99% or greater efficiency Use HEPA-filtered vacuum when cleaning holes.	None	None
	Dowel drilling rigs for concrete	Outdoor tasks ONLY: Drill bit equipped with shroud and dust collection system. Dust collector must have a filter with 99% or greater efficiency and a filter-cleaning mechanism. Use HEPA-filtered vacuum when cleaning holes.	APF 10	APF 10
	Vehicle-mounted drilling rigs for rock and concrete	Drill bit equipped with dust collection system and shroud or close capture hood with a low-flow water spray at discharge point from dust collector. OR Drill bit operated from within an enclosed cab and water used for dust suppression on drill bit.	None None	None None

Table 1: Specified exposure control methods (continued)
 All equipment must be operated and maintained
 according to manufacturer's recommendations to minimize dust emissions.
 Adapted from Oregon OSHA OAR 437-002-1057

Task	Equipment	Control method	Required respiratory protection and minimum assigned protection factor (APF)	
			≤ 4 hours/shift	> 4 hours/shift
Chipping	Jackhammers and handheld powered chipping tools	Tool equipped with continuous water delivery at point of contact OR Tool equipped with commercially available shroud and dust collection system. Dust collector must provide air flow recommended by manufacturer and have a filter with 99% or greater efficiency.	None APF 10	APF 10 APF 10
		Used outdoors Used indoors or in enclosed area		
Grinding	Handheld grinder for mortar removal	Grinder equipped with commercially available shroud and dust collection system. Dust collector must provide 25 cubic feet per minute (cfm) or greater of airflow per inch of wheel diameter and have a filter with 99% or greater efficiency and a cyclonic pre-separator or filter-cleaning mechanism.	APF 10	APF 25
	Handheld grinder for uses other than mortar removal	Grinder equipped with integrated, continuous water delivery system that feeds to grinding surface. (Outdoor tasks ONLY) OR Grinder equipped with commercially available shroud and dust collection system. Dust collector must provide 25 cubic feet per minute (cfm) or greater of airflow per inch of wheel diameter and have a filter with 99% or greater efficiency and a cyclonic pre-separator or filter-cleaning mechanism. Used outdoors Used indoors or in enclosed area	None None None	None None APF 10

Table 1: Specified exposure control methods (continued)

All equipment must be operated and maintained according to manufacturer's recommendations to minimize dust emissions.

Adapted from Oregon OSHA OAR 437-002-1057

Task	Equipment	Control method	Required respiratory protection and minimum assigned protection factor (APF)	
			≤ 4 hours/shift	> 4 hours/shift
Milling	Walk-behind milling machines and floor grinders	Machine equipped with integrated continuous water system that feeds water to cutting surface.	None	None
		OR Machine equipped with dust collection system recommended by the manufacturer. Dust collector must provide air flow recommended by manufacturer and have a filter with 99% or greater efficiency and a filter-cleaning mechanism . When used indoors or in enclosed area, HEPA-filtered vacuum used to remove loose dust between passes.	None	None
	Small drivable milling machines (less than halflane)	Machine equipped with water-supplied dust suppression system. Water must be combined with surfactant.	None	None
Large drivable milling machines (half-lane and larger)		For cuts of any depth on asphalt ONLY Machine equipped with exhaust ventilation on drum enclosure and supplemental water sprays to suppress dust.	None	None
		For cuts of four inches in depth or less on any substrate: Machine equipped with exhaust ventilation on drum enclosure and supplemental water sprays to suppress dust.	None	None
		OR Machine equipped with supplemental water sprays to suppress dust. Water must be combined with surfactant.	None	None

Table 1: Specified exposure control methods (continued)

All equipment must be operated and maintained according to manufacturer's recommendations to minimize dust emissions.
Adapted from Oregon OSHA OAR 437-002-1057

Task	Equipment	Control method	Required respiratory protection and minimum assigned protection factor (APF)	
			≤ 4 hours/shift	> 4 hours/shift
Crushing	Crushing machines	Equipment with water spray or mist for dust suppression at crusher and other points of dust generation (e.g., hoppers, conveyers, sieves/sizing, or vibrating components). Ventilated booth that provides fresh, climate-controlled air to operator, or a remote control station.	None	None
Abrading or fracturing	Heavy equipment and utility vehicles used to abrade or fracture silica-containing materials	Operate equipment from within an enclosed cab. Workers outside cab use water or dust suppressants.	None None	None None
Grading or excavating	Heavy equipment and utility vehicles for tasks such as grading and excavating <u>Does not include:</u> Demolishing, abrading, or fracturing silica-containing materials	Water or dust suppressants used. OR Sole operator operates equipment from within enclosed cab.	None None	None None

Regulated and restricted access areas

Fixed sites – regulated areas

Regulated areas must be established at fixed sites where employee exposures to respirable crystalline silica exceed or can be expected to exceed the PEL of 50 $\mu\text{g}/\text{m}^3$.

Regulated areas must also be demarcated from the rest of the worksite to reduce the number of employees exposed to respirable crystalline silica dust. Signs are required at all entrances and must read:

<p>DANGER RESPIRABLE CRYSTALLINE SILICA MAY CAUSE CANCER CAUSES DAMAGE TO LUNGS WEAR RESPIRATORY PROTECTION IN THIS AREA AUTHORIZED PERSONNEL ONLY</p>
--

Access must be limited at regulated areas to authorized personnel only. Authorized personnel consists of employees or contractors required by work duties to be in the area, any designated representative of employees for the purpose of observing monitoring, and anyone authorized by the Occupational Safety and Health Act or regulations issued under it to be in a regulated area.

Respiratory protection must be required for and provided to every authorized person entering a regulated area.

Construction activities – restricted areas

Written procedures

Employers engaged in construction activities or using the specific exposure control methods in Table 1 must have written procedures to restrict work areas where respirable crystalline silica dust is generated and employees may be exposed. These procedures must be included in the written exposure control plan.

Competent person

A competent person must be identified to control access to restricted areas and ensure exposure control procedures are followed at the site. This is an individual who is capable of identifying existing and foreseeable respirable crystalline silica hazards and who has the authorization to implement corrective measures.

Methods of compliance

Engineering and work practice controls

If an employee is exposed to respirable crystalline silica at or above the PEL, the employer must implement engineering and work practice controls (including administrative controls) to reduce and control employee exposures. There are many types of engineering and work practice controls.

Not all possible control methods have been included in the Specified Exposure Control Methods (see Table 1). Manufacturing activities cannot use the Table 1 methods since they are not considered construction or construction-like activities. Wet methods, ventilation, and enclosures are still excellent methods for controlling dust in any environment.

Whenever controls are not feasible to reduce employee exposures to or below the PEL, controls must still be implemented that will reduce employee exposure to the lowest feasible level. Respiratory protection must be provided and used for all activities where feasible controls cannot reduce the exposure to below the PEL or during the time period feasible engineering controls or work practices are being installed or implemented.

Written exposure control plan

A written exposure control plan is required for worksites where respirable crystalline silica exposures are at or above the PEL or when using Table 1. The exposure control plan must include, at minimum, the following elements:

- Task descriptions that involve exposure to respirable crystalline silica in the workplace.
- Engineering controls, work practices, and respiratory protection used to limit employee exposure to respirable crystalline silica for each task
- Housekeeping measures used to limit employee exposure to respirable crystalline silica.
- Annual review, at minimum, of the written exposure control plan to evaluate the effectiveness of the plan. Updates to the plan should be made as necessary.
- Designation of a competent person if employees are engaged in construction activities or if employees are using any of the specific exposure control methods allowed in Table 1 of the standard. The competent person must make frequent and regular inspections of job sites, materials, and equipment to ensure implementation and effectiveness of the written exposure control plan.
- Provision of the written exposure control plan for review, or copies of the plan, upon request to affected employees, designated employee

representatives, and the Director of the Oregon Department of Consumer and Business Services, or designee, and the Director of the National Institute for Occupational Safety and Health (NIOSH), United States Department of Health and Human Services, or designee.

Abrasive blasting

Employers engaged in abrasive blasting activities where blasting agents contain crystalline silica or where abrasive blasting is conducted on substrates that contain crystalline silica must also comply with other Oregon OSHA standards, when applicable. These may include OAR 437-002-1910.94 (Ventilation) or 437003-1926.57 (Ventilation).

Respiratory protection (including Table 2: respiratory protection for silica exposures)

Respiratory protection is required for reduction of employee exposure to hazardous levels of respirable crystalline silica when exposures cannot be feasibly controlled to below the PEL (50 $\mu\text{g}/\text{m}^3$). Respirators are to be provided at no cost to employees and a respiratory protection program is required to be in place in accordance with Oregon OSHA regulations 29 CFR 1910.134. Specific circumstances when the appropriate respiratory protection is required include:

- When feasible engineering or work practice controls are not sufficient to reduce employee exposures to or below the PEL
- During periods when feasible engineering and work practice controls are being installed or implemented
- During certain maintenance and repair tasks where engineering controls and work practices are not feasible
- When specified by an exposure control method listed in Table 1: Specified Exposure Control Methods
- During periods when employees and employee representatives are in a regulated area

Table 2: Respiratory protection for silica exposures

Airborne concentration of respirable crystalline silica or condition of use	Required respiratory protection
At or above 25 $\mu\text{g}/\text{m}^3$ but less than 500 $\mu\text{g}/\text{m}^3$ (Up to 10 x PEL)	Half-mask, air-purifying respirator equipped with high efficiency filters Assigned protection factor (APF) = 10
Above 0.5 mg/m^3 but less than 2.5 mg/m^3 (50 x PEL)	(1) Full-face, air-purifying respirator with high efficiency filters (2) Half-mask powered air-purifying respirator (PAPR) with high efficiency filters APF = 50
Less than 50 mg/m^3 (1,000 x PEL)	(1) Any full-face powered, air-purifying respirator with high efficiency filters (2) Half mask supplied-air respirator operated in positive pressure mode (3) A full-face supplied-air respirator (SAR) or airline respirator in continuous or pressure-demand or other positive-pressure mode APF = 1000
Less than 500 mg/m^3	Full-face or helmet/hood self-contained breathing apparatus (SCBA) in pressure-demand or other positive-pressure mode.
Greater than 500 mg/m^3 or unknown concentration (Up to 10,000 x PEL)	Full facepiece, SCBA in pressure-demand mode. APF = 10,000

Housekeeping

The following practices are prohibited under the silica rule where the activity could contribute to employee exposure to respirable crystalline silica:

- Dry sweeping or dry brushing
- Use of compressed air to clean clothing or surfaces

Wet sweeping, HEPA-filtered vacuuming, cleaning with compressed air with a dust collection system, or other methods of minimizing exposure should be used to clean silica-containing dust.

If none of these methods are feasible, this must be documented and exposures still maintained below the PEL using respiratory protection and other feasible control methods.

Medical surveillance

Medical surveillance must be provided to each employee covered under the silica rule at no cost to the employee and at a reasonable time and place. The following are the requirements for inclusion in the medical surveillance program based on industry:

Construction or construction-like activities

- When using a respirator for 30 or more days per year for Table 1 tasks
- When exposures are at or above the PEL for 30 or more days per year
- When employee is in a regulated area for 30 or more days per year

General industry (non-construction activities)

- When exposures are at or above the PEL for 30 or more days per year (until June 30, 2020)
- When exposures are at or above the AL for 30 or more days per year (after July 1, 2020)

A qualified physician or other licensed health-care professional (PLHCP) who manages silica medical surveillance programs and performs medical exams should have a thorough knowledge of silica-related diseases and health effects.

A qualified NIOSH B-Reader must be utilized to interpret all chest X-rays. The B-Reader certification is a unique certification for physicians and specialists. A classification scheme was created to codify and describe radiographic abnormalities in a simple, systematic, and reproducible manner by the International Labour Organization (ILO), a specialized agency of the United Nations. This type of interpretation and classification has been shown to help in the early detection of silicosis. X-ray analysis alone was estimated to miss about 63 percent of patients who would have otherwise been diagnosed with silicosis.

A list of NIOSH B-Readers can be obtained by accessing the B-Reader list in the resources section of this guide.

The employer is required to provide the PLHCP with a copy of the respirable crystalline silica rule and the information below:

- A description of the employee's former, current, and anticipated duties related to the employee's occupational exposure to respirable crystalline silica
- The employee's former, current, and anticipated levels of occupational exposure to respirable crystalline silica
- Personal protective equipment used or anticipated to be used and the expected time and duration of use
- Previous employment-related medical exams provided to employee and still within control of the employer

Baseline (initial) medical surveillance

The initial employee medical examination must consist of:

- A medical and work history, with emphasis on: past, present, and anticipated exposure to respirable crystalline silica, dust, and other agents affecting the respiratory system; any history of respiratory system dysfunction, including signs and symptoms of respiratory disease (e.g., shortness of breath, cough, wheezing); history of tuberculosis; and smoking status and history;
- A physical examination with special emphasis on the respiratory system
- A chest X-ray [a single posteroanterior radiographic projection or radiograph of the chest at full inspiration recorded on either film (no less than 14 x 17 inches and no more than 16 x 17 inches) or digital radiography systems], interpreted and classified according to the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses by a NIOSH-certified B Reader;
- A pulmonary function test to include forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) and FEV1/FVC ratio, administered by a spirometry technician with a current certificate from a NIOSH approved spirometry course;
- Testing for latent tuberculosis infection; and
- Any other tests deemed appropriate by the PLHCP.

Periodic medical surveillance

Medical exams are required every three years (excluding the TB test) for employees who remain in the medical surveillance program. The PLHCP may recommend a higher frequency for this medical exam based on individual medical and health factors.

PLHCP written medical report for employee

The results of an employee medical exam must be explained to the employee by the PHCLP. A written medical report must also be provided to the employee within 30 days of each medical exam performed. Details for the information required in the written medical report can be found in Appendix A: Medical Surveillance Guidelines on the Oregon OSHA website listed in the resources section.

PLHCP written medical opinion for employer

Employers should obtain a written medical opinion for each covered employee stating the employee has met the requirements to perform their work and any recommended limitations. The employer must provide a copy of the written

medical opinion to the employee within 30 days of the exam. The medical opinion instructions must be followed and may include employee referral to a specialist.

Employee authorization

An employee may provide written authorization to allow for more information to be included in the written medical opinion made available to the employer. The additional information can include recommended limitations on the employee's exposure to respirable crystalline silica and a statement that the employee should be examined by a specialist if chest X-rays are classified as 1/0 or higher by the B Reader or if the PLHCP deems a specialist visit is otherwise necessary.

Communication and training

The elements required for communication to employees must be included in the overall hazard communication program and include at least the health hazards listed below:

- Cancer
- Lung effects
- Immune system effects
- Kidney effects

Training and hazard communication must also include:

- Any other health hazards associated with respirable crystalline silica;
- Specific tasks that could result in exposure and any regulated or restricted access areas;
- Specific protective measures to prevent or reduce exposures;
- Medical surveillance program purpose and description; and
- When a competent person is required and the identity of this person.

Employees must be able to demonstrate knowledge and understanding of the communication and training elements listed above.

A copy of the Oregon OSHA silica rules (437-002-1053 through 437-002-1065) must be made available at no cost to each employee covered by the rules.

Recordkeeping

Employers are required to maintain records according to OAR 437-002-360 (1910.1020) depending on the type of record:

- Exposure records (including objective data records) must be retained for 30 years.

- Medical records must be retained for the duration of employment plus 30 years.

All medical records and exposure assessment records must be made available to employees upon request.

Exposure assessment records

Air monitoring records must include the following information:

- The date of sampling;
- The task(s) evaluated;
- Sampling and analytical methods used;
- The number, duration, and results of samples;
- The identity of the laboratory that performed the analysis;
- The type of PPE used during sampling; and
- The name, social security number, and job classification of all employees represented by the sampling with a note as to which employees actually participated in the sampling. (Note: Oregon OSHA does not enforce the requirement for recording the employee's social security number.)

Objective data records used to determine employee exposures must include at least the following:

- The crystalline silica-containing material used by employees • The source of the objective data
- The results of material testing and the testing protocol used
- Description of the process, task, or activity using the material
- Any other data relevant to the objective data and associated exposures

Medical surveillance records

Records associated with medical surveillance must include the following employee information:

- Name and social security number
- A copy of the PLHCP's and specialists' written medical opinions
- A copy of the information provided to the PLHCPs and specialists

Additional resources

Create-A-Plan to Control the Dust (Silica Exposure Control Plan Online Tool),
The Center for Construction Research and Training; CPWR® 2012
<http://plan.silica-safe.org/>

Developing a Silica Exposure Control Plan, WorkSafe BC
<https://www.worksafebc.com/en/resources/health-safety/books-guides/developing-a-silica-exposure-control-plan?lang=en>

B Reader Information for Medical Professionals, The National Institute for Occupational Safety and Health (NIOSH)
<http://www.cdc.gov/niosh/topics/chestradiography/breader-list.html>

Medical Surveillance Guidelines, Appendix A, as contained in the Oregon OSHA silica rules
<http://osha.oregon.gov/Pages/topics/silica.aspx>

Silica, Crystalline, OSHA Safety and Health Topics
https://www.osha.gov/dsg/topics/silicacrystalline/hazard_recognition_silica.html

OSHA's Proposed Crystalline Silica Rule: General Industry and Maritime, OSHA Fact Sheet
https://www.osha.gov/silica/factsheets/OSHA_FS-3682_Silica_GIM.html

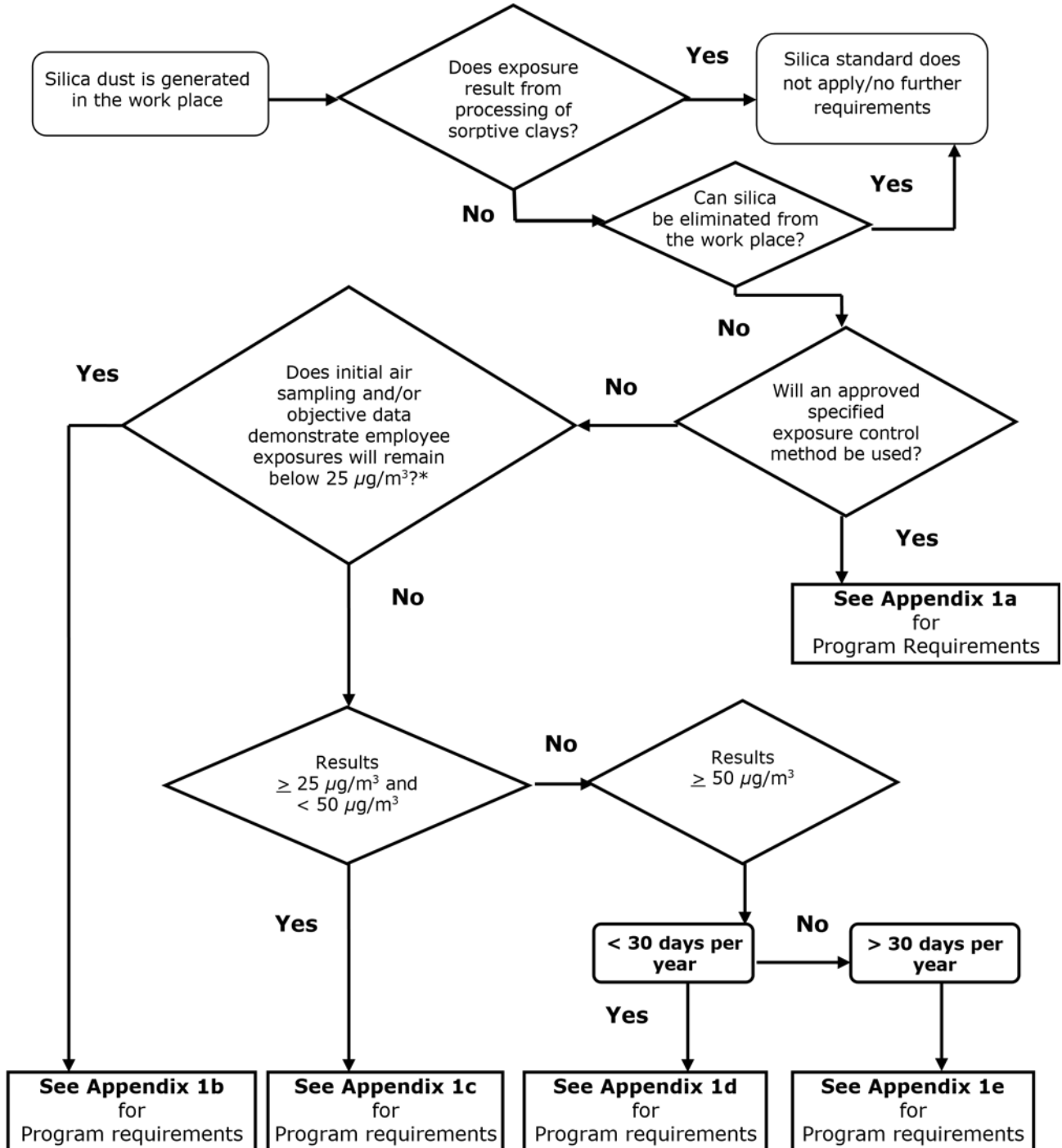
Controlling Silica Exposures in Construction, Federal OSHA, 2009
<https://www.osha.gov/Publications/3362silica-exposures.pdf>

It's not just dust! What you should know about silicosis and crystalline silica, Oregon OSHA, 2015
<http://osha.oregon.gov/OSHAPubs/3301.pdf>

Silica dust control during wall and ceiling grinding, WorkSafe BC Toolbox Meeting Guide
<https://www.worksafebc.com/en/resources/health-safety/toolbox-meeting-guides/silicadust-control-during-wall-and-ceiling-grinding>

Appendix 1: Silica rule flowchart guide

Silica flowchart guide to requirements



Appendix 1a: Requirements when Table 1 specific exposure control methods are used

1. Establish a written exposure control plan that includes the following information:
 - Description of tasks where silica exposures are possible;
 - Control methods used to protect workers;
 - Restricted access areas; and
 - The name and title of the competent person.
2. Designate a competent person to implement the written exposure control plan.
3. Restrict housekeeping practices that expose workers to silica where feasible alternatives are available.
4. Medical surveillance is required for workers who wear a respirator as part of their exposure control for more than 30 days per year per the Table 1 task. Establish a medical surveillance program per 1910.1062. The medical examination must be conducted:
 - Upon initial assignment to work involving respiratory protection for respirable crystalline silica exposure; and
 - Every three years or as recommended by the PLHCP as long as the employee remains in the medical surveillance program.
5. Train employees in the hazards associated with respirable crystalline silica as part of hazard communication training. A copy of the standard must be made readily available without cost to employees. Include the following elements in the training:
 - Health hazards associated with silica exposure, including cancer, lung effects, immune system effects, and kidney effects;
 - Any other health hazards associated with respirable crystalline silica;
 - Specific tasks that could result in exposure and any regulated or restricted access areas;
 - Housekeeping measures to reduce silica dust generation;
 - Other specific protective measures to prevent or reduce exposures;
 - Medical surveillance program purpose and description; and
 - When a competent person is required and the identity of this person.
6. Maintain all records in accordance with 29 CFR 1910.1020.

Appendix 1b: Requirements for using objective data or when air sample results are less than the AL of 25 $\mu\text{g}/\text{m}^3$

1. Record objective data used to determine exposure(s) (if used). Include the following information:
 - a. The silica-containing material encountered/used by employees;
 - b. The source of the objective data;
 - c. Results of all material testing and testing protocol used;
 - d. Description of the process, task, or activity using the material; and
 - e. Any other data relevant to the objective data and associated exposures.

2. Record air sample data (if collected) and include the following information:
 - a. The date of each sample measurement;
 - b. The task(s) evaluated;
 - c. Sampling and analytical methods used;
 - d. The number, duration, and results of samples;
 - e. The identity of the laboratory that performed the analysis;
 - f. The type of PPE used during sampling (including respiratory protection); and
 - g. The name, social security number, and job classification of all employees represented by the sampling with a note as to which employees actually participated in the sampling. (Note: Oregon OSHA does not enforce the requirement for recording the employee's Social Security number.)

3. Maintain all records in accordance with 29 CFR 1910.1020.

4. Notify the affected employees of sampling results by either posting the results in an appropriate location that is accessible to all affected employees or notifying each affected employee individually in writing of the results. For construction employees, notify within five days of receipt of results. For employees other than construction employees, notify within 15 days of receipt of results.

5. Train employees in the hazards associated with respirable crystalline silica as part of hazard communication training. A copy of the standard must be made readily available without cost to employees. Include the following elements in the training:
 - a. Health hazards associated with silica exposure including cancer, lung effects, immune system effects, and kidney effects;
 - b. Any other health hazards associated with respirable crystalline silica;
 - c. Any objective data used to determine exposures;
 - d. Specific tasks that could result in exposure and any regulated or restricted access areas;
 - e. Housekeeping measures to reduce silica dust generation;
 - f. Other specific protective measures to prevent or reduce exposures;
 - g. Medical surveillance program purpose and description; and
 - h. When a competent person is required and the identity of this person.

6. Reassess exposures if changes in the workplace may result in new or additional exposures to respirable crystalline silica at or above the action level. New samples must be collected to accurately represent the changed conditions and exposures.

Appendix 1c: Requirements when air sample results are at or above the AL and less than the PEL ($\geq 25 \mu\text{g}/\text{m}^3$ and $< 50 \mu\text{g}/\text{m}^3$)

1. Repeat exposure monitoring every six months.
2. Notify the affected employees of monitoring results by either posting the results in an appropriate location that is accessible to all affected employees or notifying each affected employee individually in writing of the results. For construction employees, notify within five days of receipt of results. For employees other than construction employees, notify within 15 days of receipt of results.
3. Medical surveillance is necessary for **non-construction employees** if air sample results show respirable crystalline silica exposures at or greater than $25 \mu\text{g}/\text{m}^3$ for more than 30 days per year after July 1, 2020. Establish a medical surveillance program per 1910.1062. The medical examination must be conducted:
 - Upon initial assignment to work involving respirable crystalline silica exposure at or above the action level; and
 - Every three years or as recommended by the PLHCP as long as the employee remains in the medical surveillance program.

The medical exam must include:

- A medical and work history, with emphasis on: past, present, and anticipated exposure to respirable crystalline silica, dust, and other agents affecting the respiratory system; any history of respiratory system dysfunction, including signs and symptoms of respiratory disease (e.g., shortness of breath, cough, wheezing); history of tuberculosis; and smoking status and history;
- A physical examination with special emphasis on the respiratory system;
- A chest X-ray [a single posteroanterior radiographic projection or radiograph of the chest at full inspiration recorded on either film (no less than 14 x 17 inches and no more than 16 x 17 inches) or digital radiography systems], interpreted and classified according to the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses by a NIOSH-certified B Reader;
- A pulmonary function test to include forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) and FEV1/FVC ratio, administered by a spirometry technician with a current certificate from a NIOSH approved spirometry course;
- Testing for latent tuberculosis infection (initial medical exam only); and

- Any other tests deemed appropriate by the PLHCP.
 - Employee medical records must be kept for at least 30 years beyond duration of employment and employees must be granted access to the records in accordance with the OSHA regulation 1910.1020, Access to Employee Exposure and Monitoring Records.
4. Train employees in the hazards associated with respirable crystalline silica as part of hazard communication training. A copy of the standard must be made readily available without cost to employees. Include the following elements in the training:
- Health hazards associated with silica exposure, including cancer, lung effects, immune system effects, and kidney effects;
 - Any other health hazards associated with respirable crystalline silica;
 - Specific tasks that could result in exposure and any regulated or restricted access areas;
 - Housekeeping measures to reduce silica dust generation;
 - Other specific protective measures to prevent or reduce exposures;
 - Medical surveillance program purpose and description; and
 - When a competent person is required and the identity of this person.
5. Continue monitoring until at least two consecutive measurements, taken at least seven days apart, are below the action level. At this time, monitoring can be discontinued for that employee.
6. Repeat monitoring if changes in the workplace may result in new or additional exposures to respirable crystalline silica at or above the action level. New samples must be collected to accurately represent the changed conditions and exposures.

Appendix 1d: Requirements when air sample results are at or above the PEL (> 50 µg/m³) less than 30 days/year

1. Repeat monitoring quarterly.
2. Notify employees of the results of sampling either by posting them in an area that is accessible to all employees or by providing them to each affected employee individually in writing. For construction employees, notify within five days of receipt of results. For employees other than construction employees, notify within 15 days of receipt of results.
3. Provide respiratory protection to employees to reduce and maintain their exposures to respirable crystalline silica to or below the PEL of 50 µg/m³. The use of respirators by employees must comply with the OSHA respiratory protection standard, 1910.134.
4. Establish a regulated area where employee exposures to respirable crystalline silica can reasonably be expected to exceed the PEL. This area must be demarcated from the rest of the workplace in a manner that adequately establishes boundaries and alerts employees of the boundaries of the regulated area.
5. Train employees in the hazards associated with respirable crystalline silica as part of hazard communication training. A copy of the standard must be made readily available without cost to employees. Include the following elements in the training:
 - Health hazards associated with silica exposure including cancer, lung effects, immune system effects, and kidney effects;
 - Any other health hazards associated with respirable crystalline silica;
 - Specific tasks that could result in exposure and any regulated or restricted access areas;
 - Housekeeping measures to reduce silica dust generation;
 - Other specific protective measures to prevent or reduce exposures;
 - Medical surveillance program purpose and description; and
 - When a competent person is required and the identity of this person.

Appendix 1e: Requirements when air sample results are at or above the PEL (> 50 µg/m³) more than 30 days/year

1. Repeat monitoring quarterly.
2. Notify employees of the results of sampling either by posting them in an area that is accessible to all employees or by providing them to each affected employee individually in writing. For construction employees, notify within five days of receipt of results. For employees other than construction employees, notify within 15 days of receipt of results.
3. Implement engineering and work practice controls to reduce and maintain employee exposure to respirable crystalline silica to or below the PEL, unless it can be demonstrated that they are not feasible.
4. Wherever feasible engineering and work practice controls are not sufficient to reduce employee exposures to or below the PEL, they must be used to reduce the exposures to the lowest levels achievable, and then must be supplemented with the use of respiratory protection. The use of respirators by employees must comply with the OSHA respiratory protection standard, 1910.134.
5. Establish a medical surveillance program (see 1910.1062). The medical examination must be conducted:
 - Upon initial assignment to work involving respirable crystalline silica exposure at or above the action level; and
 - Every three years or as recommended by the PLHCP as long as the employee remains in the medical surveillance program.

The medical exam must include:

- A medical and work history, with emphasis on: past, present, and anticipated exposure to respirable crystalline silica, dust, and other agents affecting the respiratory system; any history of respiratory system dysfunction, including signs and symptoms of respiratory disease (e.g., shortness of breath, cough, wheezing); history of tuberculosis; and smoking status and history;
- A physical examination with special emphasis on the respiratory system;
- A chest X-ray [a single posteroanterior radiographic projection or radiograph of the chest at full inspiration recorded on either film (no less than 14 x 17 inches and no more than 16 x 17 inches) or digital radiography systems], interpreted and classified according to the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses by a NIOSH-certified B Reader;

- A pulmonary function test to include forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) and FEV1/FVC ratio, administered by a spirometry technician with a current certificate from a NIOSH approved spirometry course;
- Testing for latent tuberculosis infection (initial medical exam only); and
- Any other tests deemed appropriate by the PLHCP.

Employee medical records must be kept for at least 30 years beyond duration of employment and employees must be granted access to the records in accordance with the OSHA regulation 1910.1020, Access to Employee Exposure and Monitoring Records.

6. Train employees in the hazards associated with respirable crystalline silica as part of hazard communication training. A copy of the standard must be made readily available without cost to employees. Include the following elements in the training:
 - Health hazards associated with silica exposure, including cancer, lung effects, immune system effects, and kidney effects;
 - Any other health hazards associated with respirable crystalline silica;
 - Specific tasks that could result in exposure and any regulated or restricted access areas;
 - Housekeeping measures to reduce silica dust generation;
 - Other specific protective measures to prevent or reduce exposures;
 - Medical surveillance program purpose and description; and
 - When a competent person is required and the identity of this person.

Appendix 2: Example written exposure control plan

[Company Name] Silica written exposure control plan				
Address/location	Date range for plan:	Contact information: (competent person or area supervisor)		
Regulated and/or restricted area(s):				
Silica-containing materials encountered or used:				
_____ _____ _____ _____				
Task	Specific exposure control method (from approved methods Table 1)	Engineering controls	Administrative controls (including work practices and cleaning methods)	Personal protective equipment (including respiratory protection)