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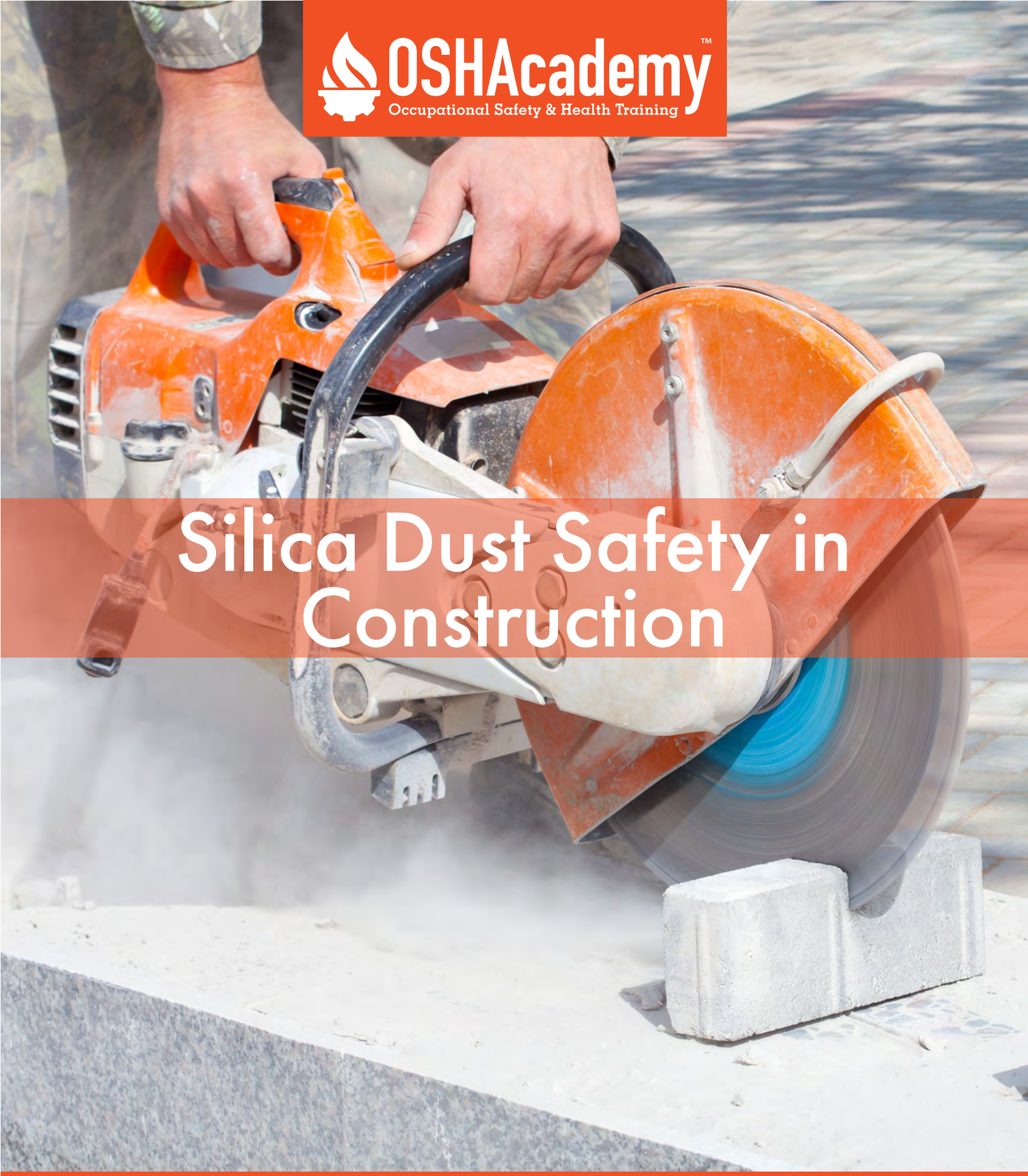

Silica Dust Safety in Construction

About two million construction workers are exposed to respirable crystalline silica in more than 600,000 workplaces. This course discusses provisions of OSHA's respirable crystalline silica rule with special emphasis on effective control measures eliminate or reduce exposure to safe levels.

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OSHAcademy Course 851 Study Guide

Silica Dust Safety in Construction

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 851.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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Course Introduction

Crystalline silica commonly occurs in nature as the mineral quartz. It is found in granite, sandstone, quartzite, various other rocks, and sand. Workers who inhale very small crystalline silica particles are at risk for silicosis – an incurable, progressively disabling and sometimes fatal lung disease.

About 2.3 million workers are exposed to respirable crystalline silica in their workplaces. About two million construction workers are exposed to respirable crystalline silica in more than 600,000 workplaces. OSHA estimates more than 840,000 of these workers are exposed to silica levels that exceed the permissible exposure limit (PEL).

OSHA's 29 CFR 1926.1153, Respirable crystalline silica for general industry and maritime requires employers to limit worker exposures to respirable crystalline silica and to take other steps to protect workers.

Among other things, the standard requires employers to:

- Assess employee exposures to silica if it may be at or above an action level of 25 µg/m3 (micrograms of silica per cubic meter of air), averaged over an 8-hour day;
- Protect workers from respirable crystalline silica exposures above the permissible exposure limit (PEL) of 50 µg/m3, averaged over an 8-hour day;
- Limit workers' access to areas where they could be exposed above the PEL;
- Use dust controls to protect workers from silica exposures above the PEL;
- Provide respirators to workers when dust controls cannot limit exposures to the PEL;
- Use housekeeping methods that do not create airborne dust, if feasible;
- Establish and implement a written exposure control plan that identifies tasks that involve exposure and methods used to protect workers;
- Offer medical exams - including chest X-rays and lung function tests - every three years for workers exposed at or above the action level for 30 or more days per year;
- Train workers on work operations that result in silica exposure and ways to limit exposure; and

- Keep records of exposure measurements, objective data, and medical exams.

In this course, we'll discuss these new provisions with special emphasis on effective control measures eliminate or reduce exposure to safe levels.

Module 1: The Basics

Silica is more than just dust

Silica dust can be generated at dangerous levels anytime materials such as ceramics, concrete, masonry, rock and sand are mixed, blasted, chipped, cut, crushed, drilled, dumped, ground, mixed or driven upon.

Employees at construction sites may be exposed to silica dust during general housekeeping activities such as sweeping, emptying vacuum cleaners, and using compressed air for cleaning.

Silica exposures may also occur whenever silica-containing dust is disturbed, such as during material handling. The small particles generated during these activities easily become suspended in the air and, when inhaled, penetrate deep into employees' lungs.

Quartz

Quartz is the most common form of crystalline silica. In fact, it is the second most common surface material accounting for almost 12% by volume of the earth's crust. Quartz is present in many materials in the construction industry, such as brick and mortar, concrete, slate, dimensional stone (granite, sandstone), stone aggregate, tile, and sand used for blasting. Other construction materials that contain crystalline silica are asphalt filler, roofing granules, plastic composites, soils, and to a lesser extent, some wallboard joint compounds, paint, plaster, caulking and putty.

Cristobalite and Tridymite

Cristobalite and tridymite are natural constituents of some volcanic rock. Man-made forms result from 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 have repeatedly been subjected to contact with molten metal.

Visible and Respirable Dust

Visible dust contains large particles that are easy to see.

Respirable dust particles pose the greatest risk because they are not visible. They are are so small they can get into the deep lung.

When exposed to silica dust, it's important to remember the following:

- Most dust-generating construction activities produce a mixture of visible and respirable particles.
- You should use visible dust as a general guide for improving dust suppression efforts. If you see visible dust being generated, emissions of respirable silica are probably too high.
- Methods that control tool-generated dust at the source can reduce all types of particle emissions, including respirable particles.
- Do not rely only on visible dust to assess the extent of the silica hazard. There may be more airborne respirable dust present that is not visible to the naked eye.

Written Exposure Control Plan (ECP)

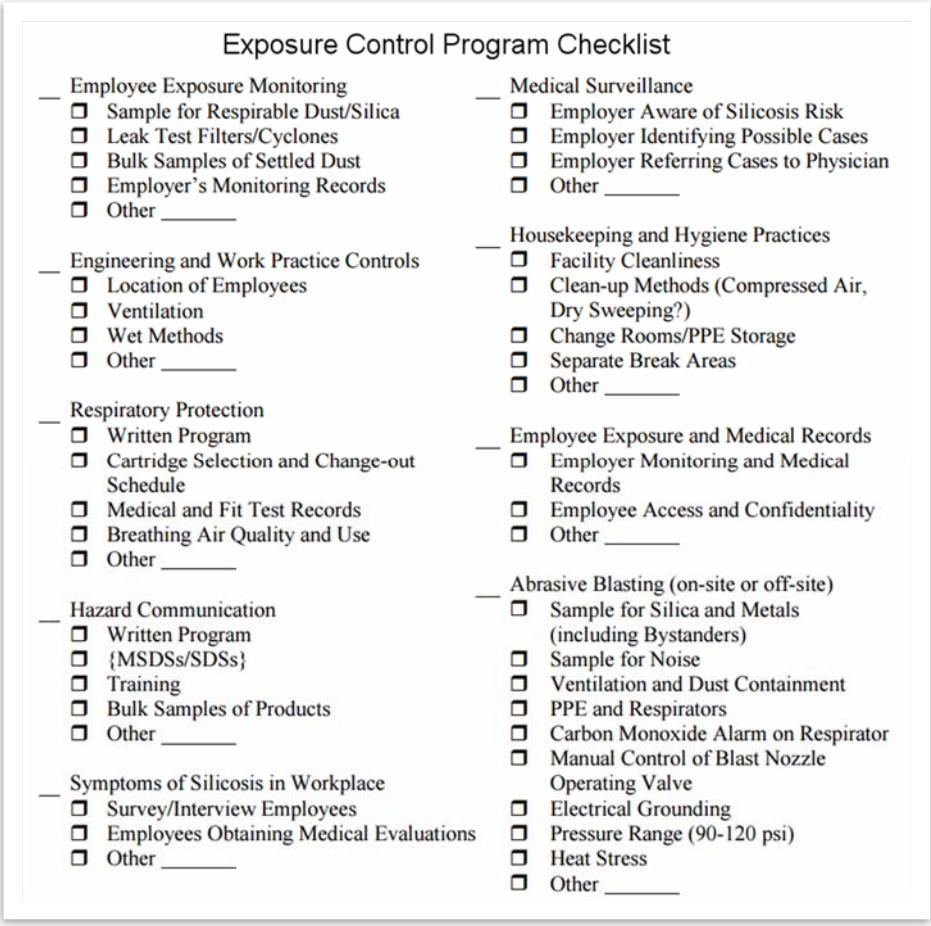
The first step, and a very important OSHA requirement, in making sure exposure to silica dust is controlled is to design, development, and deploy of an effective Exposure Control Plan (ECP).

- The components of an effective ECP should include at least the following elements:
    - A description of the tasks in the workplace that involve exposure to respirable crystalline silica;
    - A description of the engineering controls, work practices, and respiratory protection used to limit employee exposure to respirable crystalline silica for each task;
    - A description of the housekeeping measures used to limit employee exposure to respirable crystalline silica; and
    - A description of the procedures used to restrict access to work areas, when necessary, to minimize the number of employees exposed to respirable crystalline silica and their level of exposure, including exposures generated by other employers or sole proprietors.

- The employer should review and evaluate the effectiveness of the written exposure control plan at least annually and update it as necessary.
- The employer should make the written exposure control plan readily available to each employee and their designated representatives.
- The employer should designate a competent person to make frequent and regular inspections of job sites, materials, and equipment to implement the written exposure control plan.

ECP Evaluation

It is important to conduct regular inspections in general industry workplaces and construction worksites for silica dust exposures, and evaluations of the ECP. To help ensure an effective ECP and positive OSHA enforcement inspections, be sure to check and evaluate the areas in the checklist below:



Exposure Control Program Checklist

__ 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/SDSs}
- ❒ Training
- ❒ Bulk Samples 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 _____

Module 1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Silica dust may be generated anytime masonry or rock are _____.**

    a. blasted, cut, or drilled
    b. rolled, painted, or moistened
    c. mixed with a surfactant
    d. demolished or washed

2. **What is the most common form of silica?**

    a. Dolomite
    b. Quartz
    c. Tridymite
    d. Cristobalite

3. **What indicates that the level of respirable silica is probably too high?**

    a. eye irritation
    b. OSHA PEL
    c. visible dust
    d. difficult breathing

4. **What is the first step, and a very important OSHA requirement, in making sure exposure to silica dust is controlled?**

    a. design, development, and deploy an Exposure Control Plan (ECP)
    b. stop all operations that might produce exposure to silica dust
    c. wait until OSHA has approved the respiratory protection plan (RPP)
    d. always use wet methods during masonry operations

5. **Who should make frequent and regular inspections under the exposure control program (ECP)?**

    a. General contractor
    b. Safety Manager
    c. OSHA consultant
    d. Competent Person

Module 2 - Exposure to Silica Dust

Exposure to fine particles of silica while cutting, drilling, and blasting has been shown to cause silicosis, a serious and sometimes fatal lung disease. Construction employees who inhale fine particles of silica may be at risk of developing this disease. The small particles easily become suspended in the air and, when inhaled, penetrate deep into employees' lungs.

Although the primary effect of overexposure to silica dust is silicosis, let's not forget employees may also suffer from lung, stomach and other cancers, tuberculosis, chronic obstructive pulmonary disorder, immune system effects, and kidney effects. The only way to prevent disease is to eliminate exposure to crystalline silica or reduce crystalline silica exposure to safe levels.

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, many common names for the lung disease, such as "masons' disease" were given to silicosis. Despite its different names through the centuries, silicosis is a single disease with a single cause–exposure to respirable crystalline silica dust.

There are three types of silicosis, depending upon the airborne concentration of crystalline silica to which a worker has been exposed:

1. **Chronic/classic silicosis**, the most common form of the disease, occurs after 15-20 years of moderate to low exposures to respirable crystalline silica. Symptoms associated with chronic silicosis may or may not be obvious; therefore, workers need to have a chest x-ray to determine if there is lung damage. As the disease progresses, the worker may experience shortness of breath upon exercising and have clinical signs of poor oxygen/carbon dioxide exchange. In the later stages, the worker may experience fatigue, extreme shortness of breath, chest pain, or respiratory failure.

2. **Accelerated silicosis** can occur after 5-10 years of high exposures to respirable crystalline silica. Symptoms include severe shortness of breath, weakness, and weight loss. The onset of symptoms takes longer than in acute silicosis.

3. **Acute silicosis** occurs after a few months or as long as two years following exposures to extremely high concentrations of respirable crystalline silica. Symptoms of acute silicosis include severe disabling shortness of breath, weakness, and weight loss, which often leads to death.

Symptoms of Exposure

Chronic silicosis may go undetected for years in the early stages; in fact, a chest X-ray may not reveal an abnormality until after 15 or 20 years of exposure. The body's ability to fight infections may be overwhelmed by silica dust in the lungs, making workers more susceptible to certain illnesses, such as tuberculosis. As silicosis progresses, you may exhibit one or more of the following symptoms:

- shortness of breath following physical exertion
- severe cough
- fatigue
- loss of appetite
- chest pains
- fever

If You Are Exposed

If you believe you are overexposed to silica dust, visit a doctor who knows about lung diseases. A medical examination that includes a complete work history, a chest X-ray, and lung function test is the only sure way to determine if you have silicosis. The National Institute of Occupational Safety and Health (NIOSH) recommends medical examinations occur before job placement or upon entering a trade, and at least every 3 years thereafter.

Exposure Limits

Permissible Exposure Limit (PEL): OSHA regulates silica exposure using the permissible exposure limit, which is the maximum amount of airborne dust an employee may be exposed to during a full work shift.

As of June 23, 2016, the PEL for an airborne concentration of respirable crystalline silica is 50 micrograms per cubic meter (µg/m3) of air calculated as an 8-hour time-weighted average (TWA). The employer should make sure workers are not exposed to silica dust levels above the PEL. Construction companies have one year to comply with this new standard.

Action level: OSHA requires construction employers to "take action" to any exposures to respirable crystalline silica where employee exposure may reach or exceed the Action Level which is 25 µg/m3 as an 8-hour TWA under any foreseeable conditions.

Remember, there is potential for danger ONLY when crystalline silica particles are in the air. There may be materials that contain silica, but if the operations on those materials do not generate dust, there is little chance of inhaling the silica. Likewise, there may be silica particles in the air even though you don't see any dust.

Measuring Airborne Silica

If it is known or suspected silica is being used and it may be in the air, the next step is to determine how much is there. To do that, sample the air during the work being conducted.

Collecting an Air Sample: A trained specialist, such as a certified industrial hygienist, will use a combination device called a cyclone assembly and a sampling pump to trap tiny respirable silica particles from the air in the work environment.

- The cyclone assembly and sampling pump will be placed on an employee, who will wear the device throughout the work shift for up to 8 hours.
- All employees may be fitted with the sampling device or just a select few who are closest to the silica source may be fitted. The industrial hygienist can help you determine what will be most appropriate.
- The hygienist will return at the end of the sampling period to de-activate the sampling pump and remove the filters to be sent for analysis.

Laboratory Analysis: After collecting the air sample, the next task is to select a competent laboratory that does quality analysis work. This is critical to determining compliance with the OSHA crystalline silica standard. The work in monitoring exposure is wasted if samples are mishandled or analyzed incorrectly.

Comparing Exposure Results to OSHA's Limit

It is important to know there is not one crystalline silica exposure limit for all cases. Rather, the limit is derived from a calculation that takes into account the percentage of quartz, cristobalite, tridymite, and respirable dust specific to your particular worksite.

OSHA regulation 29 CFR 1910.1000 Table Z-3 is used to determine the exposure limits for crystalline silica. Though this regulation is under the General Industry Standard, crystalline silica exposures in the Construction and Maritime Industries are subject to this same limit. Regulating

these industries under the General Industry Standard is specifically addressed in Appendix E of the OSHA Special Emphasis Program (SEP) for Silicosis.

If you are a math whiz, you can calculate the degree of exposure to which employees are exposed by following the instructions on OSHA's "Determining Exposure Limits for Silica" webpage.

However, we recommend using OSHA's "Advisor Genius" to compare silica levels to the OSHA Limit. The Genius performs calculations for a respirable dust sample. Note: The Advisor Genius has been written using JavaScript. If your software does not support this, the Genius will not operate properly.

Module 2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **What serious disease is caused by exposure to fine particles of silica?**

    a. Salmonella
    b. Silicosis
    c. Silicitis
    d. Sarconosis

2. **Which of the following occurs after 15-20 years of moderate to low exposures to respirable crystalline silica?**

    a. Accelerated silicosis
    b. Long-term Acute silicosis
    c. Acute silicosis
    d. Chronic/classic silicosis

3. **What is the only sure way to determine if you have silicosis?**

    a. A medical examination
    b. Accurate exposure measurements
    c. The type of work being performed
    d. Severity of symptoms at work

4. **What is the measurement OSHA uses to regulate silica dust exposure during a full workshift?**

    a. Time-Limited Value (TLV)
    b. OSHA Exposure Limit (OEL)
    c. Acceptable Exposure Value (AEV)
    d. Permissible Exposure Limit (PEL)

5. **What is the procedure to determine how much silica dust is present?**

    a. Sample the air
    b. Sample the material
    c. Sample the water
    d. Sample the blood

Module 3: Silica Dust Control Strategies

Controlling the exposure to silica in construction can be done by applying engineering controls, administrative actions, and personal protective equipment (PPE), similar to practices in other industries. These prioritized control strategies are called the "Hierarchy of Controls."

1. Engineering controls include strategies that eliminate or reduce the hazard (silica dust) itself. Examples include such things as treating material so it does not create dust, replacing silica with another material, isolating, containment, and using ventilation systems.

2. Administrative/work practice controls include limiting workers' exposure time and providing showers.

3. Use of personal protective equipment (PPE) includes wearing proper respiratory protection and protective clothing.

In this module, we will discuss these control strategies in more detail. It is important to know to best control exposure to silica dust, a higher priority control strategy may actually be less effective. For more information on the Hierarchy of Controls, check out Course 704, Hazard Analysis and Control, Module 5.

Engineering Controls

As mentioned earlier, if possible, we want to do something about the hazard first. Then we don't have to worry so much about employee behaviors. Engineering controls attempt to do that.

If silica products are used, OSHA requires engineering controls to be used first wherever possible. This type of control involves a mechanical process to eliminate or reduce the amount of silica dust.

The most effective way to eliminate the silica hazard is to eliminate the silica! Doing that is not possible for many masonry operations, but engineering controls are possible and especially important for many applications.

For instance, where abrasive blasting is done outside, substitution of silica with some other material can be used. Substituting the silica means using a different, safer material, like plastic beads, corn cobs, walnut shells, etc., in place of the silica-containing substance.

There are two basic types of engineering control methods:

1. **Wet methods**: As we mentioned earlier, wet methods for cutting, drilling, hammering and grinding is the most effective method for controlling airborne silica dust because it controls the exposure at its source. In most cases, wet methods keep exposures below the allowable limit.

2. **Dry methods:** The most common dry control method is vacuum dust collection (VDC). This engineering control method can significantly reduce silica levels, but may not reliably keep them below 0.1 mg/m3 as an 8-hour TWA. VDCSs include a dust collector (hood or shroud), vacuum, hose and filter(s).

Wet Methods

- **Cutting:** Wet cutting is the most effective method for controlling silica dust generated during sawing because it controls the exposure at its source. Wet dust is less able to become or remain airborne. Wet masonry saw operators' exposures usually well below 0.1 mg/m3.

  Most stationary saws come equipped with a water basin that typically holds several gallons of water and a pump for recycling water for wet cutting. Handheld saws spray water that is held in separate containers.

- **Drilling:** Wet drilling systems pump water through the drill stem to prevent dust from being released into the air. The drill operator controls the flow using a control valve. Some drills are equipped with a flow meter.

- **Hammering:** Wet methods are generally not appropriate for use with electric rotary hammers; however, pneumatic drills can be used for wet drilling and some come equipped with water-feed capability.

  The best way to control silica dust when using a jackhammer is with wet methods, where water is constantly sprayed to reduce the amount of dust that gets into the air.

Wetting the surface with a spray or mist of water at the point where the jackhammer's tip strikes the surface material helps reduce the amount of airborne dust.

- **Grinding:** Wet grinding is highly effective in reducing silica exposures. Water provides excellent dust control during tasks involving abrasive action on concrete. When applied at the point where dust is generated, water wets the dust particles before they can become airborne. Wet methods consistently keep employee exposures below OSHA limits.

Dust Suppression

Dust suppression is a wet dust control method that can be applied to many different operations, such as materials handling, rock crushing, abrasive blasting and operation of heavy construction vehicles.

- **Pre-wetting surfaces:** When blasting, a separate water hose can be strung next to the hose containing the blasting medium. When using heavy construction vehicles on unpaved surfaces, a water truck can spray the site grounds.
- **Fogging Methods:** Fog, fine particles of water, can be an effective dust suppressant in certain situations because it provides a larger contact area than do water sprays. Fog is most effective when the water droplets are approximately the same size in diameter as the dust particles to be suppressed. The dust particles stick to the water droplets. The added weight prevents the particles from remaining suspended in the air.
- **Steam Methods:** Steam is the gaseous state of water. Like fog, steam can reach a larger contact area than sprayed water. Also like fog, steam can visually restrict operations and condense on surfaces.
- **Electrostatic Charging**: Particles from most industrial dust clouds possess either a positive or negative charge. Electrostatic water sprays may enhance dust removal by attracting oppositely-charged dust particles to the charged water droplets.
- **Surfactants and Other Soil-Binding Materials:** A surfactant is a highly concentrated soap or detergent that can be added to water to help control dust. Surfactants are often referred to as "wetting agents." Surfactants break the surface tension of water, allowing the water to penetrate deeper, to better saturate the dust particles and slow evaporation. When using surfactants on a ground surface (soil), the surface stays moist longer and fewer water applications are needed.

- **Organic Resin Emulsions:** Organic resin emulsions are natural resins, emulsified in liquid form such as pine tree sap. They bind and adhere to dust particles as they cure and create a surface crust.

Dry Control Methods

Cutting: When wet methods cannot be used, one alternative is the use of vacuum dust collection (VDC) systems. Stationary masonry and hand-held saws with VDC systems are commercially available and have the ability to capture a substantial amount of dust.

With these systems, a vacuum pulls dust from the cutting point through special fittings connected directly to the saw (fixed-blade saws) or, alternatively, through a dust collection device connected to the back of the saw. A dust collector mounted to the back of a saw requires a high exhaust airflow to ensure good dust capture between the saw blade and dust collector.

Drilling: Dry collection systems require an enclosure around the area where the drill stem enters the ground. The enclosure is made by hanging a rubber or cloth shroud from the underside of the drill deck. The enclosure is ducted to a dust collector that has a fan outside of the filter opposite the drill hole. The fan creates a negative pressure inside the enclosure capturing dust as it leaves the hole during drilling.

Rock drilling equipment should use enclosed positive-pressure cabs with air conditioning and filtered air supply to isolate the operator from the dust. Older cabs can be retrofitted with systems that filter, heat, and cool the air.

Grinding: Vacuum dust collection systems for grinders include a shroud, which surrounds the grinding wheel, hose, filters and a vacuum to pull air through the shroud. Many manufacturers offer grinders with dust collection options. Employers may also purchase equipment to retrofit grinders for vacuum dust collection.

Hammering: Vacuum dust collection systems are the primary way to control dust when using rotary hammers. The drill bit is surrounded by a shroud attached to a vacuum to collect dust and bits of concrete. VDCSs are available in a variety of designs and should include a dust collection device (shroud), vacuum, hose and filter(s).

Blasting: 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. To

minimize exposure during dry abrasive sand blasting, dust collection systems can be installed on the equipment. Also, the workspace may be enclosed, or ventilation hoods may be used.

Isolation, Containment and Ventilation

Isolation: Methods can be used to isolate or increase the distance between the employee and the point of work can reduce exposure levels. For instance, modifications in construction work methods for pouring, casting, finishing and installing concrete can reduce the amount of grinding required, which, in turn, can lower exposures.

Employee Positioning: Where possible, exposures can be reduced if employees work from a position that minimizes exposure. For instance, greater distance from the grinding point, especially when grinding on ceilings and sanding drywall when the dust can fall directly on the employee.

If the grinder is attached to an adequately supported pole, the employee can manipulate the grinder at a distance from one side where the dust is less concentrated. While this method does not eliminate exposure, it can help reduce the amount of dust in the employee's breathing area.

Ventilated containment structures: Exhaust ventilation systems in containment structures can be effective in capturing and removing silica dust. However, task requirements may make this method infeasible. Both the structure and exhaust systems should be properly designed to be effective.

Ventilation Booths: A booth (with fan) erected around a saw can help reduce dust, but may require some experimentation. For example, one employer built a plywood booth around the saw and installed a large exhaust fan at the rear wall to pull dust away from the employee, who operated the saw through an opening in the front of the booth.

Fans: Fans are not effective dust control devices when used as the sole control method and should not be used as the primary method for managing dust. Fans can, however, be useful as a supplement to other control methods. Use fans in enclosed areas, such as bathrooms, where dust would build up due to poor air circulation.

Vacuums for general cleaning: Vacuums offer a versatile option for collecting dry debris from smooth and uneven surfaces, cracks, expansion joints and irregular shapes. Wet/dry vacuums can also collect water, slurry, and damp materials. Use pneumatic vacuums where electricity is not available.

Vacuums do not produce the clouds of dust often generated during dry sweeping or blowing with compressed air, but they are not dust-free. Vacuum cleaners with inadequate or damaged filters can increase employee silica dust exposures due to the agitating action of the vacuum and incomplete filtration of fine dust particles. Employers should choose vacuum filter media carefully.

Module 3 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Which of the Hierarchy of Controls strategies are used to eliminate or reduce silica dust hazards?**

    a. Administrative controls
    b. Engineering controls
    c. Work practice controls
    d. OSHA-mandated controls

2. **What is the most effective method for controlling airborne silica dust because it controls the exposure at its source?**

    a. Dry methods
    b. Wet methods
    c. Containment methods
    d. Dust suppression methods

3. **Vacuum dust collection systems for _____ include a shroud, hose, filters and a vacuum to pull air through the shroud.**

    a. drilling
    b. cutting
    c. sanding
    d. grinding

4. **What methods increase the distance between the employee and the point of work to reduce silica dust exposure?**

    a. suppression
    b. containment
    c. isolation
    d. ventilation

5. **Which of the following should not be used as the primary method for managing silica dust?**

    a. Fans
    b. ventilation
    c. water
    d. vacuums

Module 4: Administrative and Work Practice Controls

If engineering controls are not sufficient to reduce exposure limits below OSHA's PEL, it may be necessary to use administrative and work practice controls that focus on controlling worker behaviors rather than physical hazards of silica dust.

Administrative Controls

It's always important to include administrative controls no matter what your control strategies are. Policies, program, plans, processes, and procedures all play an important part in making sure the exposure control program functions as intended. Here are some basic guidelines for an effective program:

- First, develop a written silica dust exposure control program and a respiratory protection plan.
- Write policies, processes, procedures and safe work practices to control worker behaviors and reduce exposure to silica dust.
- Develop policies that require the use of respirators if engineering controls are not sufficient to lower exposure levels adequately.
- Ensure exposed employees are taught how to properly use and maintain respirators.
- Provide medical examinations for employees who may be exposed to respirable crystalline silica, as recommended by NIOSH, and have X-rays read by a specialist in dust diseases. Develop a plan for reducing exposures of employees whose X-rays show changes consistent with silicosis.
- Report all cases of silicosis to state health departments and to the Mine Safety and Health Administration (MSHA), and record cases on OSHA logs, as required.
- Post warning signs to identify work areas where respirable silica is present.
- Develop effective corrective and preventive equipment maintenance programs to reduce silica exposures and ensures optimal operation of the equipment.
- Inspect equipment regularly during the workshift. Equipment and dust control devices should be on a routine maintenance schedule.

Operation and Maintenance

Operate and maintain all equipment in accordance with manufacturer's instructions to minimize dust emissions.

Water Flow Rate

For tasks performed using wet methods, apply water at flow rates sufficient to minimize the release of visible dust.

Dust Collection Systems

When using commercially available shrouds and dust collection systems with any equipment, the following should be met:

- Dust collectors should provide at least 25 cubic feet per minute (cfm) of airflow per inch of wheel diameter, and
- have filters with 99% or greater efficiency and cyclonic pre-separators or filter-cleaning mechanisms.

Exhaust Systems

For tasks performed indoors or in enclosed areas, provide a means of exhaust as needed to minimize the accumulation of visible airborne dust.

Work While in Enclosed Cabs or Booths

For measures implemented that include an enclosed cab or booth, ensure that the enclosed cab or booth:

- is maintained as free as practicable from settled dust;
- has door seals and closing mechanisms that work properly;
- has gaskets and seals that are in good condition and working properly;
- is under positive pressure maintained through continuous delivery of fresh air;
- has intake air that is filtered through a filter that is 95% efficient in the 0.3-10.0 micro meter range (e.g., MERV-16 or better); and
- has heating and cooling capabilities.

Respiratory Protection and Assigned Protection Factor (APF)

Assigned Protection Factor (APF) means the workplace level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a continuing, effective respiratory protection program. When required by OSHA

for reducing exposure to silica dust using the above equipment discussed in this module, using respiratory protection with an APF of 10 is required.

Maximum Use Concentration (MUC) means the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator. The MUC is determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance.

The MUC for respirators is calculated by multiplying the APF for the respirator by the PEL. The MUC is the upper limit at which the class of respirator is expected to provide protection. Whenever the exposures approach the MUC, then the employer should select the next higher class of respirators for the employees.

For more information on APFs and MUCs, refer to OSHA Publication 3352-02, Assigned Protection Factors (pdf).

Best Practices for Cutting

- **All saws:** When possible, make sure they are equipped with integrated water delivery systems that continuously feed water to the blade.
- **Handheld saws:** In addition to water delivery systems, use respiratory protection with an Assigned Protection Factor (APF) when using handheld power saws as follows:
    - when working outdoors for longer than four hours per shift
    - always when working indoors in an enclosed area
- **Fiber-cement handheld saws**: When using handheld saws for cutting fiber-cement board outdoors, use saws equipped with commercially available dust collection system. If the above requirements are met, respiratory protection is not required.
- **Walk-behind saws**: In addition to water delivery systems, use respiratory protection with an Assigned Protection Factor (APF) when using handheld power saws as follows:
    - when working outdoors for longer than four hours per shift
    - always when working indoors in an enclosed area
- **Drivable saws:** For outdoor tasks only, use with integrated water delivery system that continuously feeds water to the blade. When this requirement is met, no respiratory protection is required when working outdoors.

Best Practices when Drilling

- **Rig-mounted core saws or drills:** Use tool equipped with integrated water delivery system that supplies water to cutting surface. When adequate water delivery systems are used, no respiratory protection is required.

- **Handheld and stand-mounted drills** (including impact and rotary hammer drills). Use drills equipped with commercially available shrouds or cowlings with dust collection systems. Use HEPA-filtered vacuums when cleaning holes. When these requirements are met, no respiratory protection is required.

- **Dowel drilling rigs for concrete:** (For outdoor use only). Use shrouds around drill bits with dust collection systems. Use HEPA-filtered vacuums when cleaning holes. Always use respiratory protection with a Minimum Assigned Protection Factor (APF) during the work shift.

- Vehicle-mounted drilling rigs for rock and concrete. Two primary best practices are recommended by OSHA:

    - Use dust collection systems with close capture hoods or shrouds around drill bits with a low-flow water sprays to wet the dust at discharge points from the dust collectors, or

    - Operate the equipment from within enclosed cabs and use water for dust suppression on drill bits.

      When either of these two requirements has been met, no respiratory protection is required.

Best Practices for Hammering

- **Jackhammers and handheld powered chipping tools:** Two primary strategies may be used to reduce exposures:

    - Use tools with water delivery systems that supply a continuous stream or spray of water at the point of impact.

    - Use tools equipped with commercially available shrouds and dust collection systems.

  For both strategies, when used outdoors, and when exposure is less than or equal to 4 hours during the workshift, respiratory protection is not required. However if exposure is greater than 4 hours during the work shift, AFP 10 respiratory protection is required.

When used indoors, AFP 10 respiratory protection is always required. This strategy may be used indoors or outdoors.

Best Practices for Blasting

- **Handheld abrasive blasting equipment:** Several strategies are possible for blasting tasks:
    - Use less toxic abrasive material like ground walnut shells or plastic beads.
    - Use abrasives that can be delivered with water (slurry) to reduce dust.
    - Use barriers and curtain walls to isolate the blasting operation.
    - Use exhaust ventilation systems in containment structures to capture dust.

Always use appropriate HEPA-filtered vacuuming. If exposed to silica dust levels above the action level, be sure to use appropriate air supplied respirators.

Best Practices for Grinding

- **Handheld grinders for mortar removal (i.e., tuckpointing):** Use grinders equipped with commercially available shrouds and dust collection systems. Always use AFP 10 respiratory protection when using this equipment.
- **Handheld grinders for uses other than mortar removal:** There are two primary control strategies used to reduce exposures:
    - When used outdoors only, use grinders equipped with integrated water delivery systems that continuously feed water to grinding surfaces, or
    - Use grinders equipped with commercially available shrouds and dust collection systems.

  When the requirements of either of these two strategies are met while working outdoors, no respiratory protection is required. If working indoors or enclosed areas for more than for more than 4 hours per work shift, use APF 10 respiratory protection.
- **Walk-behind milling machines and floor grinders:** Two strategies for this equipment may be used:
    - Use machine equipped with integrated water delivery system that continuously feeds water to the cutting surface, or
    - Use machines equipped with dust collection system recommended by the manufacturer.

When used indoors or enclosed areas, use a HEPA-filtered vacuum to remove loose dust in between passes.

When the above requirements for walk-behind milling machines and floor grinders are met, respiratory protection is not required.

Best Practices when Milling

- **Small drivable milling machines** (less than half-lane): Use a machine equipped with supplemental water sprays designed to suppress dust. Water must be combined with a surfactant. When this requirement is met, respiratory protection is not necessary.
- **Large drivable milling machines** (half-lane and larger): For cuts of any depth on asphalt only, use machines equipped with exhaust ventilation on drum enclosures and supplemental water sprays designed to suppress dust. For cuts of four inches in depth or less on any substrate:
    - Use machines equipped with exhaust ventilation on drum enclosures and supplemental water sprays designed to suppress dust, or
    - Use a machine equipped with a supplemental water-surfactant spray system designed to suppress dust.

Best Practices when Crushing

- Use equipment designed to deliver water spray or mist for dust suppression at crusher and other points where dust is generated (e.g., hoppers, conveyers, sieves/sizing or vibrating components, and discharge points).
- You may also use a ventilated booth that provides fresh, climate-controlled air to the operator, or a remote control station.

When the above methods for crushing are used, no respiratory protection is required.

Best Practices when Abrading, Fracturing, or Demolition

Abrading or fracturing includes hoe-ramming and rock-ripping.

- Operate equipment from within an enclosed cab.
- When employees outside of the cab are engaged in the task, apply water and/or dust suppressants as necessary to minimize dust emissions.

Best Practices When Grading and Excavation

These best practices include equipment used for grading and excavation, but not including equipment used for abrading, demolishing, or fracturing silica-containing materials.

- Apply water and/or dust suppressants as necessary to minimize dust emissions, or
- When the equipment operator is the only employee engaged in the task, operate equipment from within an enclosed cab.

When the above requirements for grading and excavation are met, no respiratory protection is required.

Module 4 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **If engineering controls are not sufficient to reduce exposure limits below OSHA's PEL, it may be necessary to _____.**

    a. use temporary mandatory controls
    b. use administrative and work practice controls
    c. stop work until effective engineering controls are used
    d. hire a competent person to devise solutions

2. **Administrative and work practice controls focus on controlling _____.**

    a. hazard severity
    b. engineering design
    c. worker behaviors
    d. the level of production

3. **What is the APF value required for respirators when they are used for reducing exposure to silica dust?**

    a. 5
    b. 10
    c. 50
    d. 1000

4. **Which of the following is an engineering control for limiting exposure while using a hand-held blasting equipment?**

    a. Use abrasives delivered with oil
    b. Use natural ventilation systems or fans
    c. Stand upwind to limit exposure to dust
    d. Use less toxic abrasive material like ground walnut shells

5. **OSHA requires employers to use engineering controls first, if possible to reduce exposure to silica dust. Which control strategy is an engineering control for limiting exposure while blasting?**

    a. Use abrasives delivered with water
    b. Use exhaust ventilation systems
    c. Use barriers or curtain walls to isolate the hazard
    d. Use less toxic abrasive material like ground walnut shells

Module 5: Alternative Exposure Control Methods

Under OSHA's silica dust rule, for tasks not discussed in the previous module, or where the employer does not fully and properly implement the engineering controls, work practices, and respiratory protection as listed, the employer should use the below alternative exposure control methods.

Permissible Exposure Limit (PEL)

The employer should make sure no employee is exposed to an airborne concentration of respirable crystalline silica in excess of 50 micro grams per cubic meter ($\mu g/m^3$), calculated as an 8-hour Time Weighted Average (TWA). In other words, the average exposure to silica dust should not exceed 50 ug/m^3 during the full work shift.

Exposure Assessment

The employer should assess the exposure of each employee who is or may reasonably be expected to be exposed to respirable crystalline silica at or above the action level of 25 micrograms per cubic meter ($\mu g/m^3$) using one of the following two methods:

- **Performance Option:** The employer should assess the 8-hour TWA exposure for each employee on the basis of any combination of air monitoring data or objective data sufficient to accurately characterize employee exposures to respirable crystalline silica, or
- **Scheduled Monitoring Option:** The employer should perform initial monitoring to assess the 8-hour TWA exposure for each employee on the basis of one or more personal breathing zone air samples that reflect the exposures of employees on each shift, for each job classification, in each work area.
    - **Representative Sampling:** Where several employees perform the same tasks on the same shift and in the same work area, sample a representative fraction of the employees.
    - Sample the employee(s) who are expected to have the highest exposure to respirable crystalline silica.
        - If employee exposures are below the action level, discontinue monitoring for those employees.

        - If employee exposures are at or above the action level but at or below the PEL, repeat monitoring within six months of the most recent monitoring.
        - If employee exposures are above the PEL, repeat monitoring within three months of the most recent monitoring.
    - If the most recent (non-initial) monitoring shows employee exposures are below the action level, the employer should repeat the monitoring within six months until two consecutive measurements, taken seven or more days apart, are below the action level. At this time, the employer may discontinue monitoring for those employees unless reassessment is required.

- **Reassessment of Exposures**: The employer should reassess exposures whenever the following happen:
    - a change in the production, process, control equipment, personnel, or work practices may reasonably be expected to result in new or additional exposures at or above the action level, or
    - when the employer has any reason to believe that new or additional exposures at or above the action level have occurred.
- **Methods of sample analysis:** The employer should ensure all samples are taken to satisfy the monitoring requirements discussed above. Samples must be evaluated by a laboratory meeting the requirements of 1926.1153, Appendix A.
- **Employee notification of assessment results:** Within five working days after completing an exposure assessment, individually notify each affected employee of the results.
    - Written notification can be given to each employee or posted in an appropriate location accessible to all affected employees.
    - If exposure is above the PEL, the employer should describe the corrective action being taken to reduce employee exposure to or below the PEL.
- **Observation of Monitoring:** Where air monitoring is performed, the employer should give affected employees or their designated representatives an opportunity to observe any monitoring. When observation of monitoring requires entry into an area where the use of protective clothing or equipment is required:
    - the employer should provide the observer with protective clothing and equipment at no cost, and

- make sure the observer uses such clothing and equipment.

- **Methods of compliance:** The employer should use engineering and work practice controls to reduce and maintain employee exposure to respirable crystalline silica to or below the PEL, unless the employer can demonstrate such controls are not feasible.

Wherever engineering and work practice controls are not sufficient to reduce employee exposure to or below the PEL, the employer should:

- still use them to reduce employee exposure to the lowest feasible level, and

- supplement them with approved respiratory protection.

The employer should comply with other OSHA standards, such as 29 CFR 1926.57 Ventilation, where abrasive blasting is conducted.

Electrical Safety

When using wet methods with electrical equipment of any kind, be sure to use ground-fault circuit interrupters (GFCIs) and watertight, sealable electrical connectors. These features are particularly important to employee safety in wet or damp areas, such as where water is used to control dust.

Although an assured equipment grounding conductor program is an acceptable alternative to GFCIs, OSHA recommends employers use GFCIs where possible because they afford better protection for employees.

Click on the link for more information on OSHA's Ground-Fault Protection on Construction Site page.

Freezing Temperatures

Freezing temperatures complicate the use of water. Consider heating the local work area, if practical, to prevent ice from forming in the water-feed system.

Drain the system when not in use. Large portable heating units are commonly used to heat commercial and sometimes road and highway projects.

Module 5 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **The average exposure to silica dust should not exceed _____ ug/m3 during a full work shift.**

   a. 10
   b. 25
   c. 50
   d. 100

2. **The employer should assess the exposure of each employee who be exposed to respirable crystalline silica at or above the action level of _____ µg/m3.**

   a. 5
   b. 15
   c. 20
   d. 25

3. **When sampling for exposure to silica dust, what may the employer do if several employees perform the same tasks on the same shift and in the same work area?**

   a. Sample a representative fraction of the employees.
   b. Sample each of the several employees.
   c. Sample only employees with an average exposure.
   d. Sample random employees at the beginning of the workshift.

4. **What should the employer do if engineering and work practice controls are not sufficient to reduce employee exposure to or below the PEL?**

    a. Emphasize administrative controls.
    b. Eliminate or substitute engineering controls.
    c. Modify them with reduced workshift lengths.
    d. Supplement them with approved respiratory protection.

5. **What should the employer do when using wet methods with electrical equipment of any kind to limit exposure to silica dust?**

    a. Ensure approved surfactants are added to water.
    b. Ensure water runoff does not enter the ground.
    c. Use ground-fault circuit Interrupters (GFCIs).
    d. Reduce or limit water pressure to 150 pounds/square inch.

Module 6: Respiratory Protection

As you know by now, cutting, drilling, and grinding without using engineering controls can cause exposure to respirable silica to reach much higher than the OSHA PEL.

The level of respiratory protection needed depends on the employee's silica exposure, which varies due to:

- factors in the work environment (such as enclosed, semi-enclosed, or open spaces and/or multiple operations generating silica dust),
- environmental conditions (such as wind direction and speed), and
- the percentage of silica found in the material.

The good news is respiratory protection should not be necessary when using effective wet methods. In situations where wet methods may not be appropriate or feasible, vacuum dust collection may be an alternative control option.

However, vacuum dust collection alone does not reduce exposure sufficiently. Therefore, to supplement this control option, employees need to wear a properly fitted, NIOSH-approved half-facepiece or disposable respirator equipped with an N-, R-, or P-95 filter. A half-facepiece or disposable respirator can be used for exposures up to 1.0 mg/m3.

General Requirements

Respiratory protection is required where specified by Table 1 in OSHA's 29 CFR 1926.1153, or where the employer does not fully and properly implement the engineering controls, work practices, and respiratory protection described in the table:

- Where exposures exceed the PEL during periods necessary to install or implement feasible engineering and work practice controls;
- Where exposures exceed the PEL during tasks and engineering and work practice controls are not feasible; and
- During tasks when engineering and work practice controls are not sufficient to reduce exposures to or below the PEL.

Specified Exposure Control Methods

For the tasks listed in 29 CFR 1926.1153, Table 1, if the employer fully and properly implements the engineering controls, work practices, and respiratory protection described in Table 1, the employer should be considered to be in compliance with:

- the requirements for selection of respirators, and
- with regard to exposure to respirable crystalline silica.

Housekeeping

The employer should not allow dry sweeping or dry brushing when it could contribute to employee exposure to silica dust unless wet sweeping, HEPA-filtered vacuuming or other methods that minimize the likelihood of exposure are not feasible.

- The employer should not allow compressed air to be used to clean clothing or surfaces where such activity could contribute to employee exposure to respirable crystalline silica unless:
    - the compressed air is used in conjunction with a ventilation system that effectively captures the dust cloud, or
    - no alternative method is feasible.
- Exposed surfaces should be as free as practicable of silica- containing dust (bulk samples of the dust may need to be collected).
- Wet sweeping should be used to clean areas if possible.
- If vacuuming is used for cleaning, the exhaust air should be properly filtered to prevent the release of airborne silica back into the workroom.
- There should be separate break areas for consuming food, beverages, etc. that are kept free of silica.

Respiratory Protection Plan

In any workplace where respirators are necessary or required, the employer should establish and implement a written respiratory protection plan with worksite-specific procedures and elements listed below:

- Employers should conduct exposure monitoring periodically while controls are being used to ensure that the controls are working properly and that the appropriate level of

respiratory protection is being used. Other employees working close to where silica dust is generated may also need respiratory protection if effective controls are not implemented.

- The components of an effective Respiratory Protection Program include:
    - procedures for selecting respirators for use in the workplace
    - medical evaluations required for respirator use
    - fit testing procedures for tight-fitting respirators
    - procedures for proper respirator use
    - procedures and schedules for cleaning and otherwise maintaining respirators
    - procedures for atmosphere-supplying respirator proper operation
    - training in respiratory hazards during routine and emergency situations
    - training in the proper respirator use, limitations and maintenance
    - procedures for evaluating respirator program effectiveness

For more information on respiratory protection, review 29 CFR 1910.134 and OSHA's Respiratory Protection eTool.

Medical Surveillance

The employer should make medical surveillance available at no cost to the employee, and at a reasonable time and place, for each employee who will be required to use a respirator for 30 or more days per year.

- **Initial examination**: Employees should get an initial (baseline) medical examination by a physician or Licensed Health Care Professional (PLHCP) within 30 days after initial assignment, unless they have received an examination that meets OSHA requirements within the last three years. The examination should consist of:
    - a medical and work history,
    - a physical examination with special emphasis on the respiratory system;
    - a chest X-ray, interpreted and classified by a NIOSH-certified B Reader;
    - a pulmonary function test, 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.

- **Information Provided by the PLHCP**: The employer should give the examining PLHCP a copy of related OSHA standards and the following information:
  - A description of the employee's former, current, and anticipated duties;
  - The employee's former, current, and anticipated levels of exposure to respirable crystalline silica;
  - A description of any personal protective equipment used or to be used by the employee, including when and for how long the employee has used or will use that equipment; and
  - Information from records of employment-related medical examinations.
- **PLHCP Report to Employee**: The PLHCP should explain the results of the medical examination to the employee and give them a written medical report within 30 days of the examination.
- **PLHCP's Opinion for the Employer:** The PLHCP should give the employer a written medical opinion within 30 days of the examination.
- **Employer Report to Employees:** The employer should give each employee a copy of the written medical opinion within 30 days of each medical examination performed.
- **Additional examinations:** If the PLHCP believes an employee should be examined by a specialist, the employer should schedule a medical examination within 30 days.

Communicating Hazards

The employer should include respirable crystalline silica in the Hazard Communication program (29 CFR 1910.1200).

- Each employee should have access to labels on containers of crystalline silica and safety data sheets, and be trained in accordance with the provisions of OSHA's Hazard Communication Standard (HCS).

- The employer should ensure at least the following hazards are addressed: Cancer, lung effects, immune system effects, and kidney effects.

Employee Information and Training

The employer should make sure each affected employee demonstrates knowledge and understanding of at least the following:

- The health hazards associated with exposure to respirable crystalline silica;
- Specific tasks in the workplace that could result in exposure to respirable crystalline silica;
- Specific measures the employer has implemented to protect employees from exposure to respirable crystalline silica, including engineering controls, work practices, and respirators to be used;
- The contents of 29 CFR 1926.1153;
- The identity of the competent person designated by the employer; and
- The purpose and a description of the medical surveillance program.

Recordkeeping

- **Air monitoring data**: The employer should make and maintain an accurate record of all exposure measurements taken to assess employee exposure to respirable crystalline silica. Employer exposure records should be maintained and made available to employees upon request.
- **Objective data:** The employer should make and maintain an accurate record of all objective data relied upon to comply with OSHA requirements.
- **Medical surveillance:** The employer should make and maintain an accurate record for each employee covered by medical surveillance.

Module 6 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **What is required by OSHA where the employer does not meet the requirements detailed in 29 CFR 1926.1153, Table 1?**

    a. Respiratory protection
    b. Wet methods
    c. Dry methods
    d. Administrative controls

2. **What must employers do if they their workplace requires the use of respirators?**

    a. Look for visible silica dust outdoors
    b. Require employees to purchase respirators
    c. Establish a respiratory protection plan
    d. Ensure safety committee inspections

3. **How soon should employees get an initial (baseline) medical examination after initial assignment?**

    a. immediately
    b. 10 days
    c. 15 days
    d. 30 days

4. **How soon should the employer give each employee a copy of the written medical opinion following the initial assignment and medical examination?**

    a. 10 days
    b. 30 days
    c. 45 days
    d. 90 days

5. **If employees are exposed to silica dust on worksites, the employer should include information on respirable crystalline silica in the _____ .**

    a. Hazard Communication Program
    b. Fire Prevention Plan
    c. Accident Investigation Program
    d. OSHA Evaluation Process

Endnotes

1. NIOSH Silica Controls for Construction, NIOSH, Retrieved from: http://www.cdc.gov/niosh/topics/silica/constructioncontrolmain.html

2. Model Silica Specifications, CPWR/NIOSH, Retrieved from: http://www.cpwr.com/sites/default/files/publications/CPWR%20Model%20Silica%20Specifications-2014.pdf

3. Safety and Health Topics, Silica, Crystalline, OSHA, Retrieved from: https://www.osha.gov/dsg/topics/silicacrystalline/index.html

4. Operating Handheld Masonry Saws, OSHA, Retrieved from: https://www.osha.gov/Publications/silica/OSHA_FS-3627.pdf

5. Operating Stationary Masonry Saws, OSHA, Retrieved from: https://www.osha.gov/Publications/silica/OSHA_FS-3631.pdf

6. Operating Handheld Grinders, OSHA, Retrieved from: https://www.osha.gov/Publications/silica/OSHA_FS-3628.pdf

7. Operating Rotary Hammers, OSHA, Retrieved from: https://www.osha.gov/Publications/silica/OSHA_FS-3630.pdf

8. Operating Vehicle Mounted Rock Drills, OSHA, Retrieved from: https://www.osha.gov/Publications/silica/OSHA_FS-3633.pdf

9. Jackhammering, OSHA, Retrieved from: https://www.osha.gov/Publications/silica/OSHA_FS-3629.pdf

10. Tuckpointing/Motar Removal, OSHA, Retrieved from: https://www.osha.gov/Publications/silica/OSHA_FS-3632.pdf