Silicosis: Learn the facts!

What is silicosis?
Silicosis is a disabling and often fatal lung disease caused by breathing dust that contains very small pieces of crystalline silica. The fine particles stay in the lungs, causing damage and scar tissue.

Inhalation of silica dust has been associated with other diseases such as bronchitis and tuberculosis. The lung damage can also lead to heart failure, and some studies indicate an association with lung cancer.

The disease is still around despite long-standing knowledge of its cause and methods for controlling it. There is no cure, but silicosis is 100 percent preventable if employers, workers, and health professionals work to reduce exposures.

Facts

- Since 1968, thousands of American workers have died from silicosis.
- In the U.S. each year, more than a hundred workers die of silicosis while hundreds more become disabled.
- Many workers with silicosis are only in their thirties, with some even younger. Many are unable to take care of themselves and their families.

Types of silicosis
Three types of silicosis can develop, depending on the duration of worker exposure and the airborne concentration of silica dust:

- **Acute silicosis** can occur after only weeks or months of exposure to very high levels of crystalline silica. Symptoms can develop within a few weeks or up to 5 years. Death occurs within months. The lungs drown in their own fluids.

- **Accelerated silicosis** results from exposure to high levels of crystalline silica, and occurs 5 to 10 years after exposure.

- **Chronic silicosis** usually occurs after 10 or more years of exposure to low concentrations of crystalline silica. This is the most common type of silicosis.

Symptoms and complications of silicosis
Exposure to dust that contains microscopic particles of crystalline silica can cause scar tissue to form in the lungs, which reduces the lungs’ ability to extract oxygen from the air. Initially, there may be no symptoms. Eventually, workers may have difficulty breathing and may experience coughing. Infections can cause fever, weight loss, and night sweats.

Chronic silicosis may go undetected for years in the early stages. In fact, a chest X-ray might not reveal a problem until after 15 or 20 years of exposure. The body’s ability to fight infections can be overwhelmed by silica dust in the lungs, which places the victim at risk for other illnesses. As silicosis progresses, workers may exhibit one or more of the following symptoms:

- shortness of breath following physical exertion,
- severe cough,
- fatigue,
- loss of appetite,
- weight loss,
- night sweats,
- chest pains,
- respiratory failure, and
- fever.

These symptoms can become worse over time, leading to death. Victims of silicosis also put their families and loved ones at risk because lung infections such as tuberculosis can be spread by coughing, sneezing, or talking around spouses, children, and other loved ones.

**Case studies**

The following case studies illustrate some exposure incidents. As these cases show, workers who do not perform typical “at risk” jobs (such as abrasive blasting), as well as workers who use personal protective equipment, can still suffer from silicosis.

A tile-installer was diagnosed with advanced silicosis, emphysema, and asthma at age 49. Although he didn’t directly perform risky tasks, he worked near sandblasting and was exposed to silica dust. He never wore a respirator. (Note that tile installers can also be directly exposed to silica dust when cutting tile.)

A 39-year-old sandblaster was diagnosed with progressive silicosis and tuberculosis. He had reported shortness of breath, wheezing, and lack of energy. He had worked for 22 years sandblasting welds during water tank construction, and wore a charcoal filter respirator while sandblasting. However, it was the wrong type and did not protect him.

A 36-year-old man died from advanced silicosis after working as a sandblaster for 11 years. He had been exposed to silica dust for only three years while sandblasting oil field pipes and tanks.

A 30-year-old sandblaster died 10 years after his first exposure to silica dust. He had been exposed to silica dust for only four years.

**Definition of crystalline silica**

Silica refers to silicon dioxide (SiO2), which occurs in crystalline and noncrystalline form. Silica is the second most common mineral in the earth’s crust and is a major component of sand, rock, and mineral ores. In nature, quartz is the most common form. In fact, the term quartz is often used in place of the term crystalline silica. Typical sand found at the beach does not pose a silicosis threat because the sand grains are too large to form a dust which could be inhaled.

Because quartz is a common component of soil and rocks, workers are potentially exposed to quartz dust in many occupations and industries. Burning agricultural waste or products such as rice hulls may also cause noncrystalline silica to become crystalline.

Crystalline silica is found in concrete, masonry, sandstone, rock, paint, and other abrasives. It can also be in soil, mortar, plaster, and shingles. The cutting, breaking, crushing, drilling, grinding, or abrasive blasting of these materials may produce fine silica dust.

Airborne silica dust becomes trapped in the lungs during normal breathing. Even dust that is not visible can cause harm. As the dust builds up in the lungs, the damage can make breathing more difficult.

**Workers at risk**

More than 100,000 American workers encounter high-risk silica exposures through sandblasting, rock drilling, and mining. In addition, at least 1.7 million American workers are potentially exposed to crystalline silica dust which is small enough to be inhaled (referred to as respirable crystalline silica). Many are exposed to concentrations that exceed limits defined by current regulations and standards. Workers who remove paint and rust, work with stone or clay, and work in construction are also at risk.

Finally, an unknown portion of the 3.7 million U.S. agricultural workers may be exposed to dust containing a significant percentage of respirable crystalline silica.
Exposure during construction

The construction industry has one of the highest numbers of deaths from silicosis. Most crystalline silica comes in the form of quartz. Common sand can be as much as 100% quartz, while concrete and masonry products contain quartz in the form of sand. Therefore, construction sites have many possible routes of exposure.

Working in any dusty environment where crystalline silica is present can increase the chance of getting silicosis. If a number of workers are in a dusty environment, and one is diagnosed with silicosis, the others should be examined to see if they are also developing problems.

Other occupations with exposure

Workers in a variety of industries and occupations may be exposed to crystalline silica because there are so many uses of materials and products containing it. A study by Occupational Safety and Health Administration (OSHA) compliance officers found respirable quartz in 6,779 personal samples (8-hour time weighted average) taken in 255 industries that were targeted for inspection (excluding mining and agriculture). In 48% of the industries, average overall exposure exceeded the Permissible Exposure Limit (PEL) for respirable silica.

Five industries in which workers were exposed to concentrations at least 10 times the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) include:

- Masonry and plastering,
- Heavy construction,
- Painting and paper hanging,
- Iron and steel foundries, and
- Metal services.

Many industries include potential risk for exposure. Workers in the following occupations are at risk for developing silicosis:

- Agriculture;
- Building construction, demolition, and repair;
- Ceramics, clay, and pottery;
- Concrete finishing;
- Demolition of concrete and masonry structures;
- Drywall finishing;
- Foundry work (grinding, moldings, shakeout, core room);
- Glass manufacturing;
- Highway and bridge construction and repair;
- Manufacturing and use of abrasives;
- Manufacturing of soaps and detergents;
- Masonry work;
- Mining; and
- Railroad (setting and laying track).
In addition, workers who are not in the above occupations but perform any of the following tasks are also at risk for breathing silica dust:

- Abrasive blasting of concrete, or using silica sand;
- Chipping, hammering, drilling, sawing, or grinding of rock, concrete, or masonry;
- Crushing, loading, hauling, and dumping rock;
- Dry sweeping or pressurized air blowing of concrete or sand dust;
- Jackhammering on various materials;
- Removing paint and rust with power tools;
- Rock crushing (for road base);
- Rock drilling;
- Sand and gravel screening; and
- Stone cutting (sawing, abrasive blasting, chipping, grinding).

**Preventing silicosis: Start by educating employees**

The key to preventing silicosis is to prevent dust from being in the air. OSHA requires that administrative or engineering controls be used whenever possible. A simple control may work, such as a water hose to wet dust down at the point of generation. Respirators should only be used after dust controls are in place. Respirators should not be the primary method of protection. When respirators are used, OSHA requires employers to establish a comprehensive respiratory protection program.

Steps that employers can take to educate workers include:

- Explain the health effects of breathing air that contains silica dust.
- Remind employees to avoid working in dust whenever possible.
- Know what causes silica dust at your workplace.
- Point out that even where no dust is visible, employees could still be at risk. If dust is visible, workers are almost definitely at risk.

Ensure that employees practice good personal hygiene at the workplace:

- Do not eat, drink, or use tobacco products in dusty areas.
- Wash hands and face before eating, drinking, or smoking outside dusty areas.
- Park cars where they will not be contaminated with silica.
- Change into disposable or washable work clothes at the worksite.
- Shower (if possible) and change into clean clothes before leaving the worksite to prevent contamination of other work areas, cars, and homes. When employees wear dusty clothing at home or in the car, they can carry silica dust that their families will breathe.

All workers breathing crystalline silica dust should have a medical examination. Medical examinations include a chest X-ray, a pulmonary function test, and an annual evaluation for tuberculosis.

**Steps employers can take to protect workers**

Employers can take a number of measures to prevent exposure to silica dust. First, use engineering controls to reduce silica dust levels, and make sure the controls are properly maintained. Also, make sure employees report systems that aren’t working properly.
Minimize dust by following good work practices, such as removing dust with a water hose or vacuum with a high-efficiency particulate filter rather than blowing with compressed air, or by wet sweeping instead of dry sweeping.

Ensure that workers wear, maintain, and correctly use approved particulate respirators when engineering controls alone are not adequate to reduce exposures below permissible levels. Beards and mustaches interfere with the respirator seal to the face, making most respirators ineffective.

Substitute less hazardous materials for abrasive blasting. If you must sandblast, use type CE positive pressure abrasive blasting respirators.

Have employees participate in air monitoring, medical surveillance, and training programs.

Provide workers with the results of air sampling done at your worksite.

**Engineering and administrative controls**

As noted above, administrative or engineering controls must be evaluated first. For general work, consider the following measures to protect employees:

- When sawing concrete or masonry, use saws that provide water to the blade.
- During rock drilling, use water through the drill stem to reduce the amount of dust in the air.
- Use dust collection systems which are available for many types of dust generating equipment.
- Minimize exposures to nearby workers by using good work practices.
- Use abrasives containing less than 1% crystalline silica during abrasive blasting to prevent harmful dust from being released in the air.
- Measure dust levels in the air.

When working in confined structures, reduce the amount of silica dust by using water sprays and ventilation. For example:

- Use a dust control system and keep it in good maintenance.
- Use local exhaust ventilation to prevent dust from being released into the air.
- Use a water hose to wet dust before it becomes airborne.
- Use saws that add water to the blade.
- Use drills that add water through the stem or have dust collection systems.
- Use blast cleaning machines or cabinets to control dust.

If controls cannot keep dust levels below acceptable levels, then respirators should be used. In this case, the employer must provide a properly fitted and selected respirator (e.g. particulate filter or airline supplied air respirator) designated for protection against crystalline silica.

Keeping respirators fit for use requires continual maintenance. Respirators will only provide a satisfactory level of protection when they are selected, fitted, used, and maintained according to the manufacturer’s written instructions, NIOSH approval limitations and guidelines, and OSHA regulatory requirements.

Workers who use tight-fitting respirators cannot have beards or mustaches because they do not let the respirator properly seal to the face. Sandblasting or abrasive blasting requires the highest level of protection, which is a type CE abrasive blasting respirator.

**Abrasive blasting**

Because abrasive blasting has one of the highest potentials for exposure to silica dust, NIOSH recommends the following for all abrasive-blasting operations:
1. Silica sand should not be used as an abrasive medium.

2. Respirators should not be the only means of preventing or minimizing exposures to airborne contaminants. Dust source controls such as containment systems, local exhaust systems, and good work practices should be implemented as the primary means of protecting workers. When dust source controls cannot keep exposures below the recommended exposure limits, controls should be supplemented with respiratory protection.

3. Environmental monitoring by trained personnel should be conducted in all abrasive-blasting applications. This is necessary to select the proper respirator (assigned protection factor, or APF) and insure that workers are not overexposed (i.e., measured contaminant concentration is less than the exposure limit multiplied by the respirator APF).

4. When environmental conditions, airborne contaminants, or their concentrations are highly variable or poorly defined, high level respiratory protection should be used, even if silica is not the abrasive agent.

5. If silica sand is used, only the highest level protection respirators (i.e., respirators certified by NIOSH as pressure-demand or positive pressure and with NIOSH recommended APFs of 1000 or 2000) should be used.

Choosing and using respirators

When engineering controls such as enclosures or ventilation are not feasible, or while such controls are being implemented, respirators must be used to reduce workers’ occupational exposure to airborne contaminants.

According to 29 CFR 1910.134(a)(1), respiratory protection must be used “in the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fumes, fogs, gases, smoke, sprays, mists, or vapors.” Further, 29 CFR 1910.134(a)(2) states that “Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee.”

Choosing the right respirator that fits snugly is important for protecting employee health. Always use NIOSH-approved respirators. The type of respirator needed depends on the amount of silica dust exposure and the kind of work to be performed.

Respirators used for protection from crystalline silica should not cause undue discomfort. If employees have problems with their respirators, they should report immediately to their supervisor.

Types of respiratory protection

<table>
<thead>
<tr>
<th>Protection given</th>
<th>Respirator type</th>
</tr>
</thead>
<tbody>
<tr>
<td>No protection</td>
<td>Covering your face with a cloth such as a bandana or T-shirt will not provide protection. Filtering facepiece respirators (dust masks) provide minimal protection.</td>
</tr>
<tr>
<td>Least protection</td>
<td>Half-face mask air-purifying respirators with replaceable N-95 (or higher) filters. Full-face mask air-purifying respirator with replaceable N-95 (or higher) filters.</td>
</tr>
<tr>
<td>More protection</td>
<td>Powered air purifying respirator equipped with full facepiece and high efficiency particulate filters using battery-powered motors to filter the air. Supplied-air respirator (SAR) equipped with full facepiece in pressure-demand or other positive pressure mode.</td>
</tr>
<tr>
<td>Most protection</td>
<td>Type CE abrasive-blasting respirator (SAR), operated in a pressure demand or other positive pressure mode. This is the only respirator that can be used for abrasive blasting.</td>
</tr>
</tbody>
</table>

Because each worker’s environment is different, and the amount of occupational exposure varies, an exposure determination should be completed before selecting a respirator. The minimum respiratory protection for an employee who is working with crystalline silica dust, but is not doing abrasive-blasting, may be an N-95 NIOSH-approved respirator. However, the exposure to crystalline silica must not exceed the assigned protection factor of the respirator.
Workers have a significant risk of developing chronic silicosis when they are exposed to respirable crystalline silica over a working lifetime at the current OSHA permissible exposure limit (PEL), the MSHA PEL, or the NIOSH recommended exposure limit (REL). This means that even if employees are not exposed above “legal” limits, they may still be at risk.

**Medical evaluations**

Although the reported deaths associated with silicosis have declined over the past several decades, many still occur. In addition, the number of deaths related to silicosis among persons aged 15 to 44 has not declined. An unknown number of workers also continue to die from silica-related diseases such as pulmonary tuberculosis and lung cancer. The number of cases of silicosis and silica-related diseases in the United States today is unknown.

Symptoms of acute silicosis may develop shortly after exposure to high concentrations of respirable crystalline silica. Most studies focus on chronic silicosis, which develops years after exposure to relatively low concentrations. These studies have found that chronic silicosis may develop or progress even after occupational exposure has ceased. Over a 40- or 45-year working lifetime, workers have a significant chance (at least 1 in 100) of developing silicosis when exposed at the OSHA PEL, the MSHA PEL, or the NIOSH REL.

If you believe employees are overexposed to silica dust, have them consult 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 they have silicosis. NIOSH recommends that medical examinations occur before job placement or upon entering a trade, and at least every three years thereafter.

**OSHA and MSHA regulations**

OSHA enforces a permissible exposure limit, which is the maximum amount of airborne crystalline silica that an employee may be exposed to during an eight-hour work shift. MSHA enforces its own exposure limits, has rules requiring controls for drills, and requires air sampling in certain situations. However, as noted above, employees can still be at risk even if their exposure is within regulatory limits.

Other relevant OSHA and MSHA regulations include: respiratory protection, posting of warning signs, housekeeping, recordkeeping or reporting of occupational illnesses, abrasive blasting, personal protective equipment, and training. OSHA also has rules on hazard communication, safety and health programs in construction, and access to employee exposure and medical records.

The following list of standards includes those that may, under appropriate inspection conditions, be cited for crystalline silica overexposure.

<table>
<thead>
<tr>
<th>OSHA Requirement</th>
<th>General Industry Standard</th>
<th>Construction Standard</th>
</tr>
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<tbody>
<tr>
<td>Respiratory protection</td>
<td>1910.134</td>
<td>1926.103</td>
</tr>
<tr>
<td>Permissible exposure limit and controls</td>
<td>1910.1000</td>
<td>1926.55 &amp; .57</td>
</tr>
<tr>
<td>Accident prevention &amp; warning signs</td>
<td>1910.145</td>
<td>1926.200</td>
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<tr>
<td>Access to employee exposure and medical records</td>
<td>1910.1020</td>
<td>1926.33</td>
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<tr>
<td>OSHA 300 forms</td>
<td>1904</td>
<td>1904,1926.22</td>
</tr>
<tr>
<td>Abrasive blasting, breathing air, enclosures, controls</td>
<td>1910.94</td>
<td>1926.28, .55, .95, .100, .101, .102, .103, and .300</td>
</tr>
<tr>
<td>Hygiene</td>
<td>1910.141</td>
<td>1926.27 and .51</td>
</tr>
<tr>
<td>General PPE</td>
<td>1910.132</td>
<td>1926.28, .95, .100-.105</td>
</tr>
<tr>
<td>Hazard Communication</td>
<td>1910.1200</td>
<td>1926.59</td>
</tr>
<tr>
<td>Safety and Health program</td>
<td>--</td>
<td>1926.20</td>
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<tr>
<td>General training</td>
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<td>1926.21</td>
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What you need to know

What can employers do to prevent silicosis? The following list provides a guide for implementing silicosis prevention at your worksite, and summarizes the issues addressed above.

1. Make a commitment to prevent silicosis at your worksites.

2. Comply with OSHA and MSHA regulations on respirable crystalline silica. If employees are overexposed, reduce exposure levels through engineering controls. While these controls are being installed, or if they are being repaired, provide appropriate respiratory protection.

3. Establish a written respiratory protection program. Outfit employees with appropriately selected, properly fitted, approved respirators when engineering controls alone do not keep exposures within safe levels. Be sure respirators are kept clean and properly maintained, and that employees are trained in their use.

4. Perform air monitoring as needed and when required by law, and take corrective action when silica levels are excessive. Monitoring provides a basis for:
   - selecting and ensuring the effectiveness of engineering controls,
   - selecting proper respiratory protection,
   - seeing if work practices to reduce dust levels are effective, and
   - determining if a medical surveillance program is necessary.

5. Install and maintain engineering controls to eliminate or reduce the amount of silica in the air and the build-up of dust on equipment and surfaces. Examples of controls include: exhaust ventilation and dust collection systems, water sprays, wet drilling, enclosed cabs, and drill platform skirts. Practice preventive maintenance because the extreme abrasiveness of silica dust can damage the systems you install.

6. Substitute less hazardous materials for abrasive blasting when possible. Try to use automatic blast cleaning machines or cabinets that allow operating the machines from outside using gloved armholes.

7. Supply vacuums with high-efficiency particulate air (HEPA) filters, and advise employees to vacuum, hose down, or wetsweep work areas instead of dry sweeping or blowing with compressed air.

8. Make sure workers know what operations and materials present a silica hazard. Train them about:
   - health effects, engineering controls, and work practices that reduce dust;
   - the importance of good housekeeping and hygiene (to protect them and their families); and
   - the proper type and fitting of respirators.

9. 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.

10. Report all cases of silicosis to state health departments and to MSHA, and record cases on OSHA logs, as required.

11. Post warning signs to identify work areas where respirable silica is present.
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