Background and Health Impacts

What is crystalline silica?

Crystalline silica is a common mineral found in many naturally occurring materials and used in many industrial products and at construction sites. Materials like sand, concrete, stone and mortar contain crystalline silica. Crystalline silica is also used to make products such as glass, pottery, ceramics, bricks, concrete and artificial stone. Industrial sand used in certain operations, such as foundry work and hydraulic fracturing (fracking), is also a source of crystalline silica exposure. Amorphous silica, such as silica gel, is not crystalline silica.

How can exposure to crystalline silica affect workers' health?

Inhaling very small ("respirable") crystalline silica particles, causes multiple diseases, including silicosis, an incurable lung disease that can lead to disability and death. Respirable crystalline silica also causes lung cancer, chronic obstructive pulmonary disease (COPD), and kidney disease.

Who is at risk from exposure to crystalline silica?

Around 2.3 million workers are exposed to crystalline silica on the job. Simply being near sand or other silica-containing materials is not hazardous. The hazard exists when specific activities create respirable dust that is released into the air.

Respirable crystalline silica – very small particles typically at least 100 times smaller than ordinary sand found on beaches or playgrounds – is generated by high-energy operations like cutting, sawing, grinding, drilling and crushing stone, rock, concrete, brick, block and mortar; or when using industrial sand. Activities such as abrasive blasting with sand; sawing brick or concrete; sanding or drilling into concrete walls; grinding mortar; manufacturing brick, concrete blocks, or ceramic products; and cutting or crushing stone generates respirable dust.

What is the relationship between silica exposure and lung cancer?

There is strong scientific evidence showing that exposure to respirable crystalline silica can increase a person's risk of developing lung cancer. The World Health Organization's International Agency for Research on Cancer – the leading international voice on cancer causation – and the National Institutes of Health's National Toxicology Program have conducted extensive reviews of the scientific literature and have designated crystalline silica as a **known human carcinogen**. The American Cancer Society has adopted the WHO and NIH's determinations.

More than 50 peer-reviewed epidemiological studies that OSHA evaluated for this rulemaking have examined the link between silica exposure and lung cancer in at least 10 industries. In particular, several studies of workers in specific industrial sectors support the link between exposure to respirable crystalline silica and lung cancer among workers.

How will the crystalline silica rule protect workers' health?

The new rule requires that employers use engineering controls − such as ventilation and wet methods for cutting and sawing crystalline silica-containing materials − to reduce workers' exposure to silica dust. Once the full effects of the rule are realized, OSHA expects it to prevent 600 deaths a year from silica-related diseases – such as silicosis, lung cancer, other respiratory diseases and kidney disease – and to prevent more than 900 new cases of silicosis each year.

Need for a Silica Rule

Why is OSHA issuing a new crystalline silica rule?

OSHA's previous permissible exposure limits (PELs) for silica were outdated, inconsistent and did not adequately protect worker health. The previous PELs were based on studies from the 1960s and earlier that did not reflect more recent scientific evidence showing that low-level exposures to silica cause serious health effects, including lung cancer. In the 45 years since the previous PELs were established, the U.S. National Toxicology Program, the International Agency for Research on Cancer, and the National Institute for Occupational Safety and Health have all identified respirable crystalline silica as a human carcinogen. Previous construction and shipyard PELs were based on an old method of measuring worker exposures to silica that is not used today. Those previous limits are inconsistent, allowing permissible levels for construction and shipyards to be more than twice as high as levels in general industry. The revised rule will reduce the risk of disease among workers who inhale respirable crystalline silica and provide the same protection for all workers covered.

There is evidence of a decline of silicosis cases in recent years. Why is the rule necessary if the silicosis problem in the U.S. seems to be going away?

Silicosis deaths have declined in recent years but the problem remains serious. From 2005 through 2014, silicosis was listed as the underlying or a contributing cause of death on over 1,100 death certificates in the United States,[1] but most deaths from silicosis go undiagnosed and unreported. Also, those numbers of silicosis deaths do not include additional deaths from other silica-related diseases such as COPD, lung cancer and kidney disease.

While the number of silicosis cases has declined over the past several decades, it is still a very serious workplace health problem. In fact, more workers died from silicosis in 2014 than in fires, or from being caught in or crushed by collapsing materials, such as in trench and structure collapses.[2]

---

[1] Centers for Disease Control and Prevention, National Center for Health Statistics. Multiple Cause of Death 1999-2014 on CDC WONDER Online Database, released 2015. Data are from the Multiple Cause of Death Files, 1999-2014, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Accessed at http://wonder.cdc.gov/mcd-icd10.html on Mar 7, 2016 2:33:51 PM

[2] Bureau of Labor Statistics (2014). Fatal occupational injuries by event or exposure for all fatal injuries and major private industrial sector, all United States, 2014. http://www.bls.gov/iif/oshwc/cfoi/cftb0294.pdf

Unless action is taken, new cases of silicosis could increase as workers are being exposed to respirable crystalline silica in some newer industries such as hydraulic fracturing and artificial stone countertop fabrication.

What is the new permissible exposure limit (PEL)?

The PEL limits worker exposures to 50 micrograms of respirable crystalline silica per cubic meter of air ($\mu g/m^3$), averaged over an eight-hour day. This level is the same for all workplaces covered by the standard (general industry/maritime and construction), and is roughly 50 percent of the previous PEL for general industry, and roughly 20 percent of the previous PEL for construction and shipyards.

The National Institute for Occupational Safety and Health (NIOSH) first recommended this exposure limit to OSHA over 40 years ago, and the American Public Health Association has also recommended that OSHA adopt this PEL. The American Conference of Governmental Industrial Hygienists recommends an even lower exposure limit of 25 $\mu g/m^3$ of air, averaged over an eight-hour day.

OSHA established a PEL of 50 $\mu g/m^3$ because the agency determined that occupational exposure to respirable crystalline silica at the previous PELs resulted in a significant risk of developing or dying from silicosis and dying from lung cancer, other lung diseases, or kidney disease, and that compliance with a 50 $\mu g/m^3$ PEL would substantially reduce that risk. OSHA also finds significant risk remaining at the new PEL, but considers a PEL of 50 $\mu g/m^3$ to be the lowest level that can reasonably be achieved through use of engineering controls and work practices in most affected operations.

Impacts on Industry

What industries will be affected by the rule?

The main industries affected include:

- Construction
- Glass manufacturing
- Pottery products
- Structural clay products
- Concrete products
- Foundries
- Dental laboratories
- Paintings and coatings
- Jewelry production
- Refractory products
- Landscaping
- Ready-mix concrete
- Cut stone and stone products
- Abrasive blasting in:
  - Maritime work
  - Construction
  - General industry
- Refractory furnace installation and repair
- Railroads
- Hydraulic fracturing for gas and oil
- Asphalt products manufacturing

How many workplaces will be affected by the rule?

Approximately 676,000 workplaces will be affected, including in construction and in general industry and maritime.

How many workers will be affected by the rule?

About 2.3 million workers are exposed to respirable crystalline silica in their workplaces. The majority of these workers, about 2 million, are in the construction industry.

What is the economic impact of the rule?

The rule is estimated to provide average annual net benefits over the next 60 years of $3.8 to $7.7 billion. The total annualized cost of the rule is just over $1 billion dollars.

The rule is expected to result in annual costs of about $1,524 for the average workplace covered by the rule. The annual cost to a firm with fewer than twenty employees will be less, averaging about $560.

Based on OSHA's analysis, the economic impact of the silica rule on most affected firms, including small businesses, will be minor.

Why does the total compliance cost of the rule appear to be so high?

The standards for general industry and construction are among the broadest that OSHA has issued, in terms of the number of industry sectors and establishments potentially affected. It potentially affects 2.3 million workers and 676,000 establishments. The costs are thus spread over a large number of affected establishments and workers.

OSHA's economic analysis indicates that the silica rule will not have a significant economic impact on firms, nor a significant effect on jobs due to implementation of the rules. The aggregate costs are more than offset by the potential benefits to society in terms of reduced costs associated with preventing silica-related illnesses and deaths.

How will the rule impact jobs?

According to a study conducted by Inforum, a well-recognized macroeconomics modeling firm based at the University of Maryland, the rule will have a negligible (but positive) net effect on overall U.S. employment.

How were small businesses included in design and evaluation of the rule?

OSHA consulted with small businesses through the normal Small Business Regulatory Enforcement Fairness Act (SBREFA) process and as part of its extensive analysis of the impacts on small businesses.

Before issuing its proposed silica rule, OSHA convened a Small Business Advocacy Review Panel in accordance with SBREFA. After issuing the proposed rule, OSHA gave members of the public, including small businesses, the opportunity to express their concerns about the

rulemaking through written comments, testimony at a public hearing, and submission of data and post-hearing briefs. OSHA considered all information it received from the SBREFA panel, in addition to comments and testimony on the proposed rule, to inform the final rule and evaluate its impacts on small businesses.

In Table VII-40 in the preamble to the rule, OSHA addresses nearly 50 recommendations from small business representatives. Many of these resulted in changes to the rule or underlying cost, benefit, and economic analysis.

Rule Requirements

How can silica exposures be controlled to keep exposure at or below the PEL?

Employers must use engineering controls and work practices as the primary way keep exposures at or below the PEL.

- Engineering controls include wetting down work operations or using local exhaust ventilation (such as vacuums) to keep silica-containing dust out of the air and out of workers' lungs. Another control method that may work well is enclosing an operation ("process isolation").

- Examples of work practices to control silica exposures include wetting down dust before sweeping it up or using the water flow rate recommended by the manufacturer for a tool with water controls.

- Respirators are only allowed when engineering and work practice controls cannot maintain exposures at or below the PEL.

For construction, the standard includes Table 1, a list of common construction tasks along with exposure control methods and work practices that work well for those tasks and can be used to comply with the requirements of the standard.

Why can't silica-exposed workers just wear respirators all the time?

Respirators are not as protective as engineering controls, and they aren't always as practical either. Unless respirators are selected for each worker, individually fitted and periodically refitted, and regularly maintained, and unless filters and other parts are replaced as necessary, workers will continue to be exposed to silica. In many cases, workers using only respirators would also have to wear more extensive and expensive protection. Even when respirators are selected, fitted, and maintained correctly, they must be worn consistently and correctly by workers to be effective. Respirators can also be uncomfortable, especially in hot weather, and cannot be used by some workers.

What is Table 1: "Specified Exposure Control Methods When Working with Materials Containing Crystalline Silica"?

Table 1 is a flexible compliance option that effectively protects workers from silica exposures. It identifies 18 common construction tasks that generate high exposures to respirable crystalline silica and for each task, specifies engineering controls, work practices, and respiratory protection that effectively protect workers. Employers who fully and properly implement the engineering controls, work practices, and respiratory protection specified for a task on Table 1 are not required to measure respirable crystalline silica exposures to verify that levels are at or below the PEL for workers engaged in the Table 1 task.

OSHA developed Table 1 in response to stakeholders in the construction industry, who indicated the need for guidance and a standard that is different than a standard for general industry. Among the concerns of construction industry stakeholders were the impracticality of exposure monitoring based on short duration of task and constantly changing conditions, such as weather, job sites and materials.

Are the air sampling methods used to detect and measure silica reliable?

Yes, worker exposures to silica at the new PEL and action level can be reliably measured using existing sampling and analytical methods. Moreover, to improve reliability of silica measurements, employers must ensure that their silica samples are analyzed by laboratories that meet the qualifications and use methods specified in Appendix A of the standard.

- OSHA has carefully reviewed the available science and expert testimony contained in the rulemaking record on the ability of modern sampling and analytical methods to reliably measure respirable crystalline silica at the new PEL and action level.

- Published OSHA, NIOSH, and MSHA methods for analyzing respirable crystalline silica are able to measure concentrations at the new PEL and action level with acceptable precision, based on analyses of quality control samples and on studies conducted when those methods were developed in the 1970s.

- There are high-flow dust samplers now available that can collect more airborne dust, and more silica, than other samplers commonly used. Collecting more dust means that laboratories can measure the amount of silica in the dust with greater precision.

Why are construction employers required to implement engineering and work practice controls a year before laboratories are required to meet specifications for analyzing air samples?

There are approximately 40 laboratories in the U.S. that already meet the sample analysis requirements in the final rule. Demand for laboratory analysis of construction industry samples is likely to be modest because OSHA expects most construction employers to implement the specified exposure control measures in Table 1; therefore they will not be required to conduct exposure assessments. The small portion of construction employers that do not implement Table 1 will need to perform air monitoring, but they will be able to obtain reliable measurements of their employees' exposures from those laboratories. Employers in general industry and maritime, who are required to conduct exposure assessments, have an additional year to come into compliance.

What is the purpose of medical surveillance?

The purpose of medical surveillance is, when reasonably possible, to:

- Identify adverse health effects associated with respirable crystalline silica exposure so that appropriate actions can be taken.
- Determine if an employee has any condition, such as a lung disease, that might make him or her more sensitive to respirable crystalline silica exposure,
- Determine the employee's fitness to use respirators.

In response to the information gained through medical surveillance, employees can take actions to improve their health, such as making job choices to reduce exposures, wearing a respirator for extra protection, or making personal lifestyle or health decisions, such as quitting smoking or getting flu shots.

Why are the results of medical surveillance only given to the worker and not the employer?

The employer receives the physician or other licensed health care professional's recommended limitations on respirator use, which is vitally important information that the employer needs to protect the worker because those who are not fit to wear a respirator but wear one can be at risk of sudden incapacitation or death.

Other findings of the medical examination are only given to the employee because many employees and physicians testified that if employers received the results of the examination, many employees would not participate in medical surveillance because they feared discrimination or retaliation.

Employers do not need medical findings because they should base employee protections on exposure levels and how well controls are working. On the other hand, employees need the results of medical examinations to manage their health.

Compliance Dates

When must employers comply with the standard for general/industry and maritime?

For all operations in general industry and maritime, other than hydraulic fracturing operations in the oil and gas industry:

- Employers are required to comply with all obligations of the standard, with the exception of the action level trigger for medical surveillance, by June 23, 2018.
- Employers are required to offer medical examinations to employees exposed above the PEL for 30 or more days a year beginning on June 23, 2018.
- Employers are required to offer medical examinations to employees exposed at or above the action level for 30 or more days a year beginning on June 23, 2020.

For hydraulic fracturing operations in the oil and gas industry:

- Employers are required to comply with all obligations of the standard, except for engineering controls and the action level trigger for medical surveillance, by June 23, 2018.
- Employers are required to comply with requirements for engineering controls to limit exposures to the new PEL by June 23, 2021. From June 23, 2018 through June 23, 2021, employers can continue to have employees wear respirators if their exposures exceed the PEL.
- Employers are required to offer medical examinations to employees exposed above the PEL for 30 or more days beginning on June 23, 2018.
- Employers are required to offer medical examinations to employees exposed at or above the action level for 30 or more days a year beginning on June 23, 2020.

Why is there a different compliance date for the hydraulic fracturing industry?

Because controls for respirable crystalline silica in hydraulic fracturing are still in development, the rule allows hydraulic fracturing employers additional time to implement engineering controls to take advantage of emerging technologies. Those employers do not have to implement engineering controls to limit exposures to the new PEL until June 23, 2021, three years later than other general industry and maritime employers. From June 23, 2018 to June 23, 2021, hydraulic fracturing employers can continue to have employees use respirators when exposures exceed the PEL.

When must employers comply with the standard for construction?

Employers are required to comply with all obligations of the standard (except methods of sample analysis) by June 23, 2017.

Employers are required to comply with methods of sample analysis by June 23, 2018.

State Plans and Compliance Assistance

Will states with OSHA-approved programs adopt the standards?

Yes. States with OSHA-approved state plans have six months to adopt standards that are at least as effective as Federal OSHA standards. Many state plans adopt standards identical to OSHA, but some state plans may have different or more stringent requirements.

What resources are available to help small businesses and other employers comply with the standards?

OSHA recognizes that most employers want to keep their employees safe and protect them from workplace hazards. We therefore provide extensive compliance assistance through our Compliance Assistance Specialists, website, publications, webinars, and training programs, many of which are geared toward small and mid-sized employers. For silica, OSHA will develop a Small Entity Compliance Guide, fact sheets and other compliance assistance resources. For more information, see the Crystalline Silica Rulemaking page.

OSHA's On-site Consultation Program provides professional, high-quality, individualized assistance to small businesses at no cost. This service, which is provided by consultants from state agencies or universities, is separate and independent from enforcement programs in federal or state OSHA's programs, and provides free and confidential workplace safety and health evaluations and advice to small and medium-sized businesses. In FY 2015, the On-site Consultation Program conducted more than 27,800 free visits to small and medium-sized business worksites, helping to remove more than 3.5 million workers from hazards nationwide.

Additional information about the silica rule is available at www.osha.gov/silica. The website provides additional information on the hazards of occupational exposure to silica with links to fact sheets and an updated silica safety and health topics page, and further explains the provisions of the final rule.

Can Silicosis Be Cured?

No. There is no known medical treatment to reverse silicosis or stop its progress. This disease can only be prevented by controlling exposure to silica dust. Workers who have been exposed to silica should stop smoking to reduce their risk of developing lung cancer.

Are There Other Potential Health Hazards Associated With Working in a Dental Lab?

Yes. They include the following:

☑ ***Bloodborne pathogens*** – Exposure to the agents that cause HIV, Hepatitis B, and C can occur when handling impressions and other items if contaminated with blood or saliva.

☑ ***Methyl methacrylate*** – Used in making dentures and plates, it can be absorbed into the body by inhalation, through the skin, and by ingestion. It is irritating to the eyes, skin, and respiratory tract. Repeated and prolonged exposure can cause skin sensitization and asthma, as well as adverse effects on the nervous system.

☑ ***Electroplating chemicals*** – The process of electroplating can release hazardous contaminants into the air that pose a variety of risks to the dental lab worker. The contaminants include various acid and alkaline mists that can cause respiratory and skin problems.

☑ ***Metals*** such as beryllium, chromium, cobalt, and nickel. These metals in alloys used for castings of bridge framework and other dental prosthesis components can cause a variety of lung problems.

☑ ***Repetitive motion disorders*** – A range of injuries to the muscles, tendons, nerves, ligaments and joints of arms, hands, wrists, shoulders, neck, and upper back. These injuries result from damage to the body over a period of time. If not treated they can result in chronic pain and permanent disability.

☑ ***Noise*** – grinding, sandblasting, and other dental lab machinery can make noise that may cause hearing loss.

☑ ***Chemical sterilants*** – These are used to sterilize impressions and prosthetic devices, received from dental offices, contaminated with blood and saliva. Sterilant chemicals include aldehydes, phenols, and quaternary ammonium compounds. These chemicals may cause lung problems and dermatitis.

Who Can I Contact for Additional Information?

If you have any questions about silicosis or need information about occupational health hazards in dental laboratories, please write, phone, e-mail, or fax your request as shown below:

NJ Department of Health & Senior Services
Occupational Health Surveillance Program
PO Box 360
Trenton, NJ 08625-0360

Phone: (609) 984-1863
e-mail: surveillance@doh.state.nj.us
Fax: (609) 292-5677

Visit our web site at www.state.nj.us/health/eoh/survweb

James E. McGreevey
Governor

Clifton R. Lacy, M.D.
Commissioner

What Dental Technicians Need to Know About Silicosis

Division of Epidemiology, Environmental and Occupational Health

What is Silicosis?

Silicosis is a disabling and incurable lung disease. However, **it is preventable!** Silicosis is caused by breathing in fine dust containing crystalline silica. Once in the lungs, this dust causes damage that stops the body from using oxygen properly. Breathing in dust containing crystalline silica has been linked to other diseases such as tuberculosis, kidney disease, and lung cancer.

Silicosis begins with few, if any, symptoms. Once present, these symptoms can include shortness of breath, severe cough, wheezing, and chest tightness. Silicosis can get worse even after exposure has stopped.

Do Dental Technicians Get Silicosis?

Yes. Silicosis has been diagnosed and confirmed in dental laboratory workers. One individual developed the disease after only six years of exposure.

What Tasks in a Dental Lab Cause Silica Exposure?

Casting – Exposure can occur when mixing investment materials and during divestment of castings. Investment materials often contain large amounts of cristobalite. Cristobalite is a very toxic form of crystalline silica.

Sandblasting – Sandblasting of castings can cause exposure to the investment material or the sand itself. Silica sand is often used to clean castings. It contains almost 100% crystalline silica. Exposure can also occur when the blasting box has leaks. Opening the door of the blasting box **before** the dust has settled or been removed by a dust collection system is dangerous.

Grinding porcelain – Silica content in porcelain varies. Exposure can occur when mixing porcelain powders or when grinding or polishing dried porcelain material.

Cleaning/Maintenance – Tasks that involve cleaning dusts that contain silica pose a major hazard if dust is raised. The same is true when maintaining local exhaust ventilation or dust collection systems.

Dental lab materials that contain silica:

- **sand**
- **investment materials**
- **porcelain**
- **shop dust**

How Can Exposure to Silica be Controlled in a Dental Lab?

Substitution – The ideal method to stop exposure is to eliminate materials containing crystalline silica. This method is most feasible for sandblasting media. Aluminum oxide is one of many acceptable substitutes.

Ventilation – When there are no good substitutes, dust exposure should be minimized through the use of local exhaust ventilation systems. These systems capture dust at its source and transport it to a dust collection system.

Respirators – The worker should wear a respirator when other control methods are missing or do not work. The type of respirator recommended is, **at a minimum**, a half-mask air-purifying respirator with type N-100 particulate filters.

Good housekeeping – Wet wiping, wet moping, and vacuuming with a HEPA vacuum are recommended. Dry sweeping, dry dusting, use of compressed air, and use of ordinary vacuum cleaners should be avoided because they reintroduce the dust into the air.

What Medical Tests Should I Have If I Think That I May Have Been Exposed to Silica?

In the case of silicosis, disease symptoms and clinical signs are usually delayed. They may not show up for as many as 20 years after the first exposure. If you think you have been exposed or begin to notice symptoms such as cough and shortness of breath, you should go to your doctor and explain your work history.

Your doctor should give you a medical exam that checks your respiratory system. This exam should include pulmonary function tests. You will also need a chest X-ray that should be read and evaluated by a certified "B-reader," a person trained to read X-rays showing silicosis. A skin test for tuberculosis is also recommended because people with silicosis are more susceptible to this disease. Additional information can be found in the factsheet, "*To My Doctor: What Physicians Need to Know about Occupational Silicosis and Silica Exposure Sources*." Call the Occupational Health Service or visit our web site. See back of brochure for details.