WHITE PAPER

The New OSHA Standard for Industrial Silica Exposure: Are You in Compliance?

Magnified silica dust

camfil
AIR POLLUTION CONTROL

By Mike Walters and Alex Wells

OSHA has issued a final rule that provides stronger protection for workers against the harmful effects of respirable crystalline silica dust. Silica is a common mineral found in products and materials used in many industries. If your processes produce dust, you may have a respirable silica dust hazard, and you need to determine if your facility is at risk. This white paper summarizes the impact of the new OSHA rule, how to achieve compliance, and the specific role of cartridge dust collection as a proven and reliable engineering control strategy.

The New OSHA Standard for Industrial Silica Exposure: Are You in Compliance?

By Mike Walters and Alex Wells

After years of study and research, the Occupational Safety and Health Administration (OSHA) has issued a new silica rule that updates regulations established in 1971. It features a lower limit for worker exposure to harmful respirable crystalline silica dust as well as more stringent measures to monitor compliance. OSHA estimates that the implementation of this rule will save more than 600 lives a year and prevent more than 900 cases of silicosis.

The new rule, which has an effective date of June 23, 2016, is comprised of two standards: one for the construction industry and one for general industry and maritime. This white paper will focus on the standard for general industry and will highlight the most significant aspects of the new standard; the detrimental health effects and how to determine if your workers are at risk; and the proper design and use of high efficiency dust collection as a recognized engineering control to achieve compliance.

High efficiency cartridge dust collector contains fugitive silica dust at a batching plant used in the manufacture of paving stones.

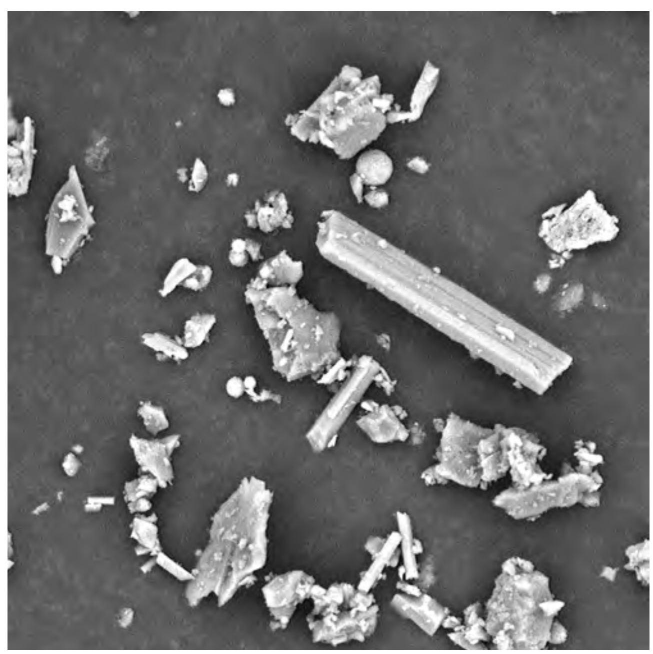


Photo of silica dust, magnified to 6000 times its original size, shows the jagged shape of the particles.

Silica is everywhere

Crystalline silica is one of the most abundant minerals on the planet. It is estimated that silica makes up 59 percent of the earth's crust and is found in nearly all known rocks. It has three main crystalline forms, of which quartz is by far the most prevalent. It is therefore not surprising that silica dust turns up in a wide range of industrial processes and applications.

These include but are not limited to abrasive blasting processes used in construction, maritime work and general industry; cement production; pottery, structural clay, stone and concrete products manufacturing; asphalt pavement manufacturing; foundry production; electronics manufacturing; production of abrasives, paints, soaps, and glass; shipbuilding; filtration in food and beverage production (where silica-containing diatomaceous earth is often used); and hydraulic fracturing.

Given silica's abundance in nature, exposure can sometimes exist where you least expect it. So even if your manufacturing operation does not fall into any of the above categories, there is still a chance you are at risk. To determine if your facility is at risk, a good starting point is to review the Material Safety Data Sheets (MSDS) for the materials that you are using. A standard MSDS will list hazardous ingredients in Section 2. The dust might be identified as crystalline silica, silicon dioxide, quartz, cristobalite or tridymite. Silicon carbide and fly ash are examples of substances that may contain respirable silica. The percentage of silica in the product will affect the OSHA exposure limit that you need to maintain.

Key Provisions of the Industrial Silica Rule

Significant aspects of the new rule are:

Reduced exposure limit: The new OSHA Permissible Exposure Limit (PEL) for respirable crystalline silica has been reduced to 50 micrograms per cubic meter of air, averaged over an 8-hour time-weighted average (TWA) work shift. This limit is two to five times stricter than the previous threshold limits of 100 micrograms per cubic meter of air for general industry and 250 micrograms for construction. The new more stringent PEL is expected to enhance worker protection by sharply reducing both short-term and long-term exposure to respirable silica dust.

Engineering controls: OSHA requires employers to use engineering controls such as water to keep the dust down, and/or dust collection (ventilation) to capture airborne particulate and keep worker exposure below the 50 microgram PEL. While engineering controls are the preferred approach, employers are required to provide personal respiratory protection when engineering controls are not able to limit exposures to the permissible level.

Exposure control plan: Employers are required to develop a written exposure control plan (hazard plan) to show how compliance will be achieved. The plan should also limit access to high-exposure areas and incorporate training of workers on silica risks and basic safety practices so they can recognize how to limit their own exposure.

Medical surveillance: Medical exams, lung health monitoring and recordkeeping are required for employees who have been identified as "highly exposed workers". Exposures above 25 micrograms per cubic meter in an 8-hour TWA over 30 days per year represents an action level where the medical surveillance is required. Effective engineering controls are often capable of maintaining silica dust concentrations below this action level.

Deadline for compliance: Companies in general industry have until June 23, 2018 to implement engineering controls and other requirements set forth in the new standard. Companies involved in hydraulic fracturing have until June 23, 2021 to comply.

Silica exposure and health risks

Respirable crystalline silica causes silicosis, a progressive and often fatal disease of the lungs and is also classified as a human carcinogen that causes lung cancer. Silica particles of 10 microns and less are small enough to enter the lungs when a worker breathes dust-laden air. These tiny silica particles have jagged edges that embed in the lungs and do not dissolve. Over time, the body's natural reaction is to create scar tissue or fibrosis over the embedded lung tissue, so the particles remain in the lungs and more layers of silica and scar tissue build up over years of exposure. This reduces the lungs' ability to extract oxygen from the air, creating difficulty breathing and eventually causing other symptoms such as fatigue, appetite loss, severe shortness of breath, chest pain and respiratory failure.

OSHA accepts several methods of air monitoring to determine worker exposure to silica dust – including personal air sampling as shown in photo.

Silicosis cannot be cured, so prevention – accomplished by minimizing human exposure – is the best and only strategy. Chronic silicosis usually occurs after 10 or more years of exposure, though acute silicosis may develop after short periods of exposure to very high levels of the dust. Exposure is also linked to an increased risk of lung cancer, tuberculosis, chronic obstructive pulmonary disease and kidney disease.

How to determine if you are in compliance

Are your workers exposed to harmful levels of silica? Wherever a process generates crystalline silica dust, OSHA states that air monitoring must be performed to determine a worker's 8-hour TWA exposure. Several different accepted methods of monitoring are listed in Appendix A of the ruling.

The role of cartridge dust collection

OSHA has stated in its general provisions that "the first and best strategy is to control the hazard at its source. Engineering controls do this, unlike other controls that generally focus on the employee exposed to the hazard." OSHA goes on to say that when a hazard cannot be removed or enclosed completely to isolate it from the workplace, the solution is to "establish barriers or local ventilation to reduce exposure to the hazard in normal operations". These principles apply not only to crystalline silica but to all hazardous dusts.

A well-designed dust collector is an accepted and proven engineering control that will filter hazardous contaminants to make indoor environments safer and healthier. Dry media dust collectors containing high efficiency cartridge filters along with HEPA secondary filters are the best control for respirable particulate, ensuring that it will not spread and be inhaled by workers in other areas of the plant.

The new OSHA crystalline silica PEL of 50 micrograms per cubic meter is achievable using this technology. Cartridge dust collectors with secondary HEPA filtration are effective in controlling hazardous dusts that have PEL limits of 5 micrograms per cubic meter, or 10 times lower than this limit.

Cutaway view shows airflow pattern through a typical cartridge dust collector.

The importance of dust testing

The collection and lab testing of dust samples is a long-established practice to help plant engineers and safety managers make informed dust collection decisions, especially where hazardous dusts are involved.

The first step of lab testing silica dust is particle size analysis. This allows proper selection of filter media with regard to the efficiency required at various particle sizes. Testing also determines moisture content of the dust, which can have an impact on the performance of a dust collector.

Silica is an inert mineral and therefore does not pose fire or explosion risks. As a result, in most applications it will not be necessary to test the dust for explosibility properties. However, if there is anything in the MSDS to indicate a mixed dust that may contain other combustible ingredients, you may need to request explosivity testing as stated in NFPA 652: Standard on the Fundamentals of Combustible Dust.

Dust collection system design considerations

There are many factors that impact the proper design of the dust collection system. Lab testing of dust samples, as noted above, can play an important role in guiding this design process by identifying the properties of the dust. Environmental factors also have an impact on equipment decisions. Here are the main points to consider as you set out to design a dust collection system for crystalline silica dust control:

Type of capture system: Source capture is the most effective control for dust emissions from any manufacturing process, whether the dust is hazardous like silica or just a nuisance. With source capture, some form of hood or enclosure is used to control the dust at the point of generation so it never has the chance to become airborne into the factory. Negative air pressure is maintained on the enclosures to help ensure containment of the dust. Ambient air cleaning systems, by contrast, work much like HVAC filtration where all the air in the room is cleaned from remote pick-up points. It is not considered a viable option for silica control because it does not prevent the dust from becoming airborne and dispersed throughout the work space. Workers would be required to wear personal protective equipment (PPE) at all times.

In a glass fabrication shop, high-speed silicon carbide belts are used to take sharp edges off cut glass. A source capture system conveys the silicon carbide and glass dusts directly to the adjacent collector.

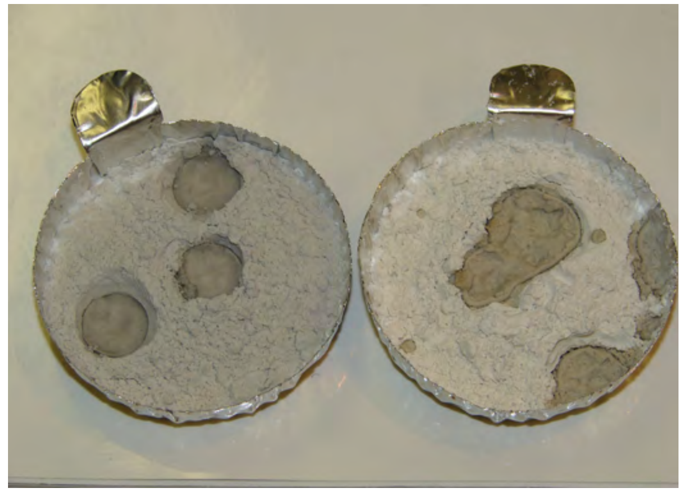
Particle size: Filter media efficiency performance is selected based on the dust particle size and distribution. For particles greater than 1.0 micron in size, a standard cellulose-polyester blend cartridge filtration media will usually suffice. But if very fine submicron particles are present, a higher efficiency media will be required. For these applications, a high efficiency nano fiber media can be a good option. When a layer of nano fibers is applied on top of the base filter media, the nano coating promotes surface loading of fine dust, preventing the fine dust from penetrating deeply into the base media and thereby reducing emissions.

A reputable filtration manufacturer should provide you with a written guarantee of emissions performance for the dust collection system you purchase, so it's a good idea to obtain that documentation. However, a manufacturer's guarantee does not constitute proof of compliance to OSHA: Air sampling must be performed, as above, to ensure that factory air is below the required threshold for silica exposure.

Particle shape: Silica dust is very abrasive due to the particles' sharp edges and jagged shapes. This is an important consideration, as the entire dust collection system must be designed for maximum resistance to abrasion to prevent operational problems and excessive wear and tear to components. The air inlet should be designed to slow down and uniformly distribute the airflow to prevent abrasive particles from entering the system at high velocity. If not accounted for, abrasive dust can cause enough wear over time that holes develop in the filter media, creating a leak path for harmful dust to escape into the workplace. Secondary HEPA filters are recommended in silica applications to protect the factory from very fine particulate emissions that may pass through the less efficient primary filters, and the pressure monitor will alert you to a leak due to wear.

The effects of moisture: Silica dust is hygroscopic, meaning it will absorb moisture from the air. It is not a difficult dust to collect if the air remains dry. If the air is moist or humid, however, the dust takes on the characteristics of mud and becomes packed in the filter pleats, reducing filter life. In some instances, where moisture is introduced for the intent of cooling, lubricating or otherwise aiding a process, a dry filter may not work. The authors recently encountered such an application where water was used in a granite-cutting process. Lab testing of a dust sample determined that dry dust collection was not a viable option because the process dust was simply too moist for cartridge filters to handle.

In northern climates with hygroscopic dust applications, condensation can cause problems with dry media filtration. Facilities in these climates are advised to locate the dust collector indoors or use a heater and/or insulated enclosure if the collector must be outside. Unless these precautions are taken, as warm moist air from indoors reaches the cold outdoor collector, water vapor will condense on all surfaces inside the collector including the filters and be absorbed by the dust, leading to premature filter failure.



Wetted silica dust takes on the characteristics of mud, as shown in these samples. A dry environment should be maintained whenever possible to prevent the muddy dust from clogging filters.

Air recirculation: Recirculating the air from a dust collector back into the factory has financial advantages. Recirculation can have a very positive impact on the bottom line, since it is the single best way to save energy and maximize return on investment with a dust collector. By recirculating heated or cooled air back through the building, you reduce the need for costly make-up air that's required when you vent the air outdoors. Facilities in all regions report five- to six-figure annual energy savings, with the greatest savings seen in northern climates which experience longer, colder winters. Recirculation also reduces the negative pressures in the facility that make doors hard to open and cause them to slam shut behind you as you move from one space to another.

HEPA safety monitoring filters are integrated on top of this dust collector, eliminating the costs of additional ductwork. Mounted downstream of the HEPA filters, the fan is protected against wear and tear from exposure to abrasive silica particles.

Recirculation requires secondary filtration to ensure that dust does not get into the factory. Secondary filters may be remotely mounted, which requires ducting to convey the air from the collector to the HEPA filters and into the factory. If an upset condition should occur, cleaning out a long duct run between the two stages of filtration is costly and time-consuming. Newer designs actually integrate the HEPA filters into or on top of the dust collector. This configuration prevents contamination of the return air ducting and the associated cost to clean the duct if a hazardous dust is leaked from the primary filters.

Fugitive silica dust, generated as material is poured into storage silos, is captured at the source and conveyed to an outdoor dust collector through this ductwork system.

Type of cartridge collector: Another design consideration involves the mounting position of the filter cartridges. Depending on the collector brand and type, filters may be installed horizontally or vertically. With horizontally-mounted systems, a heavy dust such as silica, a mineral with the density of rock, builds up on top of the filters and is not dislodged by pulse cleaning. To address this problem, manufacturers of dust collectors with horizontally-mounted cartridges recommend that you rotate the filters periodically. This unnecessarily increases employee exposure to silica dust. Vertical mounting allows the high density silica dust to release uniformly from the filter pleats, since it doesn't have to fight gravity. This reduces the load on the filters, helps extend filter life, and reduces exposure since the filter compartment only has to be opened when it is time to replace the filters.

Maintenance Practices

Even the longest-lasting filters need to be replaced eventually: Change-out is required when differential pressure through the system reaches the maximum level specified by the filter manufacturer. This is very important to ensure that filters are effectively controlling dust. Maintenance personnel must be trained in proper service procedures.

Prior to change-out, pulse the filters down to remove as much dust as possible and don't open the access door until the dust has had time to settle. Promptly after removing the used filters, place them in the same boxes in which the new filters were shipped and seal them to prevent dust from escaping. Insert the new filters and close up the system as quickly as possible. You can dispose of the boxed filters as regular (i.e., non-hazardous) waste.

Your dust collector should be equipped with a waste storage container such as a drum or bin. This storage container must be emptied regularly, or dust can back up into the hopper. Dust sitting in a hopper can affect performance adversely by clogging up the system and preventing the pulse-cleaning system from doing its job. If dust overflows from the hopper or the storage container onto the shop floor, it creates a potential health hazard to everyone in the workspace.

Finally, general housekeeping practices recommended by OSHA also include the use of water spraying to keep dust down, and/or cleaning with an ordinary shop vacuum to prevent dust from building up on floors and other surfaces before it can become airborne. Brushes, brooms, and compressed air systems should not be used because they will disperse dust particles into the atmosphere.

# # #

Mike Walters, PE, is senior manager of validation for Camfil Air Pollution Control (APC) and is a principal for the NFPA committee: "Handling and Conveying of Dusts, Vapors, and Gases (CMD-HAP)". Alex Wells is a lab test engineer for the company. Camfil APC is a global manufacturer of dust, mist and fume collection equipment and is part of Camfil, the largest air filter manufacturer in the world. For further information, contact 1-800-479-6801 or 1-870-933-8048; email ***filterman@camfil.com****; website* ***www.camfilapc.com.***

References

Occupational Safety & Health Administration (OSHA), 200 Constitution Avenue, Washington, DC 20210; www.osha.gov.

- OSHA 29 CFR Parts 1910, 1915, and 1926 Occupational Exposure to Respirable Crystalline Silica; Final Rule (2016) Crystalline Silica Exposure in General Industry (Health Hazard Training Document)
- Occupational Exposure to Respirable Crystalline Silica -- Review of Health Effects Literature and Preliminary Quantitative Risk Assessment (Docket OSHA-2010-0034)
- Safety & Health Management Systems eTool: Hazard Prevention and Control